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INDUSTRY-WIDE COMPETITIVENESS ASSESSMENT THROUGH FUZZY SYNTHETIC EVALUATION: THE CASE OF CEMENT INDUSTRY

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Abstract. This study aims to develop a fuzzy force assessment model (FFAM) for quantifying industry-wide competition conditions (CCs) using five-force framework. It employed fuzzy synthetic evaluation to assess CCs of forces and industry, and real case of Turkish cement industry was demonstrated. As a result, FFAM provides a comprehensive and practical device. As empirical findings, CCs in cement industry are medium-to-high, and pressure from substitutes is the most effective force, followed by intensity of competitors' rivalry, bargaining power of buyers, bargaining power of suppliers, and threat of entrants. Consequently, this study is first to propose a structured and fuzzy five-force quantification model and to assess CCs in cement industry.

Keywords: cement industry, competitive forces, competitiveness assessment, five forces, fuzzy sets, fuzzy synthetic evaluation, industry-wide competition, quantification model.

JEL Classification: L16, L61.

Introduction

Structural analysis of an industry is the key to understanding the current position, making relevant strategic analyses, and thereby, formulating competitive strategy (Porter 2008). Several approaches (i.e., supply-demand analysis, industrial organization economics, and value-net approach) have been introduced so far to map the competitive landscape of an industry (Ghemawat *et al.* 1999). Compared with these approaches, five-force framework postulated by Porter (1980) has wider acceptance due to its simplicity, adaptability, and flexibility (Chong *et al.* 2001). Here, competition conditions (CCs) in any industry depends on FFs as threat of new entrants, threat of substitutes, bargaining power of buyers, bargaining power of suppliers, and intensity of rivalry among existing competitors. However, this approach does not specify procedures for quantifying CCs. To date, it has been applied to many industries (Table 1).

Table 1. Force assessment methods in the previous studies

Author(s)	Industry	Method for force assessment			
		NA	SD	BS	MA
Thachenkary (1992)	Automobile dealership and lending	√			
Ramos and Thompson (1996)	Wine	√			
Sheppard (1996)	Physiotherapy	√			
Wiegmans *et al.* (1999)	Freight terminal	√			
McCosh (2003)	Hospital	√			
Oosthuizen (2003)	Management consulting	√			
Gold *et al.* (2004)	Agroforestry	√			
Gold *et al.* (2005)	Eastern red cedar			√	
Kumar *et al.* (2006)	Cosmetic	√			
Pines (2006)	Emergency medicine	√			
Braddorn and Hartley (2007)	Aerospace	√			
Hunter and Li (2007)	Furniture		√		
Oral and Mistikoglu (2007)	Brick			√	
Bollmann and Theuvsen (2008)	Brewing		√		
Hergeth (2008)	Fashion		√		
Bostrom and Wilson (2009)	Banking		√		
Houthoofd (2009)	Construction	√			
Wan and Bullard (2009)	Wood household furniture				√
Benson and Henderson (2011)	Tourism	√			
Hua (2011)	Education	√			
Lethbridge (2011)	Health	√			
Munir *et al.* (2011)	Mobile communication		√		
Oraman *et al.* (2011)	Food				√
Renko *et al.* (2011)	Bakery				√
Ross *et al.* (2011)	Mineral				√
Barutcu and Tunca (2012)	E-tailing	√			
Cernusca *et al.* (2012)	Elderberry	√			
Maumbe (2012)	Restaurant	√			
Perdana *et al.* (2012)	Smallholding teak		√		
Yasmin and Rabbanee (2012)	Real estate	√			
Akcagun and Dal (2013)	Apparel				√
Flemmig and Beikler (2013)	Periodontal care		√		

End of Table 1

Author(s)	Industry	Method for force assessment			
		NA	SD	BS	MA
Gao and Yoshida (2013)	Shipping		√		
Hin *et al.* (2013)	Medical tourism		√		
Kokwaro *et al.* (2013)	Bicycle taxis			√	
Pallapothu and Evans (2013)	Aquaculture				√
Spicka (2013)	Dairy		√		
Stroe (2013)	Engineering consulting and design	√			
Sumpio (2013)	Vascular surgery	√			
Yetkin (2013)	Maritime security	√			
Zhuang (2013)	Retail		√		
Zohrabi (2013)	Mineral water	√			
Hove and Masocha (2014)	SMEs	√			
Oduol and Franzel (2014)	Tree seedlings	√			
Ortega *et al.* (2014)	Collective urban transport		√		
Ostapenko (2014)	Farming		√		
Sutherland (2014)	Telecommunications	√			
Yunna and Yisheng (2014)	Shale gas		√		
Mathooko and Ogutu (2015)	University			√	
Ozer and Saldamli (2015)	Hotel	√			

Notes: NA: not available, SD: use of general sectoral data, BS: basic statistics (e.g., frequency, percentage, and standard deviation) of answers to questions that do not include FFs, MA: mean of answers to questions on FFs.

Any method for force assessment has not been employed in more than half of them (52%), but some general statements only. The remaining researches have used either general sectoral data (e.g., total production/sales/employment amounts) obtained from statistical yearbooks (28%), or basic statistical analyses (e.g., frequency and percentage) of answers to questions that do not include FFs (8%), or mean of answers to questions on FFs (12%). Given these techniques, it is seen that only the last one is based on direct quantititative measurement of FFs. However, it has some drawbacks as well. First, past studies that use this technique do not present any structured model that has some steps and a logical flow. Second and more importantly, this technique depends completely on classical (crisp) numbers used in respondents' judgments and solution process. However, in a real-world phenomenon, an evaluation of an object, especially an ill-defined one, is often vague and ambiguous. The evaluation is usually described in natural language terms, since a numerical evaluation is often too complex and too transient (Ulubeyli, Kazaz 2016). In this regard, fuzzy set theory presents a significant tool to properly model and interpret uncertainty or imprecision arising from subjective human perception (Ross 2010). Decision-making process on five-force principles similarly requires qualitative judgment and experiential knowledge of related experts and is multi-layered, complex, partial, and implicit in actual application. Therefore, the aim of the paper is to develop a fuzzy force assessment model (FFAM) for determining CCs of each force and industry-wide CCs, which will fill the theoretical gap. By means of fuzzy approach, related evaluations about five-force framework can be made more easily and precisely based on practitioners' qualitative judgments with linguistic terms. Thus, it assists practitioners to transform force assessment principles in linguistic terms into a more usable quantitative-based analysis using fuzzy sets. As a fuzzy approach, fuzzy synthetic evaluation (FSE) was adopted because it provides a systematic tool to deal with fuzzy multi-criteria data and information (Gorai *et al.* 2014). Lastly, industry-wide competition in cement industry has not been analyzed by FFs (Table 1), and this is the first attempt in this regard.

1. Methodology

1.1. Questionnaire

A self-administered questionnaire containing three sections was developed based on the theoretical foundation of five-force framework. Section 1 explored respondents' demographic profiles. Section 2 assessed participants' judgments on weights of FFs and their 33 sub-forces by five-point Likert-type scale from 1 (very unimportant) to 5 (very important). Section 3 measured those on CCs of each sub-force by five-point Likert-type scale from 1 (very light) to 5 (very severe).

1.2. Sampling and data collection

Target population was cement plants' top managers who are responsible for strategic management. As there are 70 factories in Turkish cement industry (TCMA 2015), respondent list contained 70 e-mail addresses to represent each plant by one manager for reflecting the specific strategic position of each plant equally. Hence, sixty (85.71%) of plants positively responded to survey request. Five (8.33%) of questionnaires were conducted face-to-face. Other ones were applied by e-mail. Number of manufacturers interviewed is statistically adequate since any return rate over 70% is excellent (Babbie 2007).

1.3. Data analysis

While developing FFAM proposed and applied to evaluate FFs and industry-wide CCs, FSE was applied. In doing this, to have a measure of consistency in weights as they are normalized, statistical tests that involve the calculation of Kendall coefficient of concordance (KCC) (Chan *et al.* 2001) for sub-forces and FFs were applied through SPSS. This ensured to observe the level of agreement among respondents in their estimates about weights. Lastly, a descriptive analysis was used to display participants' characteristics.

2. FFAM with a case study

Proposed FFAM in Figure 1 includes three steps: preliminary stage, sub-force evaluation stage, and overall force assessment stage.

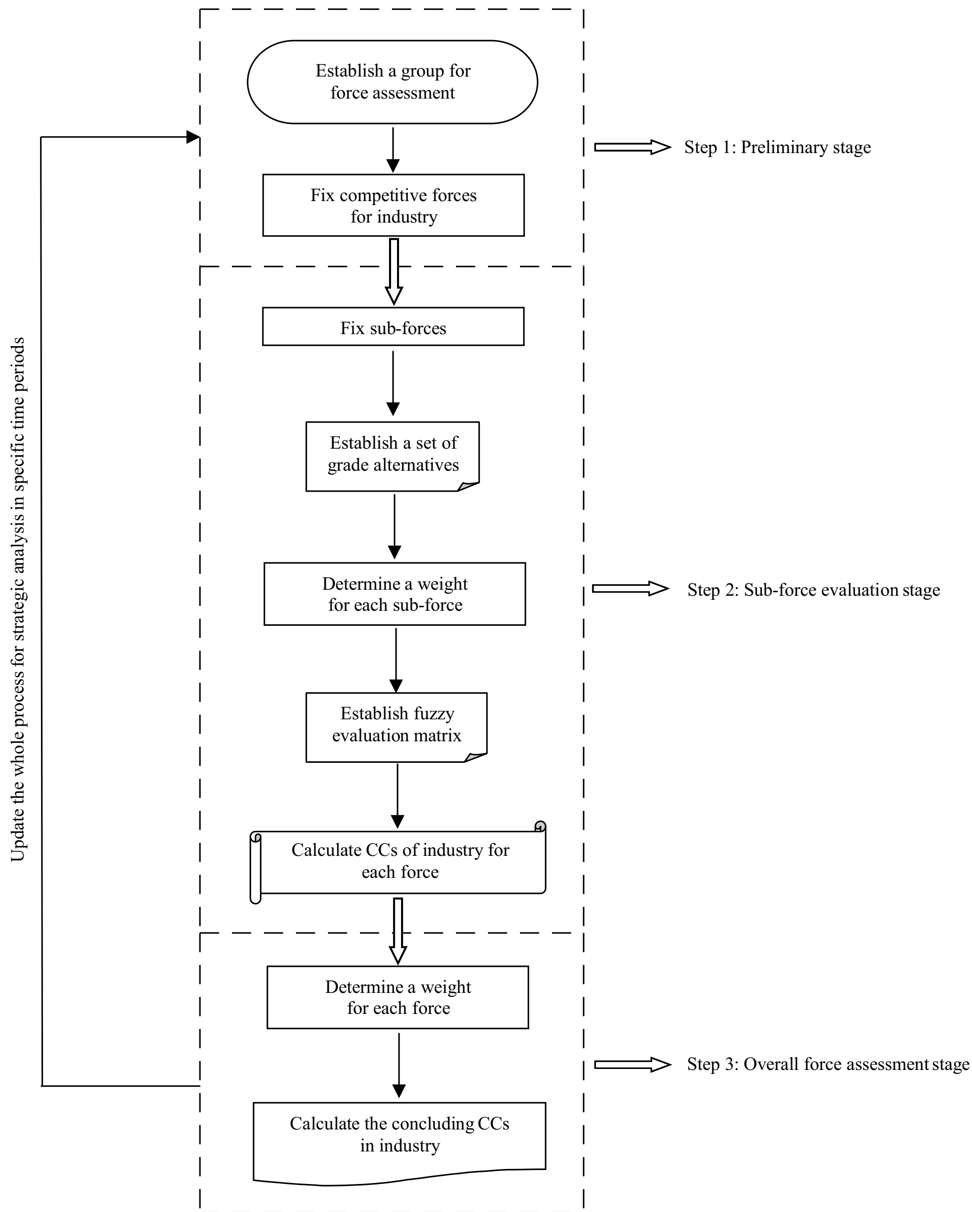

Fig. 1. FFAM for structural competition analysis of industry

To illustrate the procedure and applicability of FFAM and to validate it, a case study of Turkish cement industry is presented because the country is a strategic and key player in international cement markets. In 2014, it was the greatest producer in Europe and fifth leading producer in the world. In terms of cement exportation, third leading country in the world was Turkey (TCMA 2015). Thus, this industry has a significant position in national economy, and force assessment seems to be vital and updated in specific periods. However, it is difficult to measure and evaluate FFs owing to lack of practical and concrete data since FFs are qualitative in nature. Therefore, FFAM was established to assess FFs in industry-wide scale quantitatively.

2.1. Preliminary stage

2.1.1. Establish a group for force assessment

Members in a force assessment team (FAT) undertake the determination of FFs and sub-forces, comparison of relative importance both between FFs and between sub-forces, and evaluation of CCs of each sub-force. In this study, 85.71 percent of plant representatives comprised FAT which looked like a large-scale industry panel.

2.1.2. Fix competitive forces for industry

Force determination is a process in which CCs are investigated. Here, FAT fixes FFs only. However, FAT may modify FFs and/or add new ones. Current FAT approved FFs in Table 2.

Table 2. Fuzzy evaluation matrix and sub-force weightings

Forces	Sub-forces	Weightings of sub-forces			CCs in industry				
		Mean[1]	Rank	Weight	Very light	Light	Moderate	Severe	Very severe
Threat of new entrants[2]	Supply-side economies of scale	4.94	1	0.22	0.00	0.00	0,07	0.43	0.50
	Capital requirements	4.64	2	0.20	0.00	0.00	0.00	0.07	0.93
	Expected retaliation	3.84	3	0.17	0.00	0.00	0.02	0.18	0.80
	Government policy	2.71	4	0.12	0.00	0.00	0.03	0.12	0.85
	Cost disadvantages independent of scale	2.21	5	0.10	0.20	0.25	0.10	0.23	0.22
	Demand-side benefits of scale	1.89	6	0.08	0.05	0.47	0.33	0.15	0.00
	Access to distribution channels	1.79	7	0.08	0.32	0.35	0.25	0.08	0.00
	Customer switching costs	1.01	8	0.03	0.83	0.15	0.02	0.00	0.00

End of Table 2

Intensity of rivalry among existing competitors[3]	Numerous or equally balanced competitors	4.24	1	0.20	0.00	0.00	0.00	0.20	0.80
	Exit barriers	4.14	2	0.20	0.00	0.00	0.00	0.07	0.93
	Capacity augmented in large increments	2.52	3	0.12	0.00	0.02	0.08	0.68	0.22
	Strategic stakes	2.41	4	0.12	0.00	0.08	0.23	0.37	0.32
	Industry growth	2.21	5	0.10	0.10	0.55	0.23	0.10	0.02
	Diverse competitors	1.99	6	0.10	0.00	0.00	0.10	0.47	0.43
	Fixed or storage costs	1.71	7	0.08	0.12	0.23	0.27	0.25	0.13
	Differentiation or switching costs	1.69	8	0.08	0.30	0.40	0.30	0.00	0.00
Pressure from substitute products[4]	Switching costs	4.24	1	0.58	0.45	0.50	0.05	0.00	0.00
	Price performance	3.04	2	0.42	0.93	0.07	0.00	0.00	0.00
Bargaining power of buyers[5]	Impact on quality	4.89	1	0.22	0.00	0.00	0.02	0.53	0.45
	Volume	3.75	2	0.17	0.18	0.17	0.10	0.28	0.27
	Product differences	2.89	3	0.13	0.00	0.28	0.23	0.27	0.22
	Concentration	2.41	4	0.10	0.12	0.37	0.33	0.10	0.08
	Price/total purchases	2.21	5	0.10	0.35	0.33	0.32	0.00	0.00
	Switching costs	1.70	6	0.07	0.00	0.00	0.00	0.45	0.55
	Information	1.69	7	0.07	0.48	0.52	0.00	0.00	0.00
	Backward integration	1.69	8	0.07	0.95	0.05	0.00	0.00	0.00
	Substitute products	1.51	9	0.07	0.90	0.10	0.00	0.00	0.00
Bargaining power of suppliers[6]	Substitute inputs	4.89	1	0.30	0.00	0.00	0.00	0.53	0.47
	Switching costs	3.39	2	0.20	0.03	0.17	0.22	0.28	0.30
	Impact of inputs on cost or differentiation	2.89	3	0.17	0.20	0.17	0.23	018	0.22
	Importance of volume	2.51	4	0.15	0.42	0.45	0.13	0.00	0.00
	Concentration	2.31	5	0.14	0.43	0.40	0.07	0.08	0.02
	Forward integration	1.02	6	0.04	0.95	0.05	0.00	0.00	0.00

Notes: [1]Number (n) of samples = 60, [2]Kendall coefficient of concordance (KCC) = 0.324, [3]KCC = 0.403, [4]KCC = 0.467, [5]KCC = 0.398, [6]KCC = 0.415; [2,3,4,5,6] level of significance = 0.000.

2.2. Sub-force evaluation stage

FFs are evaluated depending on present CCs calculated by FSE. Procedures of FSE are as follows (Xu *et al.* 2010):

(a) A set of evaluation criteria $\pi = \{f_1, f_2, \ldots, f_m\}$ where m is the number of criteria or sub-forces is determined.

(b) A set of grade alternatives $E = \{e_1, e_2, \ldots, e_n\}$ where n is the number of alternatives or CCs is determined. Because of its extensive usage, a five-point Likert-type scale in a qualitative nature is defined to express criteria.

(c) Weight of each criterion is determined in a set of preference weights $W = \{w_1, w_2, \ldots, w_m\}$ where $\sum_i w_i = 1$.

(d) For each criterion, an evaluation is made via a fuzzy subset of grade set whose membership function is established by FAT based either on consensus or on mean of experts' answers as in this study. For example, if survey outcomes concerning CCs of a sub-force indicate that 20% of experts defined CCs as very light, 25% as light, 10% as moderate, 23% as severe, and 22% as very severe, membership function of CCs is given as follows,

$$f_1 = \frac{0.20}{\textit{very light}} + \frac{0.25}{\textit{light}} + \frac{0.10}{\textit{moderate}} + \frac{0.23}{\textit{severe}} + \frac{0.22}{\textit{very severe}} = \frac{0.20}{1} + \frac{0.25}{2} + \frac{0.10}{3} + \frac{0.23}{4} + \frac{0.22}{5}.$$

This function can also be expressed as (0.20, 0.25, 0.10, 0.23, 0.22). All evaluations constitute a fuzzy evaluation matrix $R = (r_{ij})_{m \times n}$ where r_{ij} is the degree to which the grade alternative e_j satisfies the criterion f_i.

(e) Results of FSE are acquired by calculating fuzzy composition of the weighting vector and fuzzy evaluation matrix. Final evaluation is made by a fuzzy subset (D) of alternative set as in Equation (1):

$$D = W \circ R, \tag{1}$$

where $\circ$ indicates a fuzzy composition operator. In fact, four composition operators can be employed to reach the results of evaluation as follows (Lo 1999),

Operator 1: $M(\wedge, \vee)$, $d_j = \vee_{i=1}^{m}(w_i \wedge r_{ij})$, $d_j \in D$;

Operator 2: $M(\cdot, \vee)$, $d_j = \vee_{i=1}^{m}(w_i \times r_{ij})$, $d_j \in D$;

Operator 3: $M(\cdot, \oplus)$, $d_j = \min\left(1, \sum_{i=1}^{m} w_i \times r_{ij}\right)$, $d_j \in D$;

Operator 4: $M(\wedge, +)$, $d_j = \sum_{i=1}^{m}\left(w_i \wedge r_{ij}\right)$, $d_j \in D$.

The symbol $\oplus$ in Operator 3 shows the total of product of weight and membership function. These four operators are suitable for different settings. Operators 1 and

2 can be applied for a single-item problem in which main criteria are considered and minor criteria are ignored. Operator 4 misses some information with smaller weights and has similar results to those derived from Operators 1 and 2. Operator 3 suits for the setting where many criteria are considered. Accordingly, Operator 3 is the best operator option.

(f) Fuzzy evaluation vector is normalized and CCs are calculated by Equation (2):

$$CCs_{overall} = \sum_{k=1}^{n} d_k \times e_k \,. \tag{2}$$

2.2.1. Fix sub-forces

Here, FAT fixes sub-forces only. However, FAT may remove or modify sub-forces and/or add new ones. Current FAT approved sub-forces in Table 2.

2.2.2. Establish a set of grade alternatives

A set of grade alternatives or linguistic evaluations and scores is established. The grades are defined for each alternative (i.e., CCs) on a five-point Likert-type scale as $E = \{1, 2, 3, 4, 5\}$ where 1 = very light, 2 = light, 3 = moderate, 4 = severe, and 5 = very severe.

2.2.3. Determine a weight for each sub-force

When using FSE, FAT assigns a weight for each sub-force. Normalized weightings are obtained by Equation (3) as it is a fast track method and easy to use and understand for practitioners (Yeung *et al.* 2007):

$$W_i = \frac{M_i}{\sum_{i=1} M_i}, \tag{3}$$

where W_i represents weight of a sub-force in a force, M_i represents mean rating of that sub-force, and $\sum M_i$ represents summation of mean ratings of all sub-forces in that force. Here, ratings are made on a Likert-type scale from 1 (very unimportant) to 5 (very important). For example, weight of "impact on quality" (W_{iq}) in bargaining power of buyers was computed as follows:

$$W_{iq} = \frac{4.89}{4.89 + 3.75 + 2.89 + 2.41 + 2.21 + 1.70 + 1.69 + 1.69 + 1.51} = 0.22 \,.$$

Weights of sub-forces in FFs were calculated as follows and are given in the fifth column of Table 2:

$$W_{entrants} = (0.22, 0.20, 0.17, 0.12, 0.10, 0.08, 0.08, 0.03);$$

$$W_{competitors} = (0.20, 0.20, 0.12, 0.12, 0.10, 0.10, 0.08, 0.08);$$

$$W_{substitutes} = (0.58, 0.42);$$

$$W_{buyers} = (0.22, 0.17, 0.13, 0.10, 0.10, 0.07, 0.07, 0.07, 0.07);$$

$$W_{suppliers} = (0.30, 0.20, 0.17, 0.15, 0.14, 0.04).$$

Table 2 shows that KCCs for sub-forces in each force were 0.324, 0.403, 0.467, 0.398, and 0.415, which were statistically significant at 1% level. If KCC is equal to 1, it means that all experts rank sub-forces/FFs identically. If it is 0, it means that the experts rank sub-forces/FFs totally differently. Therefore, null hypothesis which asserted that participant's ratings within each force were unrelated to each other was rejected. It denoted an agreement among participants within FAT.

2.2.4. Establish fuzzy evaluation matrix

Fuzzy evaluation matrix in Table 2 includes membership functions of judgments for sub-forces in a force. These membership functions are set up by FAT's appraisal. Each expert in FAT makes a judgment on CCs of each sub-force in a force. Mean of experts' judgments is the membership function for evaluation of each sub-force.

2.2.5. Calculate CCs of industry for each force

Evaluation of each sub-force is performed through fuzzy composition operators. Since Operator 3 is used, CCs of each force are calculated by Equation (2). For instance, membership function ($D_{suppliers}$) of bargaining power of suppliers was calculated as follows:

$$D_{suppliers} = \left(0.30, 0.20, 0.17, 0.15, 0.14, 0.04\right) \circ \begin{pmatrix} 0.00 & 0.00 & 0.00 & 0.53 & 0.47 \\ 0.03 & 0.17 & 0.22 & 0.28 & 0.30 \\ 0.20 & 0.17 & 0.23 & 0.18 & 0.22 \\ 0.42 & 0.45 & 0.13 & 0.00 & 0.00 \\ 0.43 & 0.40 & 0.07 & 0.08 & 0.02 \\ 0.95 & 0.05 & 0.00 & 0.00 & 0.00 \end{pmatrix} =$$

$$\begin{aligned} &\Big(\min\left(1, 0.30\times0.00+0.20\times0.03+0.17\times0.20+0.15\times0.42+0.14\times0.43+0.04\times0.95\right), \\ &\min\left(1, 0.30\times0.00+0.20\times0.17+0.17\times0.17+0.15\times0.45+0.14\times0.40+0.04\times0.05\right), \\ &\min\left(1, 0.30\times0.00+0.20\times0.22+0.17\times0.23+0.15\times0.13+0.14\times0.07+0.04\times0.00\right), \\ &\min\left(1, 0.30\times0.53+0.20\times0.28+0.17\times0.18+0.15\times0.00+0.14\times0.08+0.04\times0.00\right), \\ &\min\left(1, 0.30\times0.47+0.20\times0.30+0.17\times0.22+0.15\times0.00+0.14\times0.02+0.04\times0.00\right)\Big) = \\ &\left(0.2012, 0.1884, 0.1124, 0.2568, 0.2412\right). \end{aligned}$$

$CCs_{suppliers}$ were computed as follows:

$$CCs_{suppliers} = 0.2012\times1+0.1884\times2+0.1124\times3+0.2568\times4+0.2412\times5 = 3.1484.$$

Membership functions and CCs for other forces were computed as follows:

$$\begin{aligned} D_{entrants} &= \left(0.0745, 0.0951, 0.0794, 0.1950, 0.5560\right) \rightarrow CCs_{entrants} = 4.0629; \\ D_{competitors} &= \left(0.0436, 0.1174, 0.1158, 0.2570, 0.4662\right) \rightarrow CCs_{competitors} = 3.9848; \\ D_{substitutes} &= \left(0.6516, 0.3194, 0.0290, 0.0000, 0.0000\right) \rightarrow CCs_{substitutes} = 1.3774; \\ D_{buyers} &= \left(0.2407, 0.1822, 0.1163, 0.2408, 0.2200\right) \rightarrow CCs_{buyers} = 3.0172. \end{aligned}$$

Final evaluation results of CCs of FFs are listed in Table 3, together with corresponding membership functions in second column and effects on industry in sixth column.

Table 3. Membership functions, CCs, effects, and weightings of FFs

Forces	Membership functions	CCs in industry			Effects of FFs on industry	Weightings of FFs		
		Numerical grades	Linguistic grades	Rankings		Mean[1]	Rank	Weight
Intensity of rivalry among existing competitors	(0.0436, 0.1174, 0.1158, 0.257, 0.4662)	3.9848	Almost severe	2	Almost high	3.96	1	0.28
Threat of new entrants	(0.0745, 0.0951, 0.0794, 0.195, 0.556)	4.0629	Severe-to-very severe	1	Very low-to-low	3.83	2	0.27
Pressure from substitute products	(0.6516, 0.3194, 0.029, 0.000, 0.000)	1.3774	Very light-to-light	5	High-to-very high	2.79	3	0.19
Bargaining power of buyers	(0.2407, 0.1822, 0.1163, 0.2408, 0.22)	3.0172	Moderate-to-severe	4	Low-to-medium	2.21	4	0.15
Bargaining power of suppliers	(0.2012, 0.1884, 0.1124, 0.2568, 0.2412)	3.1484	Moderate-to-severe	3	Low-to-medium	1.61	5	0.11

Notes: [1]Number (n) of samples = 60; KCC = 0.409; level of significance = 0.000.

Numerical CCs grades of FFs are expressed by linguistic grades in Section 2.2.2. For effects of FFs on an industry, these grades are converted to another scale where 5 = very low, 4 = low, 3 = medium, 2 = high, and 1 = very high. This is because, for example, if CCs are found as severe for new entrants, this means that they will hardly penetrate the industry, and thereby, their threat will be low as an inverse proportion. Among FFs and concluding CCs, this rule is valid except intensity of rivalry among existing competitors and concluding CCs.

2.3. Overall force assessment stage

FSE is employed again with a minor difference to that used for evaluating a force. In this setting, sub-forces set turns into set of FFs, e.g., $\pi = \{f_1, f_2, \ldots, f_m\}$ where f_i is ith force. Hence, fuzzy evaluation matrix is established through judgments on FFs.

2.3.1. Determine a weight for each force

A weight for each force is assigned by FAT using Equation (3). It is given in last column of Table 3 and as follows:

$$W_{concluding}(0.28, 0.27, 0.19, 0.15, 0.11).$$

Table 3 gives KCC for FFs as 0.409 which was statistically significant at 1% level. Thus, null hypothesis which asserted that participant's ratings were unrelated to each other was rejected, indicating an agreement among participants in FAT.

2.3.2. Calculate the concluding CCs in industry

Fuzzy computation by Operator 3 is performed on weighting vector and fuzzy evaluation matrix to obtain fuzzy evaluation or membership function ($D_{concluding}$) for industry-wide CCs in Table 3. $CCs_{concluding}$ are calculated by translating it into a numerical value as follows:

$$D_{concluding} = (0.28, 0.27, 0.19, 0.15, 0.11) \circ \begin{pmatrix} 0.0436 & 0.1174 & 0.1158 & 0.2570 & 0.4662 \\ 0.0745 & 0.0951 & 0.0794 & 0.1950 & 0.556 \\ 0.6516 & 0.3194 & 0.0290 & 0.0000 & 0.0000 \\ 0.2407 & 0.1822 & 0.1163 & 0.2408 & 0.2200 \\ 0.2012 & 0.1884 & 0.1124 & 0.2568 & 0.2412 \end{pmatrix} =$$

$$(0.214364, 0.167289, 0.089181, 0.188978, 0.340188).$$

$$CCs_{concluding} = 0.214364 \times 1 + 0.167289 \times 2 + 0.089181 \times 3 + 0.188978 \times 4 + 0.340188 \times 5 = 3.273337.$$

3. Results and discussion

3.1. Participants' demographic characteristics

All participants earned a bachelor's degree or higher (Table 4) and were top managers. Only 21.7 percent have worked in their current positions for less than six years, while 71.6 percent have worked in their current positions for more than ten years. 61.7 percent also had experience of minimum 11 years. Overall, professional background and experience of participants seem to be sufficient for validation of questionnaire.

Table 4. Profile of respondents

Profile	Number of respondents	Category	Frequency	%
Qualification	60	BSc degree	39	65.0
		MSc degree	17	28.3
		PhD degree	4	6.7
Current position	60	General manager	17	28.3
		Deputy general manager	17	28.3
		Production Manager	26	43.3
Year of current position	60	1–5 years	13	21.7
		6–10 years	4	6.7
		11–20 years	35	58.3
		Above 20 years	8	13.3
Experience	60	1–5 years	8	13.3
		6–10 years	15	25.0
		11–20 years	30	50.0
		Above 20 years	7	11.7

3.2. Drivers of rivalry in cement industry

It was found that new entrants ($CCs_{entrants}$ = 4.0629), among FFs, meet with the most severe (severe-to-very severe) CCs in industry. The industry has high barriers against new entrants, making them an ineffective force rather than a threat. Therefore, threat of new entrants is called as "very low-to-low". In fact, this result is not surprising. Several reasons could lead to this outcome: (i) supply-side economies of scale, (ii) government policy, and (iii) capital requirements (Dumez, Jeunemaitre 2000). Since cement is a highly capital intensive industry and only big players can have access to it, large investment as well as specific technical and organizational knowledge needs to be available. This, in turn, leads to the fact that principle of economies of scale needs to be applied in cement plants, which are highly automated with major quality standards, as a typical example.

Existing competitors ($CCs_{competitors}$ = 3.9848) were ranked second in severity order. Current manufacturers conduct their businesses in "almost severe" or uncomfortable CCs across country. Thus, intensity of rivalry among competitors seems to be an effective force and is seen as "almost high". This result could be due to some reasons: (i) differentiation or switching costs, (ii) capacity augmented in large increments, (iii) significant capital investment and strategic vertical integration with concrete industry (Dimitrova *et al.* 2007).

In terms of suppliers ($CCs_{suppliers}$ = 3.1484) in third rank, there are "moderate-to-severe" CCs in industry, and this makes their bargaining power "low-to-medium". Concentration seems to be a reason. The other one may be related with substitute inputs and switching costs (Dumez, Jeunemaitre 2000).

Resultant linguistic grade (moderate-to-severe) for suppliers are also valid for buyers (CCs_{buyers} = 3.0172) in fourth rank. Their bargaining power was found to be "low-to-medium" because consumers can easily prefer another brand without a switching cost as cement is a standard commodity (Deolalkar 2009).

From substitute products' ($CCs_{substitutes}$ = 1.3774) point of view, CCs were found to be "very light-to-light". The industry has low barriers against substitutes, making them an effective force (Ulubeyli 2013). Thus, pressure from substitutes is called "high-to-very high".

Finally, $CCs_{concluding}$ are 3.273337 which is regarded as "moderate-to-severe". Overall, industry-wide CCs are construed as "medium-to-high". Considering CCs in fourth column of Table 3, this may be owing to FFs except pressure from substitutes.

Conclusions

The nature of force assessment makes many methods unreliable as it requires subjective decisions that mostly have uncertainties and discrepancies. Therefore, this paper aims to adopt a FSE-based novel approach to develop FFAM through allowing decision-makers to make their judgments via linguistic terms instead of crisp numbers. In this regard, FFAM (i) helps a firm to be aware of how FFs work in its industry and affect it in its particular situation, (ii) enriches current body of knowledge and understanding of researchers and practitioners, (iii) is an efficient model for assessing FFs and CCs successfully, and (iv) provides an explicit, comprehensive, and practical decision support tool rather than an untraceable approach. Hence, the most critical forces can be identified, and remedial actions can be taken.

Empirical research findings on cement industry showed that industry-wide CCs was found to be "medium-to-high". Also, participants perceived that pressure from substitutes is potentially the most effective force, followed by intensity of rivalry among competitors, bargaining power of buyers, bargaining power of suppliers, and threat of entrants. From substitutes' viewpoint, in market, there are some effective indirect substitute materials (e.g., wood and steel) that should be considered permanently. For existing competitors, importance of some factors, such as current competition strategies with price-cutting, high fixed costs, spare capacity, close connection with volatile construction sector, and vertical integration with concrete industry, can be noted for useful future strategies. For buyers, both cost leadership by using economies of scale and differentiation in products and in delivery conditions seem to be principal strategies manufacturers may follow. Given suppliers, relatively limited supply opportunity of energy with high unit costs as well as limited switching opportunity of raw materials by substitutes despite inexpensive costs of raw materials should be taken into account. In terms of new entrants, investments needed especially for equipment, facilities, energy, and environmental licenses place an extra burden on potential entrants and prove that the need to invest huge financial resources can be an extremely risky decision. Overall, all findings revealed that substitutes and intensity of rivalry may be major hurdles to stakeholders. These may be caused by effective indirect substitutes, low switching costs, spare capacity, high strategic stakes, and high exit barriers. In this regard, manufacturers may (i) foster R&D efforts to find differentiation opportunities, (ii) fulfil capacity optimization studies, (iii) establish energy-supplying facilities, (iv) follow cost leadership strategies, (v) expand their supplier network, and (vi) pay attention to news on indirect substitutes.

Consequently, this study attempts to carry out some novelties for the first time in literature. First, it presents a structured five-force quantification model that has logical steps and original design. Second, this quantification of CCs of FFs and industry-wide situation was performed through fuzzy sets. Lastly, five-force framework was employed for cement industry. Based on these originalities, this study provided empirical support and led to quantitative measurement of five-force framework using FFAM. Results appear credible and real and offer insights into how FFs increase or decrease the severity of CCs. Based on managerial perceptions, application of FFAM as a tool of industry-wide competitiveness analysis has potential to significantly enhance the understanding of how competition works.

Since FFAM focused on Turkish cement industry, it is not clear how geographical areas would affect CCs. Future researches can investigate potential differences of findings in other regions. This may provide the comparison and generalization of results to better comprehend the drivers of rivalry in different conditions. FFAM can also be applied to other parties to test it further and to present the entire perspective of industry. Otherwise, generalization of current findings to industry must be made with caution. It can also be interesting to investigate how manufacturers' perception evolves over time. Other industries can be analysed as well. Moreover, FFAM can be modified to suit another assessment problems by adjusting criteria and alternatives due to its scalable modular form. To this aim, a computer-aided flexible soft-system can be developed.

For top managers, industry analysts, and policy-makers, findings serve as a valuable agenda and are a good starting point for a more detailed industry analysis and regular reviews into possible proactive actions, strategic responses, and regulation arrangements. For cement manufacturers, FFAM can be employed for manufacturer-specific evaluation of industry especially because of the fact that each company has its own specific position in industry. This may require manufacturers to develop preventive and/or remedial strategies tailored to their strengths and possible opportunities against their weaknesses and potential threats. On this way, they will likely need to focus on differentiation, capacity optimization, energy supply, cost leadership, supplier network, and indirect substitutes, as key results of this study.

Although this study was conducted with a high number of manufacturers, complete participation could reflect a different perspective of CCs. This limitation should be taken into account in interpreting the results.

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