Fifth International Conference on Construction in the 21st Century (CITC-V)
"Collaboration and Integration in Engineering Management and Technology"
May 20-22, 2009, Istanbul, Turkey

Strategic Group Analysis by Using Fuzzy Clustering

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Abstract

Strategic group is a group of firms in an industry following the same or similar strategy along a set of strategic dimensions. The aim of strategic group analysis is to find out if clusters of firms that have a similar strategic position exist within an industry or not, therefore it can be used as one of the methods for revealing the competitive structure. Using a theoretical conceptual framework applicable for the construction industry and fuzzy clustering, the objective of this research is to identify possible strategic groups within the Turkish construction industry. In this research, by considering the cluster validation techniques developed for fuzzy clustering, the number of the strategic groups is determined as three. The membership degrees of the companies to all clusters are obtained at the end of the analysis. It is concluded that the companies in the same strategic group do not necessarily implement the strategic recipe of the group at the same degree. Therefore, the traditional strategic group concept in which the clusters are wholly separated does not reflect the real strategic group structure of the Turkish construction industry and heterogeneity of strategies implemented in each group. Findings of this study can be used by professionals to understand their current strategic positions within the competitive environment and even in their strategic groups.

Keywords

Strategic groups, Fuzzy clustering

1. Introduction

The necessity of having a clear strategic perspective in order to achieve competitive advantage has been acknowledged in the literature (Dikmen and Birgonul, 2003; Warszawski, 1996). The selected strategies should be in accordance with objectives, competencies and competitive rules prevailing in the market. Therefore, the competitive structure analysis is a pre-request in order to identify appropriate strategies to the industry. The strategic group analysis is one of the methods for revealing the competitive structure.

The strategic group concept was first introduced by Hunt (1972) for explaining the performance difference between firms which follow different strategies. The popularity of the term increased after its usage by Porter (1979) and Caves and Porter (1977). Since then, strategic group concept is adopted in different industries for both theoretical and empirical purposes. Like Hawes and Crittenden (1984) in retail grocery, Houthoofd and Heene (1997) in the Belgian brewing industry and many others. The reason of the popularity of strategic group concept can be explained by the benefits of the strategic groups. The most important benefits of the strategic group concept is to facilitate strategy researchers and managers when analyzing competitors and the strengths and weaknesses of the firm, making strategic investment decisions, and developing successful strategies by simplifying the market structure (Flavian and Polo, 1997; Mascarenhas and Aaker, 1989).

2. Strategic Groups

Strategic group is a group of firms in an industry following the same or similar strategy along a set of strategic dimensions (Porter, 1979). In other words, the companies placed in the same strategic groups are homogenous in terms of the strategies they pursue. However, Barney and Hoskisson (1990) criticized the existence of the strategic groups since the theoretical underpinning of the strategic groups does not exist, therefore they advised the abandonment of group level analysis. By the same line of thinking, Dranove *et al.* (1998) stated that grouping firms does not provide a ready substitute for firm level analysis, since it may lead to information loss and noise. Hence, it was started to argue that the traditional strategic structure was not appropriate in order to map complex industries more realistically; therefore the strategic group structure should be re-conceptualized according to the degree of group membership and overlapping between strategic groups (Reger and Huff, 1993). Consequently, from the theoretical standpoint, the existence of the heterogeneity in the extent to which firms pursue strategies is recognized by researchers (Ketchen *et al*., 1993; McNamara *et al*., 2003). However, there has been limited research on heterogeneity within a strategic group. Based on the categorization theory (Rosch, 1999), Reger and Huff (1993) proposed that the strategic groups are composed of three kinds of firms, namely core, secondary, and transient firms. Core firms are tightly adhere to the strategic groups which they belong, secondary firms are aligned loosely with the strategic group and adopted the specific strategies of a strategic group less consistently than core firms, and transient firms change form one strategic group to another. Ketchen *et al*. (1993) determined supportive findings to the assertion of Reger and Huff (1993) in the study conducted for hospital industry. Mcnamara *et al*. (2003) extended this theory by introducing solitary firm concept in order to identify the firms which are strategically unique. On the other hand, Peteraf and Shanley (1997) introduced the strategic group identity concept based on the organizational identity (Albert and Whetten, 1985) in order to reveal the heterogeneity within the strategic groups. According to them, the strategic group members could vary in the extent to which they identify with a group. In conclusion, different studies propose the emergence of variation in extent to which firms belong to or identify with a strategic group.

2.1 Strategic Group Analysis in the Construction Industry

Although the strategic group is a popular topic and was adopted in different industries, the application of strategic group analysis in construction management literature is limited with only three studies; namely Kale and Arditi (2002), Claver *et al*. (2003) and Dikmen *et al*. (Forthcoming). Kale and Arditi (2002) used one of the most influential generic typologies, Porter's (1980) generic competitive positioning typology to determine the strategic groups of US construction firms by using K-means clustering analysis. In the same manner, Claver *et al*. (2003) tried to determine the strategic groups of Spanish house-building firms by utilizing Ward's method for finding out the number of the clusters as an input of the K-means clustering analysis. On the other hand, in Dikmen *et al*. (Forthcoming)'s study, strategic group analysis for Turkish construction industry was conducted according to a conceptual model based on Price and Newson (2003). In that study, a comparative analysis with the outputs obtained by using all available traditional clustering techniques was conducted in order to determine the most appropriate solution. Finally, the strategic groups obtained by using K-means were identified as the most appropriate for Turkish construction industry. The common point of these studies is the usage of traditional clustering methods which can be used only for building distinct self-contained clusters, however as mentioned before, this structure of strategic groups is criticized, therefore, strategic group structure of the construction industry should be more complex which cannot be identified actually by using traditional clustering methods. In addition, the boundaries between the strategic groups are acknowledged as fuzzy by some of the researchers (Dranove *et al*., 1998; Reger and Huff, 1993; Thomas and Venkatraman, 1988), whereas in all these studies, the boundaries between the strategic groups are assumed as distinct. Therefore, a different approach is required in strategic group analyses performed for construction industry in order to identify the complex competitive structure. Consequently, the purpose of the current paper is identifying the strategic groups of Turkish construction companies by regarding the theories related to heterogeneity within the strategic groups.

3. Conceptual Model

One of the challenges of strategic group analysis is to identify the strategic variables to be used for clustering the firms as there is no generally accepted scheme for definition of strategic dimensions (Thomas and Venkatraman, 1988). Therefore, strategic group analysis requires choosing or developing a conceptual framework in which the strategic dimensions are defined according to the competitive conditions prevailing in an industry. In this study, the conceptual model developed by Dikmen *et al*. (Forthcoming) is used in order to determine strategic dimensions; this conceptual model is based on three dimensions of strategy mentioned by Price and Newson (2003): strategy content, strategy process and strategy context.

Strategy content: Throughout strategy formulation process, the companies should decide on mode and scope of competition. According to Porter (1980), basically there are two competition modes: cost leadership and quality differentiation. Also, Porter (1980) indicated that companies may adopt diversification strategy or a focus strategy as scope of competition.

Strategy process: The strategic planning and decision making styles may be indicators of the strategy process in a company. In this research, two strategic variables have been defined: systematic strategic planning and centralization of decision making.

Strategy context: According to the resource-based view, firms can be viewed as a collection of resources and capabilities that can be used to achieve and sustain competitive advantage. Under the title of strategy context, tangible (such as human and financial resources) and intangible resources (such as experience, company image and relations) of companies are considered as well as their capabilities (such as managerial and technical capabilities).

Finally, 13 variables that reflect the strategy content, process and context of construction companies are defined. More detailed information about the conceptual model and the variables used in the analysis has been reported in Dikmen *et al*. (Forthcoming).

4. Fuzzy C-means

Since the concept of fuzzy sets (Zadeh, 1965) was introduced, fuzzy clustering has been widely discussed, studied, and applied in various areas, and different fuzzy clustering methods have been developed. One widely used algorithm, FCM algorithm, was firstly presented by Dunn (1974), Bezdek (1981) further developed the FCM clustering algorithm. In fuzzy clustering approaches, data points can be assigned to more than one cluster and even with different degrees of membership to the different clusters (De Oliveira and Pedrycz, 2007), in other words, it only evaluates the probability to each cluster that the input belongs, just as a human does. As a result, this method can outperform hard clustering methods in many real applications, especially when clusters are not well separated, the borders of the clusters are not sharp, and clusters overlap (Chuang *et al*., 1999). Despite its advantages, the application of the fuzzy clustering is limited in business and economics.

FCM aims to minimize the fuzzy version of classical within groups' sum of squared error objective function according to the fuzziness exponent by using Picard iterations. The algorithm seeks to partition the data set into c subgroups or clusters on the basis of measured similarities among the vectors, so the number of the cluster is a prerequisite for starting the analysis. Two parameters affect the results of this algorithm, namely number of the clusters and m, degree of the fuzziness. The fuzziness of the memberships is controlled by m, and m takes values higher than 1. The closer m is to 1, the crisper the membership values are. As the values of m become progressively higher, the resulting memberships become fuzzier (Hammah and Curran, 1998). Pal and Bezdek (1995) advised that m should take the values between 1.5 and 2.5, and the number of clusters should be between 2 and $\sqrt{n}$. For more detailed information about the algorithm see Bezdek (1981).

Although FCM is used in only one strategic group study by Hsu (2000) for the credit card market in Taiwan, FCM is selected for clustering since it has got some advantages over traditional clustering methods in identification of strategic groups. Firstly, the boundaries between the strategic groups are expected to be fuzzy, besides the degree of membership of the data points provided as an output of FCM can be used for revealing the complex structure of the strategic groups.

5. Research Methodology

The target population is selected as the members of the Turkish Contractors Association (TCA). Since, the business volume of its members encompasses nearly 70% of all domestic and 90% of all international contracting work done so far by the Turkish construction companies. The strategic group analysis carried out in this research covers only the medium-big contracting firms in Turkey.

A questionnaire form was designed and submitted to 136 members of TCA. In the questionnaire, each representative of the company was requested to give relevant information about 13 strategic variables. The yearly turnover and age of the company were also questioned. Subjective reporting approach was used for performance assessment rather than collecting financial data. Each respondent evaluated his/her company's performance considering the previous 3 year period in terms of profitability, workload and other company objectives by examining relative performance within an industry. All subjective ratings are assigned using the 1-to-5 Likert scale. The total number of returned questionnaires is 83 and the return rate is 0.61.

5.1 Application of FCM

Clustering toolbox developed for Matlab is used for the FCM analysis. As mentioned before; the results of FCM are affected from two parameters: number of the clusters and fuzziness index. The validity indices can be used in order to determine the optimum values for the number of the clusters. Bensaid *et al*. (1996) clustered the validity indices into three categories. Some methods measure partition validity, some validity methods deal with the evaluation of the properties of the fuzzy membership, and the others consist of validity measures that evaluate both properties of fuzzy memberships and the structure of the data. However, none of them is perfect when used alone. Thus, different validity indices from different groups are used during the application of FCM. The validity indices used in this analysis are fuzziness performance index (FPI), modified partition entropy (MPE), partition index (SC), separation index (S), Xie and Beni's index (XB), and Dunn's index (DI). The values of these indices are calculated for m equals to 1.5 and 2, respectively for checking if any difference exists in the general structure of the indices for different fuzziness parameters. The upper boundary of the number of the clusters is determined as 9 (approximately, square root of n=84). The validity indices of the clusters are shown in Table 1.

SC, S, and DI from the first category are used for determining the compactness and separation of the clusters. For a better solution, the clusters should be well compacted and separated from each other. Since the lower values of SC and DI indicate more compacted and well separated clusters, 3-clusters solution is identified as the optimum solution for the data set according to these indices. On the other hand, it is difficult to identify that any solution is preferable definitely according to the remaining validity index, namely S. FPI and MPE from the second category are used for evaluating the fuzziness of the solutions. The lesser the FPI and MPE, the more suitable is the corresponding solution (McBratney and Moore, 1985), therefore 2-clusters solution is identified as the optimum solution for this data set, and 3-clusters solution is identified as the second best solution. Lastly, XB which evaluates both properties of fuzzy membership and structure of the data is considered. Like the other indices, the smaller values of XB indicate a better clustering of the data set. According to the Table 1, the 3-clusters solution has the lowest XB values. Consequently, 3-clusters solution is decided as the most appropriate solution for this data set.

The other parameter which affects the outputs of the fuzzy C-means is fuzziness index (m), therefore m should also be identified carefully. In this analysis, m is determined by using the method proposed by Odeh *et al*. (1992). According to this method, the optimum solution is obtained when m equals to 1.7. In conclusion, the FCM analysis is performed for three clusters by m equals to 1.7 and the membership degrees of the data points to each cluster is shown in Table 2.

Table 1: Validity Indices of FCM Cluster Analysis

Validity Indexes	Number of Clusters							
	2	3	4	5	6	7	8	9
FPI	0.334	0.494	0.636	0.689	0.724	0.761	0.772	0.784
MPE	0.937	1.177	1.410	1.490	1.530	1.602	1.608	1.631
SC	0.343	0.256	0.290	0.289	0.256	0.273	0.266	0.280
S	0.004	0.005	0.005	0.005	0.004	0.005	0.005	0.005
XB	1.282	0.975	1.120	1.250	1.553	1.750	1.848	1.789
DI	0.298	0.182	0.197	0.211	0.186	0.263	0.224	0.224
FPI	0.730	0.816	0.869	0.901	0.919	0.928	0.937	0.944
MPE	1.819	1.892	1.968	2.025	2.056	2.061	2.080	2.087
SC	0.539	0.372	0.378	0.409	0.417	0.372	0.374	0.377
S	0.006	0.007	0.007	0.007	0.007	0.006	0.006	0.006
XB	1.113	0.752	0.865	0.953	1.184	1.338	1.494	1.361
DI	0.232	0.189	0.189	0.197	0.224	0.211	0.211	0.186

Table 2: Membership of the Data

ID	1st	2nd	3rd	ID	1st	2nd	3rd	ID	1st	2nd	3rd
1	0.118	0.719	0.164	29	0.029	0.800	0.172	57	0.033	0.385	0.582
2	0.334	0.465	0.201	30	0.031	0.404	0.565	58	0.419	0.396	0.185
3	0.304	0.472	0.225	31	0.030	0.240	0.730	59	0.150	0.696	0.154
4	0.015	0.132	0.853	32	0.028	0.209	0.763	60	0.197	0.639	0.164
5	0.044	0.819	0.137	33	0.033	0.562	0.405	61	0.113	0.565	0.322
6	0.824	0.130	0.047	34	0.117	0.671	0.212	62	0.020	0.359	0.621
7	0.021	0.144	0.836	35	0.121	0.575	0.304	63	0.044	0.532	0.425
8	0.026	0.710	0.264	36	0.014	0.148	0.838	64	0.827	0.118	0.055
9	0.077	0.469	0.455	37	0.062	0.664	0.274	65	0.888	0.075	0.037
10	0.203	0.593	0.204	38	0.037	0.427	0.535	66	0.018	0.177	0.805
11	0.012	0.159	0.829	39	0.014	0.143	0.843	67	0.706	0.210	0.084
12	0.023	0.155	0.822	40	0.850	0.102	0.049	68	0.508	0.375	0.117
13	0.069	0.737	0.194	41	0.402	0.445	0.153	69	0.017	0.136	0.846
14	0.027	0.287	0.686	42	0.034	0.451	0.515	70	0.139	0.517	0.344
15	0.062	0.687	0.252	43	0.015	0.133	0.852	71	0.099	0.667	0.235
16	0.028	0.559	0.414	44	0.017	0.181	0.803	72	0.240	0.648	0.112
17	0.080	0.489	0.432	45	0.035	0.438	0.527	73	0.048	0.515	0.438
18	0.191	0.643	0.166	46	0.038	0.705	0.257	74	0.089	0.406	0.505
19	0.013	0.210	0.777	47	0.120	0.507	0.373	75	0.025	0.151	0.824
20	0.092	0.536	0.372	48	0.026	0.767	0.206	76	0.022	0.149	0.828
21	0.044	0.369	0.587	49	0.090	0.658	0.252	77	0.024	0.177	0.800
22	0.042	0.577	0.381	50	0.059	0.666	0.275	78	0.832	0.116	0.052
23	0.306	0.494	0.200	51	0.022	0.164	0.815	79	0.714	0.209	0.077
24	0.589	0.285	0.126	52	0.035	0.303	0.662	80	0.741	0.191	0.069
25	0.019	0.168	0.813	53	0.027	0.329	0.644	81	0.815	0.132	0.053
26	0.035	0.624	0.341	54	0.021	0.189	0.790	82	0.847	0.102	0.051
27	0.042	0.629	0.329	55	0.082	0.675	0.243	83	0.805	0.143	0.052
28	0.088	0.582	0.330	56	0.097	0.735	0.169	84	0.854	0.098	0.048

6. Discussion of Findings

As noted earlier, the concept of strategic groups has been critized due to the assumption of homogenity within the strategic groups. Therefore, recent literature has begun to focus on differences in firms within strategic groups, and the new theories related to the structure of the strategic groups are emerged. Specifically, the theory developed by Reger and Huff (1993) is acknowledged in the literature. As mentioned before, according to them, three kinds of firms, namely core, secondary, and transient firms are existed within the strategic groups. In this study, the complex competitive structure of the Turkish construction industry is identified by following Reger and Huff (1993)'s theory. As shown in Table 2, the degree of the membership of the firms varies within a strategic group, in other words, all of the firms placed in a strategic group does not stick to the specific strategic posture of this strategic group equally. Therefore, according to Table 2, the core and secondary firms can be identified. For that purpose, first hard clustering is performed by placing the firms under a cluster according to the highest membership values, then scatter plot of the firms versus their degree of memberships is drawn for each strategic groups. The companies whose membership points are placed closer are identified as secondary companies; the remaining companies are identified as core companies. Consequently, strategic group structure of the Turkish construction companies is illustrated in Figure 1. According to Figure 1, the first strategic groups are composed of thirteen core firms and two secondary firms. According to the degree of the membership of the secondary firms, it is interestingly observed that these companies' strategies are close to the strategies of strategic group 2. The thirty-nine firms belong to strategic group 2, however fourteen of these firms from the secondary firms within this group. When the degrees of the membership of the secondary companies are examined, it is observed that some of the secondary firms' strategic postures are close to the strategic group 1, whereas the other secondary firms' strategic postures are close to the strategic group 3, therefore unlike Refer and Huff (1993)'s proposal, the secondary strategic groups are also classified into two groups. Consequently, it is proposed that a strategic group can be composed of more than one secondary group. Lastly, the strategic group 3 is composed of thirty firms; however seven of these companies are identified as secondary firms with in this group. Like the secondary firms placed in strategic group 1, secondary firms of strategic group 3 show proximity only to the strategic group 2, therefore it is concluded that the strategic postures specific to these two strategic groups are too distinct that no common features exist between these strategic groups.

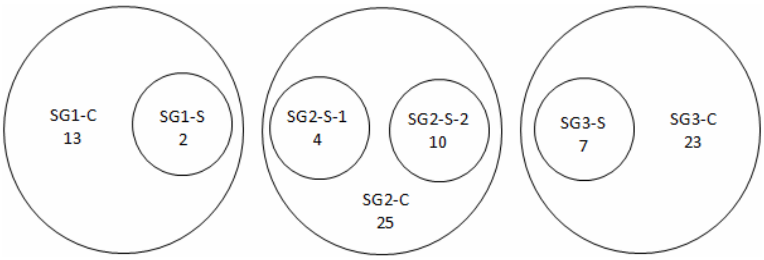

Figure 1: Strategic Group Structure of the Turkish Construction Industry

7. Conclusion

In the light of the above given research findings; it can be concluded that the traditional strategic group structure does not reflect the competitive structure of the complex industries, therefore it is proposed that the traditional strategic group should be modified. In the same line of thinking, Reger and Huff (1993)'s proposal is proved as an appropriate structure for the Turkish construction industry, however in this study, the proposal is modified by classifying the secondary firms, in other words it is proposed that the variation in degree of dependence in applying strategies between the secondary firms may be observed.

The strategic groups of Turkish construction industry were identified for one time period. Therefore, the third type of firms, namely transient firms, cannot be identified in the concept of this paper. However, this study can be repeated in the future to understand the changes in market structure in time and investigate the dynamic structure of Turkish construction industry. Information about movements between groups can provide information about the nature and characteristics of mobility barriers. Also, the concept of dynamic strategic groups can be used to predict the future strategic movements of the companies.

Finally, the results of this study are specific for Turkish construction industry, thus cannot be generalised. However, the conceptual framework and FCM used in this study may further be applied to other countries to investigate the structure of their strategic groups.

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