Knowledge-Based Systems xxx (2013) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Knowledge-Based Systems

journal homepage: www.elsevier.com/locate/knosys

A framework for strategy formulation based on clustering approach: A case study in a corporate organization

S. Ali Hadighi [a], Navid Sahebjamnia [b], Iraj Mahdavi [a,*], Mohsen Akbarpour Shirazi [c]

[a] Department of Industrial Engineering, Mazandaran University of Science and Technology, Babol, Iran
[b] Department of Industrial and Systems Engineering, College of Engineering, University of Tehran, Tehran, Iran
[c] Department of Industrial Engineering, AmirKabir University Technology, Tehran, Iran

ARTICLE INFO

Article history:
Received 23 January 2012
Received in revised form 15 April 2013
Accepted 15 April 2013
Available online xxxx

Keywords:
Strategy formulation
Clustering
Corporate strategy

ABSTRACT

Recent corporate organizations are significantly more complicated than ever. They are more distributed and networked, as supply chains, virtual organizations and corporate arrangements. By increasing the complexity of the decision making in dynamic competitive environment, managers need relevant strategic plans for their firms. In this paper, a new framework for strategic formulation based on clustering approach has been proposed to cope with these intricacies. After exploring internal and external factors influencing the goals of the organizational departments, the goal–factor matrices are formed based on their correlations. A clustering approach is applied to integrate goal–factor matrices to fulfill incorporate interactions among departments. Strategies would be formulated for clusters instead of departments individually or as organization totally. In fact, management by objective (MBO) has been substituted by management by cluster (MBC). The capability and usefulness of the proposed framework are shown through a case study in National Iranian Oil Company Training Center. Results indicate that the proposed strategic formulation outperforms other approaches and is very promising not only for solving the organization's problem, but also is appropriate for utilizing in other corporate organizations.

1. Introduction

The role and importance of strategy formulation in corporate organization is a keen subject of challenging area for both academics and practitioners. Due to frequent and significant environmental changes and enhancing complexities in organizational structures, strategy formulation has become more sophisticated in practice. Therefore, generating effective strategies are a critical issue for strategic managers. A corporate organization consists of multiple departments which act individually for achieving organizational goals through departmental goals. Departments may have different goals possibly with some conflict among them. Moreover, a great amount of internal and external factors as strength, weakness, opportunity and threat (SWOT) would be extracted from environmental survey. Consequently, strategy formulation for such organization is ever complicated than usual.

Many organizations utilize MBO approach with respect to the dynamic situation and rapid development. Although, they set goals for their departments in line of the organizational goals, the deviation from their departmental or organizational goals is most likely to occur. So, in strategy formulation it is of importance to prevent the deviation issue. Accordingly, to overcome this and generating appropriate strategies, the process will be even more complicated and effort intensive. Hadighi and Mahdavi [1] utilized clustering algorithm for strategy formulation but there were several deficiencies namely, (1) the emphasis was on an organization with plenty of goals, and it does not satisfy the organizations incorporating several departments and possibly with some conflicting goals, (2) by utilizing Mahalanobis Taguchi Systems some factors were eliminated which may cause losing a set of variables improperly, (3) the interactions among factors of one department relating to other departments based on organization goals were not considered. But, in this paper first the clusters in an individual department would be configured and then expand to the whole organization, and (4) since the experts were from different sections of organization (not departments), there were plenty of factors and goals with diverging ideas, so there were significant conflicts among them and for overcoming this issue here, first we collected ideas from intra-department and then after promotion of generated clusters in departments, the clusters have been integrated till the consensus is achieved among experts. In fact the convergences of idea at this stage took place.

In this paper, for overcoming the problems stated above a framework based on clustering algorithm has been proposed for

* Corresponding author. Tel.: +98 911 1131380.
E-mail addresses: ahadighi2002@yahoo.com (S.A. Hadighi), n.sahebjamnia@ut.ac.ir (N. Sahebjamnia), irajarash@rediffmail.com (I. Mahdavi).

0950-7051/$ - see front matter © 2013 Published by Elsevier B.V.
http://dx.doi.org/10.1016/j.knosys.2013.04.008

strategy formulation of corporate organization. By considering the complexities and obstacles and in accordance with correlations among factors and goals in each department the factor–goal matrices would be formed. Based on the matrices the relevant departmental clusters are generated. Having promoted the generated individual clusters, organizational clusters' integration will be performed. Then, we formulate the strategies based on the generated integrated organizational cluster. This framework assists to mobilize utilities from human to material resources in achieving organizational goals. The main contribution of this paper could be highlighted as follows:

1. Proposing a new framework for strategy formulation based on the clustering approach.
2. Presenting a new clustering method based on the correlation between departmental factors and goals.
3. Proposing a new MBC approach instead of MBO approach to prevent deviation of departmental goals from organizational goals.
4. Maximizing utilization of resources by integrating departmental goals as a set of organizational goals.
5. Considering the interaction among all factors and goals of the organizational departments, comprehensively.

The rest of the paper is organized as follows. Section 2 provides a review of the literature on strategic formulation and clustering techniques. Section 3 presents the proposed clustering method of the strategy formulation. In Section 4, the framework of the strategy formulation is described. Section 5 explores the implementation process of the proposed framework for strategy formulation in the Mahmoudabad Training Center as well as the corresponding experimental results. To evaluate the proposed method against contemporary approaches, Section 6 includes validation and comparison. Finally, Section 7 provides concluding remarks.

2. Literature review

Literature on strategy and organization theory emphasized, for a long time, on the environment of the firm as a major source for managers in charge to detect emerging factors and to respond on time [2–5]. SWOT analysis is an important supporting tool for decision-making, and is commonly used to systematically analyze organizations' internal and external environments. However, one of its deficiencies is in the measurement and evaluation of prioritization of the factors and strategies [6].

The term "environmental scanning" became widely used to the search for information about emerging drivers "in a company environment, the knowledge of which would assist top management in its task of charting the company's future course of action" [7]. A large set of future-oriented techniques and methods have been developed and applied including strategy formulation [8–10], roadmaps [11–13] and scenarios [14,15] are by far the most popular ones [16].

The way organizations formulate strategy has become one of the most congested areas of debate in the strategic management field. In the conventional approach, strategy development is mainly the result of a systematic, rational process of deliberate planning by a top management team, which is then communicated to the organization for implementation. In large companies, this process typically occurs through formal strategic planning systems [17]. Strategy formulation is sometimes referred to as determining where you are now, where you plan to go, and finally how to get there. It consists of performing a situation analysis, self-evaluation and competitor analysis in both inside and outside the organization, while setting the objectives concurrent with the assessment. Many approaches and techniques can be used to analyze strategic cases in the process of strategic management [18], such as the traditional SWOT analysis [19], analytical SWOT method [20], resource-based view [21,22], and quantitative SWOT methods [23,24], fuzzy quantified SWOT [25], are used to support decision making in competitive environment in a given organization. The development of strategic management has been summarized in Table 1.

According to Table 1, authors refer to the factors influencing the organization, particularly in SWOT method, but they do not directly specify how, according to the long range goals, these factors would be refined and assessed. Accordingly, in the case of great amounts of factors and presence of homogeneity or conflict among them it would be very complicated in handling all these data. Here, for overcoming this issue we took advantages of clustering method being part of data mining subject. After emerging computer technology and cyber space, the science of data mining has been evolved and spread in different field of knowledge. Clustering is an attractive and important technique in data mining that is used in many applications. Clustering refers to grouping data objects so that objects within a cluster are similar to one another, while objects in different clusters are dissimilar [45].

Table 1
Strategic management development.

Area	Authors	Contribution	Rationale	Method
Beginning of strategy in business	[26,27]	Mission and policy of business organizations in designing strategy	Strategy as a response to what the business is and what it should be	Quality of senior managers team
Definition of strategy	[28–31]	Corporate strategy, planning and growth	Strategy as a rule for making decisions	SWOT; experience curve; growth share matrix
Conceptualizing strategic management	[32–34]	Strategic management content and process	Evaluation and implementation of critical aspects of formulated strategy	Value chain
Industrial organization economics view of strategy	[35,36]	Competitive advantage development	Five forces analysis of industry attractiveness to develop competitive advantage through generic strategies	5 Forces model strategic choices
Resource-based view of strategy	[37–40]	Resources and capabilities development	Valuable, rare and costly to imitate resources without close substitutes can be sources of sustained competitive advantage	Core competence value system; game theory
Application of cluster analysis in strategic management				
New paradigm for strategic management	[41–44]	Learning, knowledge and innovation	Dynamic strategic model by which firms obtain valuable information, create knowledge and accumulate intangible capabilities in a process of learning	New integrated information technology systems

Please cite this article in press as: S.A. Hadighi et al., A framework for strategy formulation based on clustering approach: A case study in a corporate organization, Knowl. Based Syst. (2013), http://dx.doi.org/10.1016/j.knosys.2013.04.008

The nearest neighbor (kNN) rule is one of the oldest and most accurate methods to obtain nonlinear decision boundaries in classification problems [46–48]. Graepel and Herbrich [49] showed that most of previous works in this area cannot incorporate data invariance to known transformations which has been shown to improve the accuracy of a classifier. For example, Weinberger and Saul [50] learn a Mahalanobis distance metric for kNN classification so that the k-nearest neighbors always belong to the same class while samples from different classes are separated by a large margin [51].

Chiu et al. [52] proposed a distance measure dealing with mixed-type attributes in large databases. Their technique is derived from a probabilistic model that the distance between two clusters is equivalent to the decrease in log-likelihood function as a result of merging. Lee and Yun [53] proposed to measure similarities between categorical values by analyzing and mapping the values in each categorical attribute into points in a two-dimensional coordinate space using multidimensional scaling. Consequently, the mapped values make it possible to interpret the relationships between attribute values and to directly apply categorical attributes to clustering algorithms using the Euclidean distance [54].

3. Proposed three phase clustering algorithm

To develop a clustering algorithm, various issues have been considered in the literature such as the suitable level in the hierarchy, the number of the clusters and cluster validity. Here, correlations among factors and goals which construct the clusters are significant issue in generating strategies. So, a new clustering algorithm handling the whole mentioned issues has been proposed. Hence, we have introduced average distance value of factor in each cluster as the level of the hierarchy and used hierarchical agglomerative method to determine the number of the clusters. To validate the constructed clusters, the strategy–factor and strategy–goal clusters are formed by well-known nearest-neighbor method [55]. Finally, for considering the correlation among all factors and goals, the impact of factors on each goal are considered as input data of the clustering algorithm.

The logic behind the proposed clustering construction focuses on the distance of the factor's impacts on each goal. Each factor is considered as a cluster, and then the clusters are merged until the degrees of internal dissimilarity among factors in clusters are minimized and the intra-dissimilarity among clusters is maximized. It is very important to notice that a good choice of dissimilarity measure will improve clustering performance. Here, the Euclidean distance is considered as dissimilarity measurement. In this paper, a three phases clustering algorithm including initial departmental clusters construction, departmental cluster promotion and organizational cluster integration is proposed. In the first phase, factor–goal matrices have been formed for organization's departments. By following six steps below, a set of initial clusters for each department were formed. The clusters will be promoted in the second phase, to increase the intra-homogeneity of departmental clusters. In the final phase, all the departmental clusters are collected and by maximizing inter-dissimilarity a set of integrated organizational clusters are formed. The proposed clustering algorithm is precisely stated as follow:

3.1. Phase 1. Initial departmental clusters

Step 1: Let ξ_{ij}^{kp} denote the pth experts-defined value for factor–goal at kth organization departments. Calculate the value of the factor–goal at kth organization departments by:

$$\xi_{ij}^{k} = \frac{\sum_p \xi_{ij}^{kp}}{P} \quad \forall i,j,k \tag{1}$$

Step 2: Form department factor–goal matrix (ξ^k) by considering the factor's impact on goals (ξ_{ij}^k) for each department.

Step 3: Obtain the elements of the weighted factor–goal matrix (ϑ^k) by:

$$\vartheta_{ij}^{k} = W_j^k \cdot \xi_{ij}^k \quad \forall i,j,k \tag{2}$$

Step 4: Calculate factor–goal distance (d_{ij}^k) by:

$$d_{ij}^{k} = |\vartheta_{ij}^{k} - M_i^k| \quad \forall i,j,k \tag{3}$$

The mean value of the each factor has been obtained by:

$$M_i^k = \frac{\sum_{j\in\psi_i} \vartheta_{ij}^k}{n(\psi_i^k)} \quad \forall i,k \tag{4}$$

where ψ_i^k is a set of goals being impacted by ith factor and $n(\psi_i^k)$ is cardinality of ψ_i^k.

Step 5: Generate department binary factor–goal matrix by Eq. (5). To convert the department factor–goal distance matrices to binary factor–goal matrices the threshold value of individual departments are calculated as Eq. (6).

$$I_{ij}^k = \begin{cases} 1 & d_{ij}^k \leqslant \theta_i^k \\ 0 & \text{Otherwise} \end{cases} \tag{5}$$

where θ_i^k is:

$$\theta_i^k = \sum_j d_{ij}^k/q^k + \sum_j \left(\left(d_{ij}^k - \sum_j d_{ij}^k/q^k \right) \Big/ (q^k - 1) \right)^{\frac{1}{2}} \quad \forall i,k \tag{6}$$

Step 6: Configure primary clusters. At this stage, the clusters would be formed as many as the number of factors in each department. The goals in each row with a value of one would be assigned to the same cluster from binary factor–goal matrix.

3.2. Phase 2. Departmental clusters promotion

Let c^k is the number of kth department clusters. Then, a goal is eliminated from formed departmental cluster as the following procedure:

Step 1: Compute the average distance value of factors in cluster c^k with the following equation:

$$\bar{d}_c^k = \sum_{j\in J_c} \sum_{i\in\varsigma_j} (d_{ij}^k / n(\varsigma_j) \cdot n(J_c)) \quad \forall c,k \tag{7}$$

where J_{c^k} is a set of goals belonging to cluster c^k and ς_j is a set of influential factor belonging to the goal j.

Step 2: Let $z = 1$ and $j = 1$.

Step 3: Determine confidence level α^k according to department experts. Obviously, the greater value of α^k shows the higher convergence and vice versa.

Step 4: If the following conditions are held then the goal j is eliminated from formed departmental cluster z:

Condition 1. The d_{ij}^k compared to average distance value ($\bar{d}_c^k$) of factors in c^k is greater than the confidence level α^k.
Condition 2. J_{c^k} exists in another departmental cluster c^k.

Step 5: Let $j = j + 1$. And if $j \leqslant q^k$ then go to Step 4.
Step 6: Let $z = z + 1$. If $z \leqslant q^k$ then go to Step 3, else, stop.

Please cite this article in press as: S.A. Hadighi et al., A framework for strategy formulation based on clustering approach: A case study in a corporate organization, Knowl. Based Syst. (2013), http://dx.doi.org/10.1016/j.knosys.2013.04.008

3.3. Phase 3. Organizational clusters integration

Step 1: Gather all the departmental clusters. Two categories of clusters would be appeared including clusters with and without identical goals.

Step 2: The clusters of the second category (without identical goals) are kept as integrated organizational clusters.

Step 3: Calculate the dissimilarity measure ($d_{c^k j}$) from Eq. (8). The goals with lower dissimilarity measure are dedicated to the relevant cluster.

$$d_{c^k j} = \sum_{i \in \varsigma_j} d_{ij}^k \quad \forall c^k, j \tag{8}$$

Step 4: Repeat Step 3, until no cluster with the identical goal are present.

4. Proposed strategy formulation framework

A variety of strategy formulation approaches were developed as presented earlier in the literature review. Organization's characteristics such as size, mission and type, environmental scanning are severely effective on selecting strategy formulation approach. Obviously, corporate organization involving multiple departments (that each of them perform its own activity according to the objective has been set for that department), needs a specific methodology to generate strategies. While the interactions among factors (SWOT) collecting from individual departments for generating strategies is an important issue, the applied strategy formulation method, must therefore consider the interrelations between departmental factors.

Moreover, goal, factors and strategies are known as three main elements in strategy formulation and the interrelationship among them should be considered as an integrated set. In addition, in SWOT analysis considering all factors is impossible. Generally, a limited set of factors are being considered and the remaining factors are eliminated according to an overall view of strategists. But, in this paper we are going to consider all factors and their interactions in clusters.

The main objective of this paper is to present how to create strategies on a more accurate and objective-based by considering all the components and the significance of their impact on goals. The environmental analysis in organizational departments, including all opportunities and threats, in the light of organization's strengths and weaknesses, is performed. At this stage, the factor–goal matrix is formed by obtaining the impact of factors on individual departmental goals. Then, the proposed clustering approach is applied to cluster goals and relevant factors.

The factors appeared in each integrated cluster were divided in two categories based on the impact of the factors on goals in each cluster, including influential and un-influential factors. Influential factors affect cluster's goal directly and un-influential factors do not influences directly on cluster's goal. To identify the type of each factor in every cluster, a threshold value β_c was defined. If the ξ_{ij} value of a factor was more than β_c, then the factor was considered to be an influential factor; otherwise, it is considered to be in category of un-influential factors. The value of β_c is also obtained from the following equation:

$$\beta_c = \mu_c - 2 \times \left(\sum_{i=1}^{I} \sum_{j \in j_c} \sqrt{\mu_c - \xi_{ij}} \right) \Big/ I \times card(j_c) \quad \forall c, \tag{9}$$

where μ_c for each cluster is obtained by $\mu_c = \sum_{i=1}^{I} \sum_{j \in j_c} \xi_{ij} \big/ I \times card(j_c)$.

In this paper, the whole departmental goals with higher similarities are embedded within the same cluster integrally. After determining the integrated goal–factor clusters, organizational strategies are generated based on each cluster. Where, influential factors of individual cluster show the present position of the clusters in SWOT space. This allows us to survey the present position of the organization in more details. To find the present position of the clusters in SWOT space the Factor Score (FS) should be calculated by Eq. (10) for each influential factor.

$$FS_i^c = \pm \frac{\chi_i^c}{\sum_{i=1}^{I} \chi_i^c} \times \varpi_i^c, \quad \forall i, c \tag{10}$$

where ϖ_i^c presents score of ith influential factor in cluster cth, χ_i^c is the importance rate of ith influential factor in cluster cth. χ_i^c is obtained by normalizing the factor's impact on goals which falls in respective cluster and is calculated by:

$$\chi_i^c = \frac{\sum_{j \in J_{c^k}} \xi_{ij}^k}{n(J_{c^k})} \quad \forall i, c \tag{11}$$

If the factor has a positive feature (including strength and opportunity) the FS formulation sign is positive. If the factor has a negative feature (including weakness and threat) the FS formulation sign is negative. The following framework procedure is employed for strategy formulation based on clustering approach for corporate organization and schematically shown in Fig. 1.

Step 1. Collect factors and goals from individual department.
Step 2. Form factor–goals matrices for individual department (by determining interaction among departmental factors and goals).
Step 3. Apply the proposed clustering approach to create integrated organizational clusters.
Step 4. Find the position of the clusters by utilizing Eq. (10).
Step 5. Generate strategies according to each cluster.
Step 6. Assign strategies to departments for making action plans (tactics).

Since the homogenous factors and goals fall in a same cluster, it is more facile to generate strategies. In fact, our emphasis is to generate strategies for individual clusters (originated from departments) instead of organization as a whole. This way, the generation

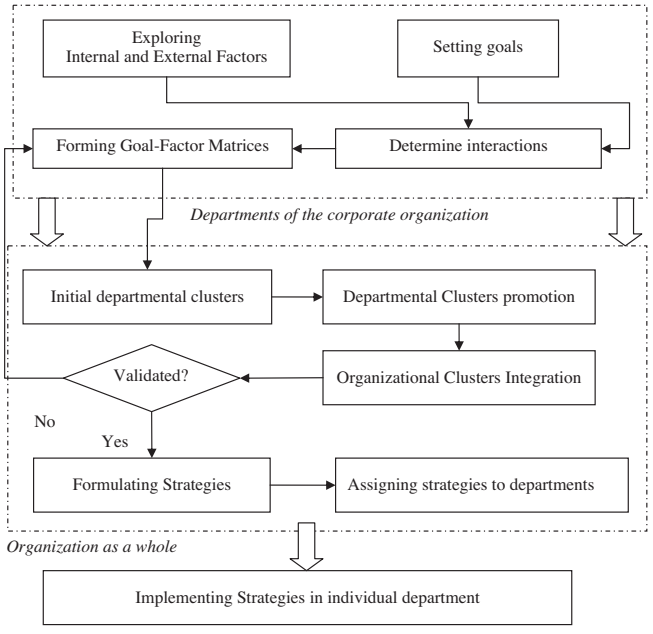

Fig. 1. The schematic view of proposed framework.

Please cite this article in press as: S.A. Hadighi et al., A framework for strategy formulation based on clustering approach: A case study in a corporate organization, Knowl. Based Syst. (2013), http://dx.doi.org/10.1016/j.knosys.2013.04.008

of strategies could be more specific and accurate, while eliminating the conflicts among departmental factors.

5. A case study

The Mahmoudabad Training Center (MTC) is one of educational centers for training personnel of petroleum industry (about 100,000 person) and also staffs from other organizations needing special on the job and recruitment trainings. It includes some full time lecturers and staffs, and also makes use of national and international educational and professional part-time visitors for training and supporting services. The center is accredited by ISO9000 of DNV Company. This center involves eight departments as mechanical, exploration and production, ICT, health, safety and environment (HSE), administrative and financial. Each department has its own organizational chart, connected to top chart with each department having a head and a number of subordinates.

Since each department has its own goals and strategies, different actions have been planned for them separately. In spite of, trying each department to move in direction of organizational goals, considerable deviations were evident. Infrastructure construction, transportation cost, supply chain problems, supplying equipment, procurement functions and educational planning are just some examples of departmental plan conflicts. The MTC is an example of corporate organization which is a sub-company of National Iranian Oil Company. Due to issues mentioned above, it has been decided to apply this framework as a pilot for MTC. The proposed framework has been implemented step by step in MCT and the reports are presented below.

According to the first step of the proposed framework, factors and goals are explored from each organizational department and have shown in Table 2. Preceding to the second step, the head of departments introduced experts from relevant departments. Then the impact of each factor on goals was determined by the department's experts through interviewing. The range of the impact has

Table 2
Departmental factors and goals.

Department	Goals	Factors
Mechanical	Increasing customer satisfaction Increasing market share Improving supply chain service utilization Improving mechanical laboratory equipments Enhancing new technical mechanical courses	Education, specialty, courtesy, appearance, performance, experience, attitude, motivation, public relation, timely, discipline, organization's brand, comfort, equipment functionality, demand, customer's attitude, competitors, reputation, social rules
Exploration and Production	Increasing customer satisfaction Increasing market share Improving supply chain service utilization Setting up well drilling simulator Increasing the number of R&D project	Education, specialty, courtesy, appearance, performance, experience, attitude, motivation, public relation, timely, organization's brand, equipment functionality, demand, customer's attitude, competitors, reputation, social rules, discipline
ICT	Increasing customer satisfaction Increasing market share Improving supply chain service utilization Increasing the capacity of hardware Developing ICT infrastructure bases of the center	Education, specialty, courtesy, appearance, performance, experience, attitude, motivation, public relation, timely, organization's brand, equipment functionality, comfort, reputation, demand, customer's attitude, social rules, discipline, competitors
HSE	Increasing customer satisfaction Increasing market share Improving supply chain service utilization Improving HSE standards in the center Developing new updated courses in HSE	Education, specialty, courtesy, appearance, performance, experience, attitude, motivation, public relation, timely, organization's brand, comfort, equipment functionality, social rules, demand, customer's attitude, reputation, discipline, competitors
Administrative	Increasing customer satisfaction Developing organization size and scope of activities Developing human resources Reducing number of staff quitting job Improving motivation of personnel Improving the performance rate of the personnel	Education, courtesy, performance, experience, attitude, motivation, public relation, timely, organizational rule, support services, discipline
Financial	Increasing the assignable budgets Facilitating and promoting the financial system Increasing customer satisfaction Developing organization size and scope of activities	Education, courtesy, performance, experience, attitude, motivation, public relation, timely, organizational rule, financial ability, support services, tax rules, discipline, economic parameters

Please cite this article in press as: S.A. Hadighi et al., A framework for strategy formulation based on clustering approach: A case study in a corporate organization, Knowl. Based Syst. (2013), http://dx.doi.org/10.1016/j.knosys.2013.04.008

Table 3
Integrated organizational clusters.

Cluster	Goals	Influential factors
I	**G1**: Enhancing new technical mechanical courses **G2**: Developing new updated courses in HSE	Education(+), specialty(−), performance(+), experience(+), motivation(−), discipline(+), demand(+)
II	**G3**: Increasing customer satisfaction **G4**: Improving the performance rate of the personnel **G5**: Facilitating and promoting the financial system	Specialty(−), appearance(+), performance(+), attitude(+), public relation(+), timely(+), equipment functionality(−), motivation(−), equipment comfort(−), organization's brand(+), discipline(+), financial ability(+), economic parameters(−), organizational rule(+)
III	**G6**: Increasing market share **G7**: Increasing the number of R&D project **G8**: Developing organization size and scope of activities **G9**: Increasing the assignable budgets	Performance(+), motivation(−), organization's brand(+), demand(+), customer's attitude(+), education(+), specialty(−), equipment functionality(+), equipment comfort(−), social rules(−), financial ability(+), economic parameters(−)
IV	**G10**: Improving supply chain service utilization	Experience(+), performance(+), attitude(+), public relation(+), discipline(+), organization's brand(+), courtesy(+)
V	**G11**: Improving mechanical laboratory equipments **G12**: Setting up well drilling simulator **G13**: Increasing the capacity of hardware **G14**: Developing ICT infrastructure bases of the center	Education(+), specialty(−), organization's brand(+), motivation(−), demand(+), discipline(+), experience(+), performance(+), attitude(+),
VI	**G15**: Improving HSE standards in the center **G16**: Developing human resources **G17**: Improving motivation of personnel	Education(+), specialty(−), performance(+), experience(+), motivation(−), organizational rule(+), attitude(+), timely(+), support services(+)

been assigned from one to ten. So that, 1 represent the least impact and 10 shows the most impact of factor on goal. The results of interviews are shown in Appendix A.

According to Step 3, we have formed the integrated organizational clusters. To do this, the proposed clustering algorithm was coded in JAVA, and the computations were carried out on an Intel Pentium 4, 1.7 GHz computer, 2 GB RAM. Six clusters with their relevant goals and influential factors have been formed and reported in Table 3. By applying Eq. (9) the influential factors of each cluster were identified. Six clusters each involves two to four goals are generated. Each cluster consisting of related goals and all factors with their rates of impact on an individual goal in that cluster. As an example, "enhancing new technical mechanical courses" and "developing new updated courses in HSE" with influential factors education, specialty, performance, experience, motivation, discipline and demand fell in cluster 1. The same explanation satisfies for the rest of clusters.

Prior to generating strategies, the position of the clusters in SWOT space has to be determined. So, factor scores FS_i^c have been calculated from Eq. (10) for each influential factor. In fact, the resultants of negative and positive influential factors show the position of the clusters. Present score and importance rate of influential factor in clusters has been obtained by interviewing from department experts. Factor scores, present score and importance rate of influential factor which obtained from each cluster and are summarized in Appendix B. After determining the position of the clusters in SWOT space as shown in Fig. 2, strategies are generated and summarized in Table 4. Based on the goals and factors of each department in clusters, the formulated strategies are dedicated to individual department. It should be noted that just a set of strategies are dedicated to each cluster with different goals. These strategies not only refer to the goals in clusters, but also belong to the department which these goals are come from.

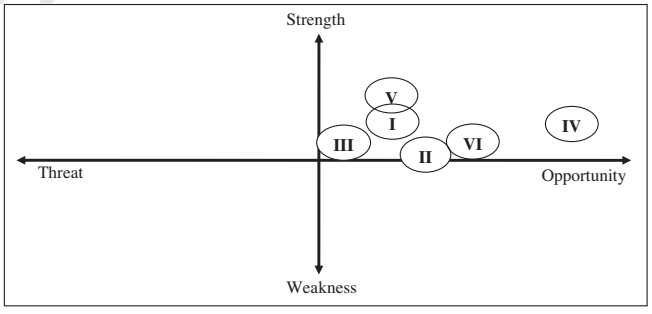

Fig. 2. Cluster position in SWOT space.

6. Discussion

To evaluate the proposed method against ordinary approaches in the literature, two sections including validation and comparison have been presented. The impact of the formulated strategies on departmental long term goals and factors are determined. These data are utilized for validating the model through clustering first, strategies with goals and then strategies with factors. Since, the results from strategy–goal and strategy–factor clustering match to the integrated organizational clusters the model is valid. Then, in comparison section, by comparing the results from SWOT method against proposed method the capability of the model is shown.

6.1. Validation

For validating the proposed framework two steps including expert consensus on formulating strategies and model validation are required.

Please cite this article in press as: S.A. Hadighi et al., A framework for strategy formulation based on clustering approach: A case study in a corporate organization, Knowl. Based Syst. (2013), http://dx.doi.org/10.1016/j.knosys.2013.04.008

Table 4
Proposed strategies with corresponding clusters.

Cluster	SWOT position (*X*, *Y*)	Strategy
I	(1.94, 1.03)	1 – Training mechanical technical personnel 2 – Training HSE personnel
II	(2.16, 0.21)	1 – Developing a customer satisfaction plan through stressing on human resource plans 2 – Developing an appropriate performance evaluation and incentive system 3 – Promoting financial system process (automation system, credit sale cashing)
III	(0.81, 0.88)	1 – Empowering marketing department in relation to contacting different petroleum sub-companies 2 – Generating R&D Dep. In the center and working on increasing size and activity 3 – Creating justification financial plan for developing in different area
IV	(5.99, 1.07)	1 – Training supply chain personnel 2 – Be strict on supply chain
V	(1.94, 1.43)	1 – Setting and implementing infrastructure plans particularly on ICT, Mech. Lab, and Extraction Dep. Lab 2 – Shifting budget on construction to educational infrastructure
VI	(2.79, 0.50)	1 – Revising HSE standards 2 – Training personnel on standards

Table 5
Concordance strategies in the integrated organizational clusters.

Cluster	Code	Strategy
I	S1 S2	Developing new and updated courses in Mechanical and H.S.E. Dep. Working on need evaluation of companies in Mechanical and H.S.E. courses
II	S3 S4 S5	Developing a customer satisfaction plan through stressing on human resource plans Developing an appropriate performance evaluation and incentive system Promoting financial system process (automation system, credit sale cashing)
III	S6 S7 S8	Empowering marketing department in relation to contacting different petroleum sub-companies Generating R&D Dep. In the center and working on increasing size and activity Creating justification financial plan for developing in different area
IV	S9 S10	Setting a supply chain selection plan according to developing plans Generating a supervisory department for supply chain
V	S11 S12	Setting and implementing infrastructure plans particularly on ICT, Mech. Lab, and Extraction Dep. Lab Shifting budget on construction to educational infrastructure
VI	S13 S14	Revising the personnel motivation plan Improving human resource development plan, by stressing on H.S.E. standards

Table 6
Strategy–goal and strategy–factor clusters.

Cluster	Strategy	Goal	Factor
CI	S1–S2–S11–S12	G1–G2–G11–G12–G13–G14	Education, specialty, performance, experience, motivation, discipline, demand, attitude, organization's brand
CII	S3–S4–S5	G3–G4–G5	Specialty, appearance, performance, attitude, public relation, timely, equipment functionality, motivation, equipment comfort, organization's brand, discipline, financial ability, economic parameters, organizational rule
CIII	S6–S7–S8	G6–G7–G8–G9	Performance, motivation, organization's brand, demand, customer's attitude, education, specialty, equipment functionality, equipment comfort, social rules, financial ability, economic parameters
CIV	S9–S10	G10	Experience, performance, attitude, public relation, discipline, organization's brand, courtesy
CV	S13–S14	G15–G16–G17	Education, specialty, performance, experience, motivation, organizational rule, attitude, timely, support services

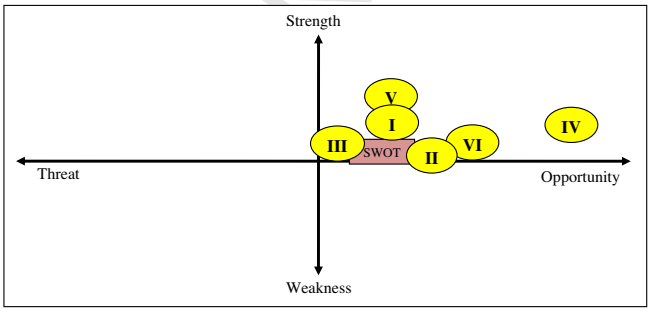

Fig. 3. The comparative results of the two methods.

6.1.1. Expert consensus

Based on the characteristics of the integrated organizational clusters, experts are asked to present the strategies. Since, different experts from various department are called, there might exist conflicts among their inferences. The Delphi approach is used to overcome this issue. Eight experts at least one from each department are invited in consensus meeting. They have been asked to give the rank of individual strategy in each cluster. Then Kendall's *W* also known as Kendall's coefficient of concordance (a non-parametric statistic) is calculated [56] for each cluster. It is a normalization of the statistic of the Friedman test [57], and can be used for assessing agreement among experts (see Appendix C). The statistics of Kendall for clusters are shown that three clusters

Please cite this article in press as: S.A. Hadighi et al., A framework for strategy formulation based on clustering approach: A case study in a corporate organization, Knowl. Based Syst. (2013), http://dx.doi.org/10.1016/j.knosys.2013.04.008

Table A1
Mechanical Department factor–goal matrix.

Factors	Mechanical Department goal				
	Increasing customer satisfaction	Increasing market share	Improving supply chain service utilization	Improving mechanical laboratory equipments	Enhancing new technical mechanical courses
Education	8	7	7	9	9
Specialty	9	8	7	10	10
Courtesy	8	7	6	4	3
Appearance	9	8	7	1	1
Performance	10	9	8	7	8
Experience	8	6	9	7	8
Attitude	9	7	8	5	6
Motivation	8	9	7	7	9
Public relation	9	7	8	5	4
Timely	10	8	7	5	6
Discipline	8	7	8	7	8
Organization's brand	8	9	8	8	6
Equipment comfort	8	7	7	4	3
Equipment functionality	9	8	5	2	5
Demand	2	10	5	7	8
Customer's attitude	8	9	6	5	6
Competitors	3	5	4	5	6
Reputation	7	8	7	6	7
Social rules	7	5	5	4	5

Table A2
Exploration and Production Department factor–goal matrix.

Factors	Exploration and Production Department goal				
	Increasing customer satisfaction	Increasing market share	Improving supply chain service utilization	Setting up well drilling simulator	Increasing the number of R&D project
Education	8	7	6	8	9
Specialty	9	8	6	9	9
Courtesy	9	7	5	4	3
Appearance	8	8	6	1	2
Performance	10	9	7	5	5
Experience	8	6	8	6	7
Attitude	9	7	7	4	5
Motivation	8	9	6	6	8
Public relation	8	7	6	4	3
Timely	10	8	7	5	6
Equipment functionality	10	9	6	1	7
Organization's brand	8	9	7	6	6
Discipline	8	7	5	6	7
Demand	2	10	5	5	6
Customer's attitude	8	9	5	4	5
Competitors	2	5	4	5	6
Reputation	7	8	5	5	7
Social rules	7	5	5	4	5

consisting of 2, 3 and 5 gained the W value more than 0.7. For the other three clusters that the Friedman tests are not significant, decision has been made in next session. After revising the strategies, experts have been asked to reassess the tests. Finally, after three iterations all the clusters attained qualified Kendall value which means the consensus have taken place. The concordance strategies in the integrated organizational clusters are reported in Table 5.

6.1.2. Model validation

In strategy formulation the main purpose is to generate strategies for achieving organizational long term goals through conducting the organization's departments. Therefore, vital effect of strategies on accomplishing the goals is shown for model validation. In this manner, experts have been asked to specify the rate of strategies impact on individual goal and factor. This has been done for all strategies, factors and goals regardless of any defaults. Having provided strategy–goal and strategy–factor matrices, the proposed clustering algorithm has been utilized to generate the strategy–goal and strategy–factor clusters. In fact, these clusters show that which strategy has more impact on predetermined goals. If the goals and factors of earlier goal–factor cluster (Table 3) match with the goals and factors of strategy–goal and strategy–factor clusters at this stage, then the model is valid. Otherwise, the generated strategies must be reconsidered.

We asked from the experts of the organization to specify the impact of each strategy on factors and goals. strategy–goal and strategy–factor matrices have been formed to cluster the goals and factors. Since, the elements of the new clusters are matching to the factor–goal clusters, the proposed strategies are valid. This

Please cite this article in press as: S.A. Hadighi et al., A framework for strategy formulation based on clustering approach: A case study in a corporate organization, Knowl. Based Syst. (2013), http://dx.doi.org/10.1016/j.knosys.2013.04.008

Table A3
ICT Department factor–goal matrix.

Factors	ICT Department goal				
	Increasing customer satisfaction	Increasing market share	Improving supply chain service utilization	Increasing the capacity of hardware	Developing ICT infrastructure bases of the center
Education	9	9	7	6	6
Specialty	10	9	7	7	8
Courtesy	9	8	8	3	4
Appearance	9	8	7	2	2
Performance	10	10	7	7	6
Experience	9	8	6	8	6
Attitude	9	8	7	7	6
Motivation	9	8	7	8	7
Public relation	9	8	8	6	5
Timely	10	9	7	5	6
Equipment functionality	10	10	7	6	5
Organization's brand	9	9	6	6	5
Equipment comfort	10	9	7	6	4
Demand	3	10	6	7	8
Customer's attitude	8	9	6	6	5
Competitors	3	5	4	6	6
Reputation	8	7	6	5	5
Social rules	8	9	7	6	6
Discipline	9	8	7	6	5

Table A4
HSE Department factor–goal matrix.

Factors	HSE Department goal				
	Increasing customer satisfaction	Increasing market share	Improving supply chain service utilization	Improving HSE standards in the center	Developing new updated courses in HSE
Education	8	7	7	9	9
Specialty	9	8	6	9	9
Courtesy	8	7	6	7	6
Appearance	7	6	5	4	3
Performance	10	9	7	9	8
Experience	9	8	7	8	9
Attitude	9	7	6	8	7
Motivation	8	9	7	9	9
Public relation	9	8	6	5	4
Timely	10	8	7	6	6
Equipment functionality	9	8	5	7	4
Organization's brand	9	8	6	8	6
Equipment comfort	9	7	6	7	4
Demand	2	10	5	7	6
Customer's attitude	8	9	6	2	6
Competitors	3	5	4	6	5
Reputation	7	8	6	7	6
Social rules	7	5	5	8	6
Discipline	8	7	6	7	6

shows that the influential factors and strategies of each initial cluster fall in the same cluster. So, the proposed strategy is appropriate according to the new clusters as reported in Table 6. Comparing strategy–goal and strategy–factor clusters with the factor–goal clusters show that goals and strategies in previous clusters again fall in the same clusters while the number of the clusters is decreased to five. For example G1, G2, G11, G12, G13 and G14 with S1, S2, S11 and S12 fall in cluster I.

6.2. Comparisons

To show the capability of the presented method, we reported the results of a comparison between a SWOT and proposed method. An important issue to be considered in the implementation phase is the utilization of strengths and opportunities against weaknesses and threats, within the development path of the organization. When an organization is partitioned into different

Please cite this article in press as: S.A. Hadighi et al., A framework for strategy formulation based on clustering approach: A case study in a corporate organization, Knowl. Based Syst. (2013), http://dx.doi.org/10.1016/j.knosys.2013.04.008

clusters, the organization is being considered more precisely and in details. This issue would be more sophisticated when we encounter with an organization with variety of departments. Each cluster will be considered as an individual organization having its own goals, factors, strategies and development path. Usually, strategists design a development path (with individual path and steps of development during strategy implementation) for current state of the organization, while in proposed method the development paths are as many as clusters. In fact, the current state of each cluster within the SWOT space was obtained by analyzing the relevant factors. The comparative results of the two methods are shown schematically in Fig. 3. The ordinary SWOT data has been reported in Appendix D.

7. Conclusion

In this paper, a new framework has been proposed for strategy formulation of corporate organization. A clustering approach was applied to develop strategy formulation by clustering factors and long term goals based on impact of factors on individual goals. Then, the strategies were generated for each cluster individually instead of the whole organization. The capability and applicability of the proposed framework has been shown through a case study in National Iranian Oil Company's Training Center. Results indicate that the proposed strategy formulation outperforms other approaches and is very promising not only for solving the problem, but also for utilizing in other corporate organizations. Thereby, the main advantages of the proposed framework can be stated as follows:

I. Utilizing an efficient data mining method forclustering corporate organization into various clusters.
II. Developing a new strategy formulation method for corporate organization which contains variety of departments.
III. Considering interactions among all goals and factors regardless of belonging to which department.
IV. Partitioning organization into different clusters based on the impact of each factor on individual goals.
V. Allocating departmental resources based on homogeneous strategies generated from integrated organizational clusters.

Here, a new strategy formulation was proposed for corporate organization. It is most likely that this approach is suitable for huge organization. Another stream that could be developed is implementation phase. Since, resources were belonging to the depart-

Table A5
Administrative Department factor–goal matrix.

Factors	Administrative Department goal					
	Increasing customer satisfaction	Developing organization size and scope of activities	Developing human resources	Reducing number of staff quitting job	Improving motivation of personnel	Improving the performance rate of the personnel
Education	7	6	8	7	8	8
Courtesy	8	5	7	5	7	8
Organizational rule	8	7	8	9	8	9
Performance	9	8	7	8	7	10
Experience	8	7	8	6	7	7
Attitude	7	8	8	7	8	9
Motivation	8	7	9	10	10	9
Public relation	8	6	6	5	6	6
Timely	9	7	8	6	6	7
Support services	7	6	6	5	7	7
Discipline	8	7	7	6	5	6

Table A6
Financial Department factor–goal matrix.

Factors	Financial Department goal			
	Increasing the assignable budgets	Facilitating and promoting the financial system	Increasing customer satisfaction	Developing organization size and scope of activities
Education	6	8	8	7
Organizational rule	7	8	8	9
Courtesy	2	3	5	4
Performance	7	8	9	6
Experience	6	7	7	6
Attitude	5	6	7	5
Motivation	4	6	8	7
Public relation	2	3	7	1
Timely	3	5	9	3
Financial ability	10	9	8	9
Support services	3	3	5	6
Economic parameters	9	8	7	7
Discipline	6	6	8	7
Tax rules	3	4	3	4

Please cite this article in press as: S.A. Hadighi et al., A framework for strategy formulation based on clustering approach: A case study in a corporate organization, Knowl. Based Syst. (2013), http://dx.doi.org/10.1016/j.knosys.2013.04.008

Table B1
Factor scores, present score and importance rate for cluster I.

Factor	χ_i^1	ϖ_i^1	FS_i^1	Factor	χ_i^1	ϖ_i^1	FS_i^c
Education	0.16	7	1.09	Motivation	0.16	6	0.93
Specialty	0.16	6	0.98	Discipline	0.12	7	0.84
Performance	0.14	6.5	0.90	Demand	0.12	8.5	1.03
Experience	0.15	7	1.03				

Table B2
Factor scores, present score and importance rate for cluster II.

Factor	χ_i^2	ϖ_i^2	FS_i^2	Factor	χ_i^2	ϖ_i^2	FS_i^2
Specialty	0.0768	6.833	0.52	Motivation	0.0680	6.500	0.44
Appearance	0.0685	7.000	0.48	Equipment comfort	0.0747	5.333	0.40
Performance	0.0813	6.667	0.54	Organization's brand	0.0705	7.833	0.55
Attitude	0.0714	6.333	0.45	Discipline	0.0680	6.833	0.47
Public relation	0.0697	7.500	0.52	Financial ability	0.0664	6.833	0.45
Timely	0.0813	7.167	0.58	Economic parameters	0.0581	5.833	0.34
Equipment functionality	0.0788	5.667	0.45	Organizational rule	0.0664	7.167	0.48

Table B3
Factor scores, present score and importance rate for cluster III.

Factor	χ_i^3	ϖ_i^3	FS_i^3	Factor	χ_i^3	ϖ_i^3	FS_i^3
Performance	0.080	6.75	0.539	Specialty	0.094	6.5	0.609
Motivation	0.077	6.5	0.501	Equipment functionality	0.083	5	0.413
Organization's brand	0.083	8.25	0.682	Equipment comfort	0.077	4.25	0.328
Demand	0.088	7	0.617	Social rules	0.055	5.75	0.317
Customer's attitude	0.077	6.5	0.501	Financial ability	0.110	6.75	0.744
Education	0.077	7.25	0.559	Economic parameters	0.099	6	0.595

Table B4
Factor scores, present score and importance rate for cluster IV.

Factor	χ_i^4	ϖ_i^4	FS_i^4	Factor	χ_i^4	ϖ_i^4	FS_i^4
Experience	0.144	6.5	0.938	Discipline	0.144	7	1.010
Performance	0.144	7	1.010	Organization's brand	0.135	8	1.077
Attitude	0.144	6.5	0.938	Courtesy	0.135	7	0.942
Public relation	0.154	7.5	1.154				

Table B5
Factor scores, present score and importance rate for cluster V.

Factor	χ_i^5	ϖ_i^5	FS_i^5	Factor	χ_i^5	ϖ_i^5	FS_i^5
Education	0.11	7.33	0.811	Discipline	0.12	6	0.692
Specialty	0.13	7.33	0.917	Experience	0.13	5	0.649
Organization's brand	0.10	8	0.769	Performance	0.12	6	0.692
Motivation	0.10	6.66	0.673	Attitude	0.12	6	0.692
Demand	0.09	7.33	0.670	Discipline	0.12	6	0.692

Table B6
Factor scores, present score and importance rate for cluster VI.

Factor	χ_i^6	ϖ_i^6	FS_i^6	Factor	χ_i^6	ϖ_i^6	FS_i^6
Education	0.119	7	0.832	Organizational rule	0.112	6	0.671
Specialty	0.126	6.5	0.818	Attitude	0.112	7	0.783
Performance	0.112	6.5	0.727	Timely	0.098	7	0.685
Experience	0.112	6.5	0.727	Support services	0.084	6	0.503
Motivation	0.126	6.5	0.818				

Table D1
The internal factors of the organization.

Factors	Type	Weight	Score	Weighted score
Education	+	0.10	4	0.40
Specialty	+	0.09	3	0.27
Courtesy	+	0.06	3	0.18
Appearance	+	0.05	4	0.20
Public relation	+	0.05	3	0.15
Comfort	+	0.01	3	0.03
Multi functionality	+	0.01	3	0.03
Organization's brand	+	0.07	4	0.28
Discipline	+	0.03	3	0.09
Timely	+	0.03	4	0.12
Performance	–	0.08	2	0.16
Attitude	–	0.13	2	0.26
Motivation	–	0.09	2	0.18
Experience	–	0.06	2	0.12
Functionality	–	0.04	1	0.04
User friendly	–	0.05	2	0.10
Comfort ability	–	0.05	1	0.05

ments and not the clusters, the share of individual department resources should be considered. For future research, applying other methods of clustering such as evolutionary methods, model-based clustering or constraint-based clustering could be used.

Appendix A.

See Tables A1–A6.

Appendix B.

See Tables B1–B6.

Appendix C.

Suppose that strategy i is given the rank $r_{i,j}$ by expert number j, where there are in total n strategies and m experts. Then the total rank given to object i is

$$\chi_i = \sum_{j=1}^{m} r_{ij}$$

and the mean value of these total ranks is

$$\bar{\chi}_i = \frac{1}{2}m(n+1)$$

The sum of squared deviations, μ, is defined as

$$\mu = \sum_{i=1}^{n} (\chi_i - \bar{\chi}_i)^2$$

and then Kendall's W is defined as

$$W = \frac{12\mu}{m^2 n(n^2-1)}$$

If the test statistic W is 1, then all the experts have been unanimous, and each expert has assigned the same order to the list of strategies. If W is 0, then there is no overall trend of agreement among the

Please cite this article in press as: S.A. Hadighi et al., A framework for strategy formulation based on clustering approach: A case study in a corporate organization, Knowl. Based Syst. (2013), http://dx.doi.org/10.1016/j.knosys.2013.04.008

Table D2
The external factors of the organization.

Factors	Type	Weight	Score	Weighted score
Demand	+	0.15	4	0.60
Customer attitude	+	0.10	3	0.30
Supply chain	+	0.10	3	0.30
Customer financial ability	+	0.05	3	0.15
Timeliness	+	0.10	4	0.40
Competitors	–	0.20	1	0.20
Economic parameters	–	0.10	2	0.20
Supply chain training	–	0.10	2	0.20
Social rules	–	0.05	2	0.10
Tax	–	0.05	2	0.10

experts, and their responses may be regarded as essentially random. Intermediate values of W indicate a greater or lesser degree of unanimity among the various experts or respondents.

Appendix D. Contemporary SWOT

See Tables D1 and D2.

Reference

[1] A. Hadighi, I. Mahdavi, A New Model for Strategy Formulation Using Mahalanobis-Taguchi System and Clustering Algorithm, September 2011, http://dx.doi.org/10.4236/iim.2011.35024. <http://www.SciRP.org/journal/iim>.
[2] R.B. Duncan, Characteristics of organizational environments and perceived environmental uncertainty, Administrative Science Quarterly 17 (1972) 313–327.
[3] H. Mintzberg, The Rise and Fall of Strategic Planning: Reconceiving Roles for Planning, Plans, Planners, Free Press, New York, 1994.
[4] D.N. Chen, T.P. Liang, Knowledge evolution strategies and organizational performance: a strategic fit analysis, Electronic Commerce Research and Applications 10 (1) (2011) 75–84.
[5] S. Samoilenko, K.M. Osei-Bryson, Using data envelopment analysis (DEA) for monitoring efficiency-based performance of productivity-driven organizations: design and implementation of a decision support system, Omega Article, in press, http://dx.doi.org/org/10.1016/j.omega.2011.02.010.
[6] C.Y. Gao, D.H. Peng, Consolidating SWOT analysis with non-homogeneous uncertain preference information, Knowledge-Based Systems 24 (6) (2011) 796–808.
[7] F.J. Aguilar, Scanning the Business Environment, McMillan, New York, 1967.
[8] Y.C. Chang, Strategy formulation implications from using a sustainable growth model, Journal of Air Transport Management 20 (2012) 1–3.
[9] M. Mohammad Pur, A. Alem Tabriz, SWOT analysis using of modified fuzzy QFD – a Case study for strategy formulation in Petrokaran film factory, Procedia – Social and Behavioral Sciences 41 (2012) 322–333.
[10] J. Bisbe, R. Malagueno, Using strategic performance measurement systems for strategy formulation: does it work in dynamic environments? Management Accounting Research. http://dx.doi.org/10.1016/j.mar.2012.05.002 (14.06.12).
[11] R.N. Kostoff, R. Boylan, G.R. Simons, Disruptive technology roadmaps, Technological Forecasting and Social Change 71 (1–2) (2004) 141–159.
[12] R. Phaal, C.J.P. Farrukh, D.R. Probert, Technology road mapping – a planning framework for evolution and revolution, Technological Forecasting and Social Change 71 (1–2) (2004) 5–26.
[13] M. Caetano, D.C. Amaral, Roadmapping for technology push and partnership: a contribution for open innovation environments, Technovation 31 (7) (2011) 320–335.
[14] M. Godet, Scenarios and Strategies: A Toolbox for Problem Solving, Cahiers du LIPS, Special Issue: Paris, 1997.
[15] J. Coates, Scenario planning, Technological Forecasting and Social Change 65 (1) (2000) 115–123.
[16] R. Vecchiato, C. Roveda, Strategic foresight in corporate organizations: handling the effect and response uncertainty of technology and social drivers of change, Technological Forecasting and Social Change 77 (2010) 1527–1539.
[17] X. Gimbert, J. Bisbe, X. Mendoza, The role of performance measurement systems in strategy formulation processes, Long Range Planning 43 (2010) 477–497.
[18] O. Dincer, Strategy Management and Organization Policy, Beta Publication, Istanbul, 2004.
[19] R.E. Bellman, L.A. Zadeh, Decision-making in a fuzzy environment, Management Science 17 (4) (1970) 141–164.
[20] S.J. Chen, C.L. Huang, F.P. Huang, Fuzzy Multiple Attribute Decision Making Methods and Applications, Springer, Berlin, 1992.
[21] E.L. Paiva, A.V. Roth, J.E. Fensterseifer, Organizational knowledge and the manufacturing strategy process: a resource-based view analysis, Journal of Operations Management 26 (1) (2008) 115–132.
[22] J.R.M. Gordon, P.M. Lee, H.C. Lucas, A resource-based view of competitive advantage at the Port of Singapore, The Journal of Strategic Information Systems 14 (1) (2005) 69–86.
[23] S.H. Chen, C.H. Hsieh, Representation, ranking, distance, and similarity of L–R type fuzzy number and application, Australian Journal of Intelligent Processing Systems 6 (4) (2000) 217–229.
[24] F.R. David, Strategic Management, Concepts and Cases, eighth ed., Prentice Hall, 2001.
[25] L. Kuo-liang, L. Shu-chen, A fuzzy quantified SWOT procedure for environmental evaluation of an international distribution center, Information Science 178 (2008) 531–549.
[26] P.F. Drucker, The Practice of Management, Harper, New York, 1954.
[27] P. Selznick, Leadership in Administration, Harper and Row, New York, 1957.
[28] A.D. Chandler, Strategy and structure: Chapters in the History of the American Industrial Enterprise, MIT Press, London, 1962.
[29] H.I. Ansoff, Corporate Strategy, McGraw-Hill, New York, 1965.
[30] E.P. Learned, C.R. Christensen, K.E. Andrews, W.D. Guth, Business Policy: Text and Cases, Irwin, Homewood, IL, 1965.
[31] K.R. Andrews, The Concept of Corporate Strategy, Dow-Jones Irwin, Homewood, IL, 1971.
[32] R.P. Rumelt, Strategy, Structure, and Economic Performance, Division of Research, Harvard Business School, Boston, MA, 1974.
[33] Mintzberg, Strategy Making in Three Modes, California Management Review, Winter, 1973, p. 44.
[34] I. Ansoff, The changing shape of the strategic problem, in: D. Schendel, C. Hofer (Eds.), Strategic Management: A New View of Business Policy and Planning, Little Brown and Co., Boston, 1979, pp. 37–44.
[35] M.E. Porter, Competitive Strategy, Free Press, New York, 1980.
[36] M.E. Porter, Competition in Global Industries, Harvard Business School Press, Boston, 1986.
[37] C.K. Prahalad, G. Hamel, Competing in the new economy: managing out of bounds, Strategic Management Journal 17 (3) (1996) 237–242.
[38] J. Barney, Firm resources and sustained competitive advantage, Journal of Management 17 (1991) 99–120.
[39] C.C. Miller, L.B. Cardinal, Strategic planning and firm performance: a synthesis of more than two decades of research, Academy of Management Journal 37 (1994) 1649–1665.
[40] D. Ketchen, Cluster analysis application in strategy and macro research as part of a research methods roundtable entitled "Ask the experts", in: Academy of Management Meeting, Cincinnati, OH, 1996.
[41] G. Hamel, Leading the Revolution, Harvard Business School Press, Boston, 2000.
[42] J. Pfeffer, R.I. Sutton, The Knowing-Doing Gap: How Smart Companies Turn Knowledge into Action, Harvard Business School Press, 2000.
[43] J.B. Barney, W.S. Hesterly, Strategic Management and Competitive Advantage, Pearson Prentice Hall, Upple Saddle River, NJ, 2005.
[44] Arnoldo C. Hax, The Delta Model: Reinventing Your Business Strategy (Hardback), 2010.
[45] A. Hatamlou, S. Abdullah, H. Nezamabadi-pour, A combined approach for clustering based on K-means and gravitational search algorithms. Swarm and Evolutionary Computation, in press. Q3
[46] T. Hastie, R. Tibshirani, Discriminant adaptive nearest neighbor classification, IEEE Transactions on Pattern Analysis and Machine Intelligence 18 (6) (1996) 607–616.
[47] D. Lowe, Similarity metric learning for a variable-kernel classifier, Neural Computation 7 (1) (1995) 72–85.
[48] H.A. Guvenir, I. Uysal, Regression on feature projections, Knowledge-Based Systems 13 (4) (2000) 207–214.
[49] T. Graepel, R. Herbrich, Invariant pattern recognition by semi definite programming machines, NIPS: Advances in Neural Information Processing Systems (2004) 33–40.
[50] K.Q. Weinberger, L.K. Saul, Distance metric learning for large margin nearest neighbor classification, Journal of Machine Learning Research 10 (2009) 207–244.
[51] Y. Gao, J. Pan, G. Ji, Z. Yang, A novel two-level nearest neighbor classification algorithm using an adaptive distance metric, Knowledge-Based Systems 26 (2012) 103–110.
[52] T. Chiu, D. Fang, J. Chen, Y. Wang, C. Jeris, A robust and scalable clustering algorithm for mixed type attributes in large database environment, in: Proceedings of the 2001 International Conference on Knowledge Discovery and Data Mining (KDD'01), San Francisco, CA, 2001, pp. 263–268.
[53] S.G. Lee, D.K. Yun, Clustering categorical and numerical data: a new procedure using multidimensional scaling, International Journal of Information Technology and Decision Making 2 (1) (2003) 135–160.
[54] C.C. Hsu, C.L. Chen, Y.W. Su, Hierarchical clustering of mixed data based on distance hierarchy, Information Sciences 177 (2007) 4474–4492.
[55] A.K.C. Wong, D.C.C. Wang, DECA: a discrete-valued data clustering algorithm, IEEE Transactions on Pattern Analysis and Machine Intelligence PAMI 1 (4) (1979) 342–349.
[56] M.G. Kendall, B. Babington Smith, The problem of m rankings, The Annals of Mathematical Statistics 10 (3) (1939) 275–287, http://dx.doi.org/10.1214/aoms/1177732186.
[57] M. Friedman, The use of ranks to avoid the assumption of normality implicit in the analysis of variance, Journal of the American Statistical Association (American Statistical Association) 32 (200) (1937) 675–701, http://dx.doi.org/10.2307/2279372.