A new approach to analyze strategy map using an integrated BSC and FUZZY DEMATEL

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ARTICLE INFO	ABSTRACT
	Today, with ever-increasing competition in global economic conditions, the necessity of effective implementation of strategy map has become an inevitable and necessary. The strategy map represents a general and structured framework for strategic objectives and plays an important role in forming competitive advantages for organizations. It is important to find important factors influencing strategy map and prioritize them based on suitable factors. In this paper, we propose an integration of BSC and Fuzzy DEMATEL technique to rank different items influencing strategy of a production plan. The proposed technique is implemented for real-world case study of glass production.

1. Introduction

Globalization process has imposed the ever-increasing competitive pressure on organizations in all over the world since 1990. Some organizations have tried to promote simultaneously the efficiency and quality of their companies manufacturing unit in reaction to this process. The use of evaluation model proportionate to organizational objectives is an inevitable and necessary task along realization of this circumstance. It is always important to apply accurate evaluation models to organizations to design future strategies of organizations, effectively. It is also a vital task to adjust the functional objectives of staffs for achieving terminal objectives of the whole organization (Wu et al., 2011). Efficient and effective measuring systems are also considered as useful instruments enabling managers to supervise and control the organizational processes to achieve higher efficiency and higher performance (Wang et al., 2010).

There are many strategic control methods and techniques to evaluate organizational activities. One of the systematic and periodic methods to control and evaluate activities is balanced score card (BSC) method introduced by Kaplan and Norton (1992). BSC is an important technique to design organizational strategies and to form performance indexes. BSC is used to create a framework for perfect evaluation and to measure organizational performance for management system (Yuksel &

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Table 1

Previous studies in BSC

Row	Title	Author/ year	Content
1	Strategic performance measurement in a healthcare organization : A multiple criteria approach based on balanced scorecard	(Grigoroudis et al., 2012).	The main objective of this study is the representation of a performance measurement system for healthcare organizations. Measurement indexes include both financial and non financial indexes. Total findings indicated that growth and learning aspect has more significance than other aspects in these organizations.
2	An integrated approach to evaluation and planning of best practices	(Xu & Yeh, 2012).	A new evaluation model is presented by the use of multi criterion decision making algorithm based on BSC framework in this paper to effectively measure the relation between low level and high level objectives of the organization.
3	Extracting leanness criteria by employing the concept of Balanced Scorecard	(Seyedhosseini et al., 2011).	The BSC concept is used for derivation of indexes with poor output in this paper. For this aim, a set of organizational objectives are derived based on different BSC aspects and by the use of organizational strategy map, and their performance was then evaluated.
4	Performance evaluation of extension education centers in universities based on the balanced scorecard	(Wu et al., 2011).	36 indexes were investigated by the use of DEMATEL, ANP and VICOR methods in the form of 4 BSC aspects in Taiwan instruction center and were finally introduced in sequence as the most important indexes in financial, customer, internal business process, growth and learning: cost control, customer continuity, service delivery and enhancing the quality of labor.
5	Developing strategic measurement and improvement for the biopharmaceutical firm: Using the BSC hierarchy	(Huang et al., 2011).	in this paper, Incorporation of BSC and AHP techniques was applied for performance evaluation of biopharmaceutical firm from 4 BSC aspects.
6	Implementation and performance evaluation using the fuzzy network balanced scorecard	(Tseng, 2010).	In this paper, BSC is applied for multi criterion evaluation in Taiwan universities. Dematel technique was applied for investigation of mutual relations between criterions.
7	Integrating hierarchical balanced scorecard with non-additive fuzzy integral for evaluating high technology firm performance	(Wang et al., 2010).	Results showed that the represented performance evaluation system can be effective in removal of the gap between created objectives by top managers and staffs.
8	A Fuzzy DEMATEL framework for modeling cause and effect relationships of strategy map	(Jassbi et al., 2011).	In this paper, 15 available indexes in SAIPA strategy map were investigated from BSC aspects and competitor examination, learning capacity, and rapid service network based on new technologies updated service network for customer need satisfaction and human capital learning and instructional policies and processes factors were introduced as the effective factors.
9	Analyzing BSC and IC's usefulness in nonprofit organizations	(Kong, 2010).	in this research, The flow of knowledge transmission was investigated from human capital, structural capital and relational capital aspects.
10	Using the fuzzy analytic network process (ANP) for Balanced Scorecard (BSC):A case study for a manufacturing firm	(Yuksel & Dag deviren, 2010).	BSC model and Fuzzy ANP are incorporated in this paper to determine business performance level based on organizational strategies and objectives. Findings of this incorporated model shows that more accurate and complete results are achieved by incorporation of these two techniques.
11	Designing a knowledge-based system for strategic planning: A balanced scorecard perspective	(Huang, 2009).	in this study, a combination of two BSC and AHP methods were applied for the performance evaluation of knowledge based systems from financial, customer, internal business processes and learning and growth aspects.
12	Evaluating petroleum supply chain performance: Application of analytical hierarchy process to balanced scorecard	(Varma et al., 2008).	In this paper, a combination of AHP and BSC is used for evaluating the performance of petroleum supply chain. Selecting the determinant factors of supply chain performance is credited by expert's opinions under four BSC aspects.
13	evaluation of performance of society assurance organization by used of combination FDEA and BSC	(Momeni et al., 2010).	In this paper, The extent of department's performance was first calculated by balance scorecard and then, efficiency of this department was measured by the use of FDEA with considering uncertain data in planned indexes by BSC model.
14	evaluation of National Nanotechnology Program with balancing scorecard in Iran	(Ghazi noori & Tavasolizadeh, 2009).	This study was designed and implemented for application of the strategy map and balance scorecard methods in technology strategy in national level which aim were investigation of the efficiency and effectiveness of NANO technology national plan of Iran to assure the accomplishment of NANO innovation chain in national innovation framework.

Dag deviren, 2010). Among performed researches in BSC, we can point to mentioned researches in Table 1. BSC method concentrates important issues for business organizations, issues such as effective measuring of organizational performance and evaluating the organizational strategy (Grigoroudis et al., 2012). The most important capability of BSC is maintaining the balance among: (a) long-term strategies and short-term activities (b) long term and short term objectives (c) financial and non-financial indexes and (d) every four aspects of strategic. By possessing this superior characteristic, BSC is used as a framework for classifying the measuring indexes and criteria for evaluating a set of methods in different parts such as IT investments, research and development projects, ERP systems, banks and other industries (Xu & Yeh, 2012).

In this paper, we propose BSC for classifying strategic objectives of Parchsaz international company and related performance indexes. Although, there are many papers in BSC framework, but little attention has been paid to how this model is implemented in Fuzzy and ambiguous conditions (Tseng, 2010).

2. Literature review

2.1. BSC concept

BSC approach is a strategic planning system widely used in business and industry. BSC is actually a management system, which enables organizations to clearly define their objectives and strategies and then implement them (Olson & Slater, 2002). Kaplan and Norton introduced BSC concept in 1992. This concept was first implemented as a performance evaluation system, especially for 12 companies in USA in 1992. The main objective of BSC was to replace and change the traditional performance evaluation model, which merely concentrated on financial indexes to obtain more complete and effective evaluation of organizational performance in this way by application of this model. Note that financial aspect is still considered as the most important aspect of organizational performance evaluation in BSC. However, other aspects of traditional model should also be considered, aspects such as customer, internal business processes and employee's growth and learning, so that performance evaluation model can achieve more balance and efficiency compared with past performance. These aspects are required for perception and implementation of a perfect performance evaluation system and formation of a general set of organization performance indexes for strategic investigation of all objectives and activities of an organization. The concept and meaning of the four aspects are as following:

1. Financial aspect: this aspect considers how organizations benefit from their strategic activities.
2. Customer aspect: this aspect pays attention to the issue that organizations should benefit of their inherent and available resources for the distinction among their competitors.
3. Internal business process aspect: all the strategic activities in an organization performed for satisfying stockholder and customer's expectations are investigated in this aspect. General process is started by perception of customer's needs and the operational and sale processes are performed after that.
4. Growth and learning aspect: if organizations want to maintain permanent activity and development, they should always rely on constant growth and innovation. Kaplan and Norton have expressed their opinions in this way: "organizations have to emphasize on some principals such as promotion of employee's capabilities and abilities, information system performance, persuasion and etc." This aspect includes three main criteria, which are employee satisfaction, employee continuity and efficiency. Companies and organizations should create performance evaluation indexes by these three criteria. Performance indexes must be unbiased and measurable based on organizational objectives. Index selection is so important for investigation of required industry performance, since we can enhance efficiency of manufacturing operations and create a lot of advantages for company by accurate investigation of these indexes. Performance key indexes should be investigated for achievement of strategic objectives in every four aspects of BSC (Wu et al., 2011). Kaplan and Norton believed that BSC includes affecting and influenced relationships among different indexes in selected aspects. Other different researchers similarly expressed experimental evidences in support of causal relations among different aspects of BSC (Schmidberger et al., 2009).These relationships point to the dependence among financial and non-financial indexes. A structured BSC method should include mutual relations among various aspects and measuring indexes of these aspects (Wang et al., 2010). Relationships among different aspects of BSC are indicated in Fig 1.
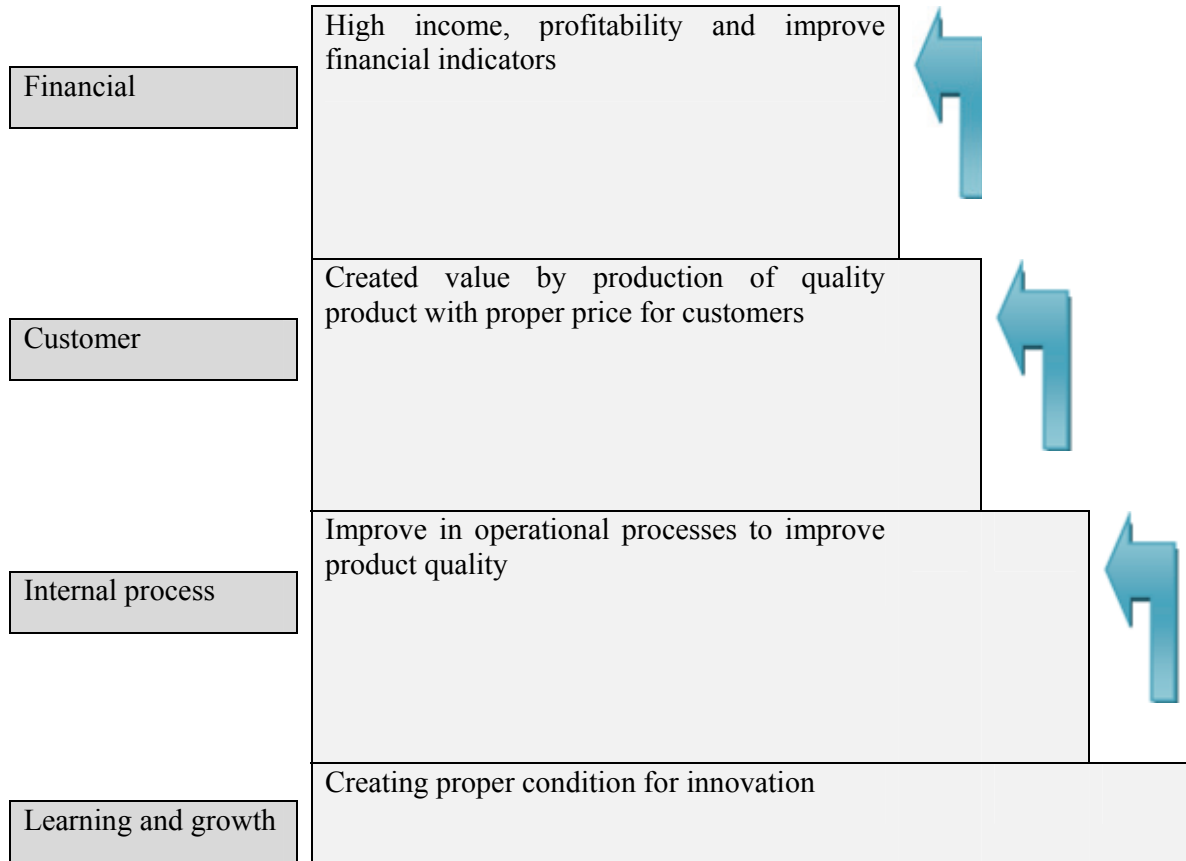
Financial	High income, profitability and improve financial indicators
Customer	Created value by production of quality product with proper price for customers
Internal process	Improve in operational processes to improve product quality
Learning and growth	Creating proper condition for innovation

Fig. 1. The relationships between different components of BSC

In summary, we can say that BSC is a multi criteria investigation concept, which clearly shows the significance of organizational performance measurement (Tseng, 2010).

2.2. Strategy map

BSC innovators believe that successful implementation of organization strategy depends on the issue that organizational individuals conceive and understand the strategies. Note that, this issue requires creating complicated processes, which cause organizational illogical assets and investments change to tangible and logical outputs. BSC innovators have introduced instruments, which could indicate the link between structures of organization strategies by identifying key objectives of organization and conceptualization of causal relations among them called strategy map (Kaplan & Norton, 2000).

In strategy map, the organization is segregated to four aspects, and key objectives of the organization interpolated in the strategic plan of the organization are classified in these four aspects. These aspects are practically indicator of all organizational parts and processes and include financial aspect, customer aspect, internal business process aspect, growth and learning aspect. Objectives such as developing profitable businesses, entrepreneurship, creating revenue, improving customer satisfaction, fostering talents and innovative creations in companies, enhancing employee and beneficiary's satisfaction are of organizational strategic objectives (Chytas, 2008). A basis is achieved by accurate drawing of causal relationships among organizational strategic objectives according to these four aspects, which can be used as a basis for balance scorecard.

2.3. Parchsaz international company (www.parchsaz.com)

Parchsaz international company as the manufacturer of all kinds of required rivet, pin, special part for automobile industries of country, started its operation in 1983 and its motto was "tenacious customers

are our close friends". One of the main policies of this company is to attract the target market customer satisfaction by providing the needs and measuring customer satisfaction with respect to the purchase mass. The company tries to reduce the costs by the aim of reducing sale price to make competition based on business plan in global target market. We need to consider all instructions and permanent improvements, employee participation, developing culture of quality and moving towards zero deviation from desirable policy. This company is now considered as one of the greatest and most reliable companies of the zone by manufacturing more than 20 different kinds of products. The main customers and markets of this company's product are territorial and foreign automobile companies such as firms located in Azerbaijan, Emirate, Armenia and Iraq. Since automobile industry is one of the industries, which has strongly been considered and criticized by customers, we need to pay special attention to manufacturing products of this company to attract automobile companies.

2.4. Fuzzy DEMATEL

DEMATEL was first introduced at Battelle Memorial Institute of Geneva Research Center. This method was applied for complicated problems of the world such as famine, energy, environmental protection and etc in that time (Fontela & Gabus, 1976). DEMATEL is one the multi criteria decision making instruments and has the ability to convert the qualitative designs to the quantitative analysis (Lee et al., 2011).The aim of DEMATEL is to convert the relationships among various criteria, causal dimensions from a complex system to an understandable structural model of that system (Dalalah et al., 2011). All criteria of a system, directly or indirectly, are mutually related to each other in a general reciprocal system. So any change in one of criteria will influence on other criterions (Tzeng et al., 2007). This technique is successfully applied in other circumstances such as development methods, management systems, electronic learning evaluation, knowledge management, etc. (Kuoa & Liang, 2011). Many forms in various countries such as Japan, Korea and Taiwan have widely used DEMATEL technique for successful solving of different problems in different fields (Lin & Wu, 2008). The following summarizes the necessary steps of DEMATEL model we need to implement.

1. First, We need to specify evaluation factors according to expert committee's opinion and research background.

2. Next, We determine how each factor influences on the whole system, according to expert's opinion. To do so, we use discussed wordy expressions in Table2. Then, we use CFC method Eqs (1-9) to convert the fuzzy results into crisp value.

Table 2
The correspondence of linguistic terms and values

Linguistic values	Linguistic terms
[0.75,1,1]	Very high influence(VH)
[0.5,0.75,1]	High influence(H)
[0.25,0.5,0.75]	Low influence (L)
[0,0.25,0.5]	Very low influence (VL)
[0,0,0.25]	No influence (NO)

$$XL_{ij}^{k} = (L_{ij}^{k} - \min_{1 \le k \le k} L_{ij}^{k}) / \Delta_{min}^{max} \tag{1}$$

$$XM_{ij}^{k} = (M_{ij}^{k} - \min_{1 \le k \le k} L_{ij}^{k}) / \Delta_{min}^{max} \tag{2}$$

$$Xr_{ij}^{k} = (r_{ij}^{k} - \min_{1 \le k \le k} L_{ij}^{k}) / \Delta_{min}^{max} \tag{3}$$

$$\Delta_{min}^{max} = \max r_{ij}^{k} - \min L_{ij}^{k} \tag{4}$$

$$Xls\,_{ij}^{\,k} = \frac{Xm\,_{ij}^{\,k}}{(1 + Xm\,_{ij}^{\,k} - Xl\,_{ij}^{\,k})} \tag{5}$$

$$Xrs\,_{ij}^{\,k} = \frac{Xr\,_{ij}^{\,k}}{(1 + Xr\,_{ij}^{\,k} - Xm\,_{ij}^{\,k})} \tag{6}$$

$$X_{ij}^{k} = \left[Xls_{ij}^{k}(1 - Xls_{ij}^{k}) + Xrs_{ij}^{k}.Xrs_{ij}^{k}\right]/(1 + Xrs_{ij}^{k} - Xls_{ij}^{k}) \tag{7}$$

$$BNP\,_{ij}^{\,k} = \min\,L_{ij}^{k} + X\,_{ij}^{\,k}\Delta_{min}^{max} \tag{8}$$

$$a_{ij} = \frac{1}{k}\sum\,_{k}^{1 \le k \le k} BNP\,_{ij}^{\,k} \tag{9}$$

A= [a_{ij}] is direct relations matrix of experts opinions.

3. Now we can determine total relationship matrix T-I, which is an identity matrix $n \times n$ and $T = \left[t_{ij}\right]$ elements indicate the direct and indirect influences of factor *i* on factor *j*. Therefore, matrix *T* represents the indicator of general relations between each pair factor in the system. Matrix D is the normalized matrix. $D = \left[d_{ij}\right], \; 0 \le d_{ij} \le 1$.

$$D = \frac{1}{\max\limits_{1 \le i \le n} \sum_{j=1}^{n} a_{ij}} A \tag{10}$$

$$T = D(I - D)^{-1} \tag{11}$$

4. In this step we calculate the summation of each row and column of *T* matrix, where the sum of row *i* is an indicator for all direct and indirect influences of *i* factor on all other factors and so can call r_i as the influencing degree. C_j is similarly, the column summation and we can call it as influenced degree of *j* factor.

$$r_i = \Sigma_{1 \le i \le n} t_{ij} \tag{12}$$

$$C_j = \Sigma_{1 \le i \le n} t_{ij} \tag{13}$$

Therefore, when $i = j$, $r_i + C_i$ shows both the influence which *i* factor on other factors of system and also the influences of other factors of system on *i* factor. Therefore, $r_i + C_i$ shows the significant degree of *i* factor in whole system, and $r_i - C_i$ indeed shows the influence of *i* on system. If $r_i - C_i$ is positive, *i* factor belongs to the cause group and if $r_i - C_i$ is negative, *i* factor belongs to the effect group.

5. Finally, We show the diagram of factors influencing on $r_i - C_i$ and $r_i + C_i$ bases. This diagram is drawn by ($r_i + C_i, r_i - C_i$) coordinate (Huang, 2009).

3. Research methodology

With respect to the significance of investigating the total processes of regarding company, we consider the strategy map of this company for BSC implementation. Then, we have identified 15 strategic objectives of this company by distributing questionnaires among 5 top managers of different parts of company and then analyze the influences of those objectives on each other by Fuzzy Logic and DEMATEL technique. The strategy map plan of Parchsaz international company is indicated in Fig. 2.
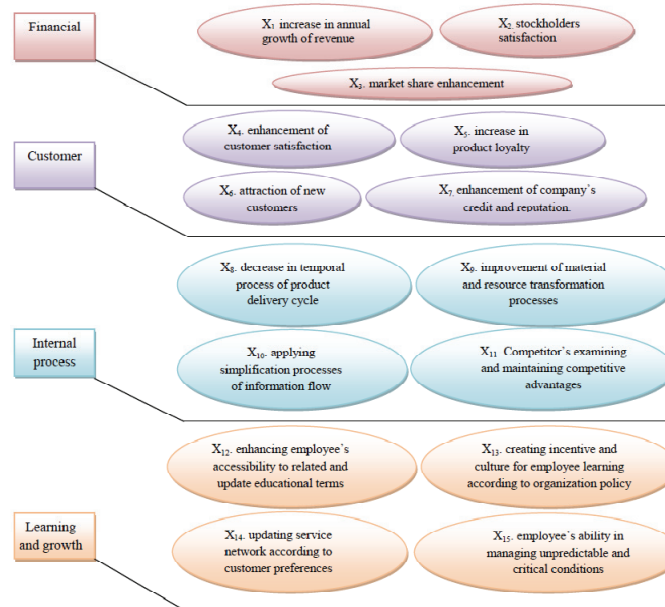
Fig.2. The strategy map plan of Parchsaz international company

Then, direct relations matrix of experts` opinions have been obtained after Defuzzification stages shown in Table 3.

Table 3
Direct relations matrix

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	0	0.957	0.833	0.791	0.309	0.359	0.833	0.309	0.499	0.254	0.041	0.602	0.499	0.791	0.699
X2	0.359	0	0.499	0.25	0.25	0.309	0.25	0.309	0.254	0.499	0.309	0.309	0.25	0.499	0.254
X3	0.957	0.828	0	0.25	0.25	0.25	0.202	0.499	0.309	0.309	0.25	0.041	0.041	0.25	0.041
X4	0.359	0.359	0.957	0	0.957	0.957	0.957	0.041	0.041	0.041	0.041	0.25	0.309	0.833	0.124
X5	0.833	0.359	0.833	0.828	0	0.602	0.957	0.041	0.041	0.041	0.041	0.25	0.25	0.499	0.041
X6	0.833	0.669	0.957	0.041	0.041	0	0.874	0.041	0.041	0.041	0.041	0.25	0.041	0.309	0.041
X7	0.957	0.669	0.957	0.957	0.957	0.957	0	0.254	0.499	0.254	0.499	0.25	0.25	0.828	0.499
X8	0.833	0.202	0.874	0.25	0.25	0.25	0.874	0	0.359	0.254	0.828	0.041	0.041	0.833	0.499
X9	0.957	0.828	0.833	0.957	0.957	0.957	0.957	0.957	0	0.309	0.791	0.041	0.041	0.833	0.828
X10	0.833	0.791	0.828	0.833	0.874	0.828	0.828	0.874	0.874	0	0.833	0.309	0.309	0.833	0.833
X11	0.791	0.669	0.874	0.467	0.467	0.669	0.791	0.12	0.2	0.2	0	0.499	0.467	0.669	0.041
X12	0.833	0.669	0.791	0.91	0.91	0.833	0.791	0.602	0.669	0.91	0.602	0	0.2	0.791	0.833
X13	0.25	0.602	0.828	0.2	0.124	0.082	0.082	0.25	0.25	0.25	0.25	0.041	0	0.041	0.041
X14	0.791	0.669	0.791	0.957	0.91	0.791	0.669	0.602	0.2	0.2	0.25	0.041	0.041	0	0.041
X15	0.2	0.254	0.25	0.25	0.25	0.041	0.254	0.041	0.041	0.041	0.499	0.041	0.041	0.041	0

According to steps that mentioned above:

Table 4
 General relations matrix -T Matrix

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	0.109	0.181	0.195	0.159	0.114	0.122	0.173	0.082	0.091	0.065	0.057	0.088	0.076	0.159	0.109
X2	0.103	0.063	0.122	0.080	0.076	0.084	0.088	0.064	0.054	0.070	0.062	0.051	0.043	0.102	0.055
X3	0.152	0.135	0.076	0.078	0.072	0.076	0.083	0.079	0.058	0.053	0.055	0.029	0.026	0.081	0.037
X4	0.124	0.111	0.183	0.071	0.149	0.155	0.164	0.044	0.039	0.034	0.039	0.051	0.053	0.142	0.045
X5	0.156	0.107	0.166	0.140	0.062	0.121	0.160	0.041	0.039	0.033	0.037	0.051	0.048	0.112	0.039
X6	0.138	0.119	0.154	0.056	0.051	0.049	0.132	0.036	0.034	0.029	0.032	0.045	0.024	0.080	0.034
X7	0.208	0.169	0.222	0.183	0.175	0.183	0.117	0.080	0.093	0.065	0.097	0.065	0.060	0.173	0.096
X8	0.171	0.105	0.182	0.102	0.095	0.100	0.165	0.046	0.073	0.056	0.118	0.037	0.033	0.152	0.086
X9	0.228	0.198	0.233	0.198	0.190	0.199	0.220	0.149	0.057	0.075	0.135	0.053	0.047	0.192	0.134
X10	0.227	0.204	0.243	0.196	0.191	0.196	0.217	0.149	0.140	1.052	0.146	0.078	0.073	0.199	0.142
X11	0.172	0.152	0.191	0.124	0.117	0.141	0.162	0.060	0.062	0.056	1.044	0.079	0.073	0.142	0.048
X12	0.225	0.192	0.238	0.203	0.195	0.196	0.213	0.126	0.123	0.133	0.125	1.050	0.063	0.195	0.143
X13	0.071	0.097	0.125	0.054	0.045	0.044	0.049	0.048	0.044	0.041	0.046	0.020	1.014	0.043	0.025
X14	0.171	0.147	0.183	0.163	0.153	0.151	0.155	0.098	0.058	0.051	0.065	0.039	0.035	1.083	0.046
X15	0.051	0.052	0.059	0.049	0.047	0.031	0.053	0.018	0.017	0.015	0.059	0.016	0.015	0.031	1.013

Table 5
Calculating the influences of each factor

	r_i	C_i	$r_i + C_i$	$r_i - C_i$
X_1	1.781	2.306	4.087	- 0.525
X_2	1.116	2.033	3.149	- 0.917
X_3	1.089	2.571	3.660	- 1.482
X_4	1.404	1.854	3.258	- 0.450
X_5	1.313	1.732	3.045	- 0.419
X_6	1.013	1.847	2.860	- 0.834
X_7	1.985	2.152	4.137	- 0.167
X_8	1.520	1.117	2.637	0.403
X_9	2.308	0.981	3.289	1.327
X_{10}	2.453	0.829	3.282	1.624
X_{11}	1.623	1.119	2.742	0.504
X_{12}	2.420	0.752	3.172	1.668
X_{13}	0.764	0.683	1.447	0.081
X_{14}	1.598	1.886	3.484	- 0.288
X_{15}	0.529	1.052	1.581	- 0.523

Finally, Fig. 3 shows the results of casual diagram of Fuzzy DEMATEL technique.
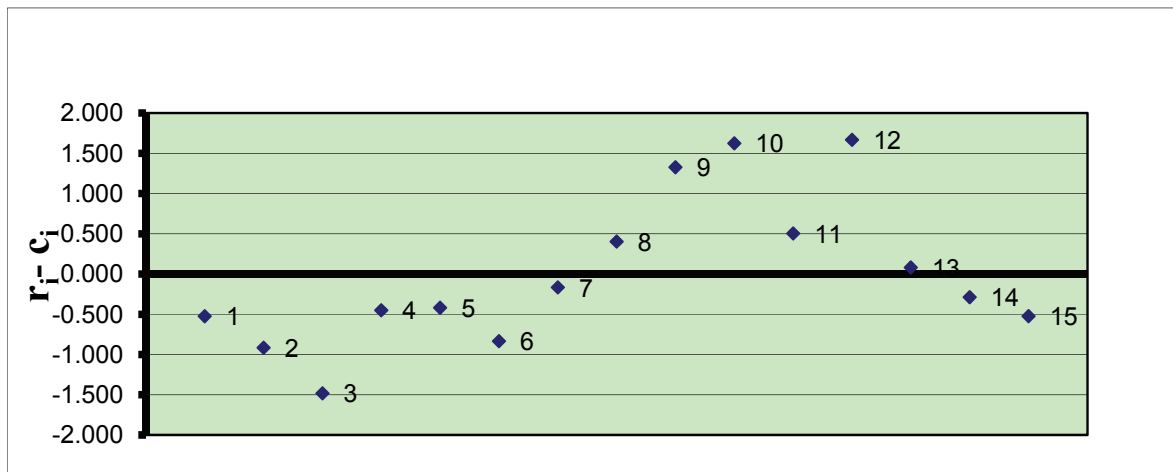
Fig.3. The casual diagram

4. Conclusion

In modern competitive industrial world, traits such as process integration, necessity of cooperation among them, effective relationship with customers and sellers, variety of customer demands, global scale and wise employees are constantly emphasized by organizations to maintain their competitive advantages in this way and to promote it if possible.

By considering the strategy map as a basis for balance scorecard, a pattern is produced, which leads to accelerating successful implementation of balance scorecard. The strategy map enables managers to identify and extract key objectives (strategic) for modeling causal relations between organizational strategic objectives. In this paper, strategic objectives available in strategy map of Parchsaz international company have been investigated from four aspects of financial, customer, internal business process and learning and growth. For achieve this purpose, we have used a fuzzy DEMATEL method, as a powerful structural decision making system, for investigation cause and effect relationships of the strategy map. As the shown in Fig. 3, the strategic objectives are divided into two groups:
1. Cause group which includes X_{12}, X_{10}, X_9, X_{11}, X_8 and X_{13} .
2. Effect group which includes X_3, X_2, X_6, X_1, X_{15}, X_4, X_5, X_{14} and X_7.

By analyzing obtained results, the importance of growth, learning and internal business are clearly prominent in the strategy map of this company and top manager of this company are required to investment on this objectives for achievement of higher competitive advantage. The results also point to the dependence among financial and non financial indexes. Companies consider the growth and learning aspect for developing new processes and technologies for decreasing the costs and enhancing the efficiency in internal business processes of company. Finally, considering the growth and learning aspect leads to customer satisfaction and customer attraction, this ultimately leads to higher financial results. Therefore, a structured BSC method should include mutual relations among different aspects and measuring indexes of these aspects.

Acknowledgement

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