An integrated approach to analyze strategy map using BSC – FUZZY AHP: A case study of auto industry

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A R T I C L E I N F O	A B S T R A C T
	In an environment, which is highly competitive and everything changes rapidly, managers of organizations face with problems such as how to identify important factors preventing organizations from optimum use of available resources and capacities and invest more on key factors. To achieve this goal, we need to develop an effective strategy map for organizations. The strategy map is a constructional and expanding procedure to identify relationships among all the organization's strategic goals, which play a key role in achieving competitive advantage. Undoubtedly, representing a model to identify and to evaluate the important items for each of available goals in strategy map of each organization is a significant help for management to access higher competition benefits. In this paper, strategic objectives in the strategy map of one of the best producer of electric auto part makers in Iran called Electric Vehicle Co. East are evaluated based on balanced score card perspective and to assign appropriate values to available factors we use a hybrid method consist of AHP technique with Fuzzy logic.

1. Introduction

In today's highly competitive global environment, companies strongly consider the efficiency and performance associated with their all sources to achieve long-term competitive advantages. To protect competitive advantages, organizations must constantly monitor their performance measurement systems for operational measurement using assessment model to help them plan future strategies and set up performance targets of employees to achieve the final target of the entire organizations (Wu et al., 2011). The effective measurement systems, as a useful tool, enable many managers to control and monitor companies to process and to improve to achieve higher productivity and performance. An expanding model for measurement of companies operations is balanced score card (BSC), which is based on interaction financial, customer, internal process, learning and growth (Wang et al., 2010).

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The implementation of BSC is fairly straightforward by expanding strategy goals of organization and performance indicators. There are different advantages of using BSC: (A) it provides a balance between long terms strategies and short terms actions, it provides link between long term and short terms goals, it provides relationship between financial and non financial indicators and finally it create relationship between each four strategic aspects (Xu & Yeh, 2012). During the past two decades, BSC has been widely used in companies and different private and public organizations. BSC has been able to establish comprehensive system management approaches at the head of the organization (Creelman & Makhijani., 2005; Niven, 2008). BSC has also been used as a frame for criteria categorization and measurement indicators, for evaluating solution set in deferent parts such as investment, research projects, ERP systems and banks (Xu & Yeh, 2012).

In this paper, we use BSC to categorize strategic goals in strategy map of a case study of auto makers in Iran called Electric Vehicle Co. East and operational indicators, which are associated with these goals .

2. Balanced score card

Kaplan and Norton (1996, 2000) explained the need for effective fulfillment of strategies and creating the comprehensive system of management and improving the performance by introducing BSC. Management system of balanced scorecard has been proposed as an expanding and comprehensive frame for evaluating operation and developing strategy, which leads to create a balance between short terms and long terms goals, financial and non-financial indicators, inside and outside operation and conductor indicators and performance function. BSC is a proven framework, which operates organization strategy (Niven, 2006; Creelman & Makhijani, 2008). Fig. 1 shows details of the implementation of BSC method. BSC enables expression of the vision and strategies of a business in terms of performance indicators and thus ensures establishment of the framework required for strategic measurement and management system. While underlying that traditional financial indicators are important, BSC describes that financial indicators are proven to be insufficient in explaining the business performance since they only contain the information associated with the issues taken place in the past and we cannot rely on these factors (Yuksel & Dagdeviren, 2010). Kaplan and Norton explained four perspectives needed to create a balance in measurement of organization performance in terms of financial, customer, internal process, learning and growth.
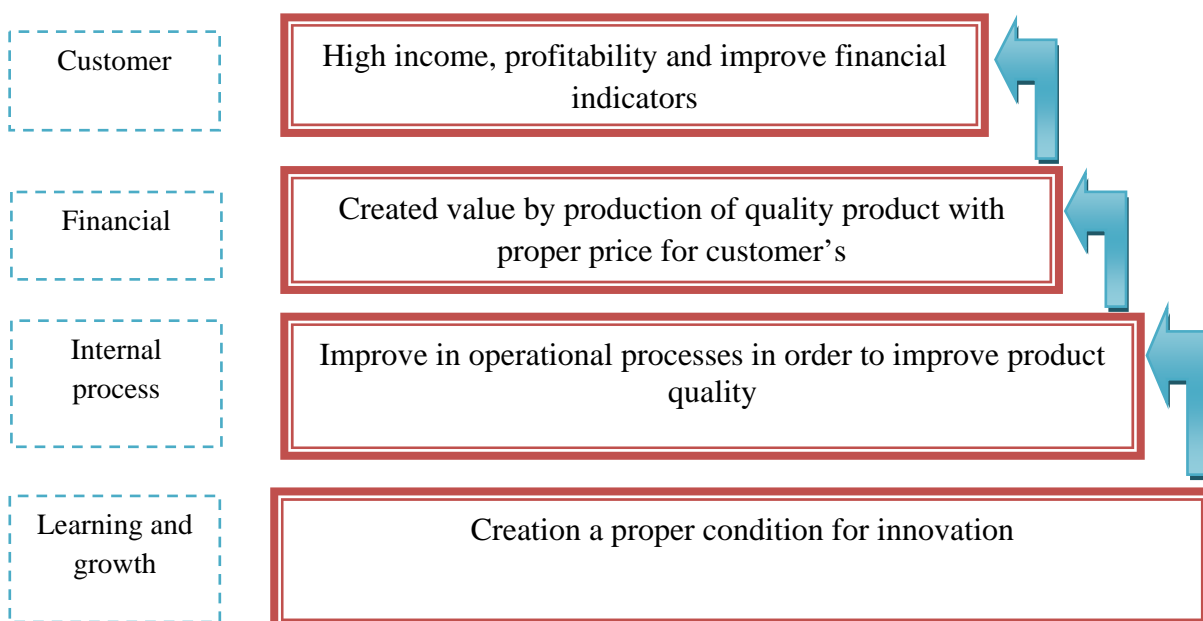

Fig.1. Relations between different aspects of BSC

By considering these four views, financial factors are considered along with other important factors. However, BSC has some limitations (Abran & Buglione, 2003; Lee et al., 2008 Leung et al., 2006). Kaplan and Norton argued that the BSC program involves a cause-and-effect relationship among different factors in selected perspectives. Similarly, numerous different scholars have provided empirical evidence supporting the existence of a cause-and-effect relationship among BSC various perspectives (Schmidberger, et al., 2009).The relationship reflects the interplay and interdependencies among financial and non-financial measures. A well-constructed BSC method must consider the interactive relationship among various selected perspectives and their measurement criteria (Wang et al., 2010; Lee et al., 2008). There are literally many studies on BSC but there is a little attention on how to implement this model in uncertain situations (Tseng, 2010). Table 1 shows some of the important issues.

Table 1
Previous studies in BSC

Title	Author/ year	Description
Strategic performance measurement in a healthcare organization : A multiple criteria approach based on balanced score	Grigoroudis et al., 2012	The main purpose of this study is representing a performance measurement system for health care organizations. The work measures indicators including both financial and non-financial indicators and the results indicated that learning and growth aspect in these organizations is most important than other aspects.
An integrated approach to evaluation and planning of best practices	Xu and Yeh, 2012	In this paper, using a multifaceted decision-making algorithm based on the BSC, a new evaluation model was driven for affective measurement of relationship between low-level and high-level goals in organizations.
Extracting leanness criteria by employing the concept of Balanced Scorecard	Seyedhosseini et al., 2011	The work uses BSC concept to derive indices of low efficiency and to achieving this purpose, set of company's goals based on different aspects of BSC was extracted from the company's strategic map and their performances were evaluated.
Performance evaluation of extension education centers in universities based on the balanced scorecard	Wu et al., 2011	In this paper, 36 indicator in 4 aspect of BSC was evaluated in educational centers of Taiwan and by use of DEMATEL, ANP, VICOR.
Developing strategic measurement and improvement for the biopharmaceutical firm: Using the BSC hierarchy	Huang et al., 2011	In this study, BSC is used to evaluate the performance biopharmaceutical firm and it was used from combination AHP with BSC techniques.
Implementation and performance evaluation using the fuzzy network balanced scorecard	Tseng, 2010	Tang used BSC in Taiwan universities in order to evaluate multiple criteria associated with BSC using DEMATEL method.
Integrating hierarchical balanced scorecard with non-additive fuzzy integral for evaluating high technology firm performance	Wang et al., 2010	They showed that represented system of performance evaluation in this study could be effective in eliminating some issues created goals by high level manager and employees.
A Fuzzy DEMATEL framework for modeling cause and effect relationships of strategy map	Jassbi et al., 2010	In this study 15 available indicators of strategy map in an auto-maker company was evaluated using BSC perspective. The study evaluated competitors evaluate, capability of learning and fast service network, comprehensive support system based on new technologies, up to date network services to meet customers' needs and processes and educational policy and learning of Human capital was identified as affecting indicators .
Analyzing BSC and IC's usefulness in nonprofit organizations	Kong, 2010	In this study, the non-profit organizations to transfer knowledge from the perspective of human capital, structural capital and relational capital was investigated
Using the fuzzy analytic network process (ANP) for Balanced Scorecard (BSC):A case study for a manufacturing firm	Yuksel and Dag deviren, 2010	In this study, BSC procedure with fuzzy ANP has been integrated to determine the level of business performance based on company goals and strategies. Result of this combination model shows that Combining these two techniques can be fuller and more accurate the results achieved.
Designing a knowledge-based system for strategic planning: A balanced scorecard perspective	Huang, 2009	In this paper author used a combination of BSC and AHP methods for performance evaluation of a knowledge-based systems in terms of four BSC views.
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 to evaluate performance of the supply chain of crude oil was used.
evaluation of performance of society assurance organization by used of combination FDEA and BSC	Momeni et al., 2010	In this paper, first, operation level of branches was computed by balancing scorecard and then efficiency of these branches are measured based on fuzzy DEA.
evaluation of National Nanotechnology Program with balancing scoredcard in Iran	Ghazi noori & Tavasolizadeh, 2009	This study was designed to utilize strategy map and it provided a BSC about technological strategy in national level.

3. Strategy map

The inventors of the BSC believe that successful strategy depends on understanding organization components, very carefully (Kaplan & Norton, 2000). Drawing precise causal relationships among the organization's strategic goals in the four perspectives can be used as a foundation for BSC. The case study of this paper is called Electric Vehicle Co. East, which was established in 1974 and produced some of the vehicle components such as wire dart established.
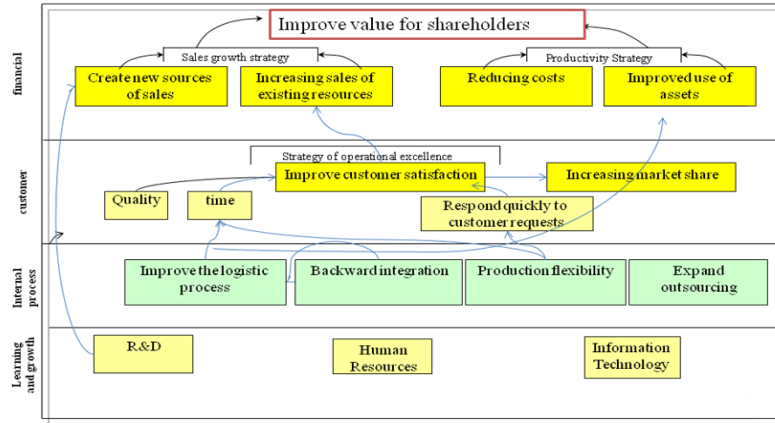

Fig. 2. Strategy map

The main activities of the company is production, export, import different kinds of wire dart and its components and engineering services, designing and manufacturing various automobile parts. Electric Vehicle Co. East has domestically considered as the best electrical and electronic automotive parts supplier in the country by using of new technology and it has succeeded to design, produce and supply parts for domestic and international arena. Some of the most important strategic goals are summarized in Fig. 3.
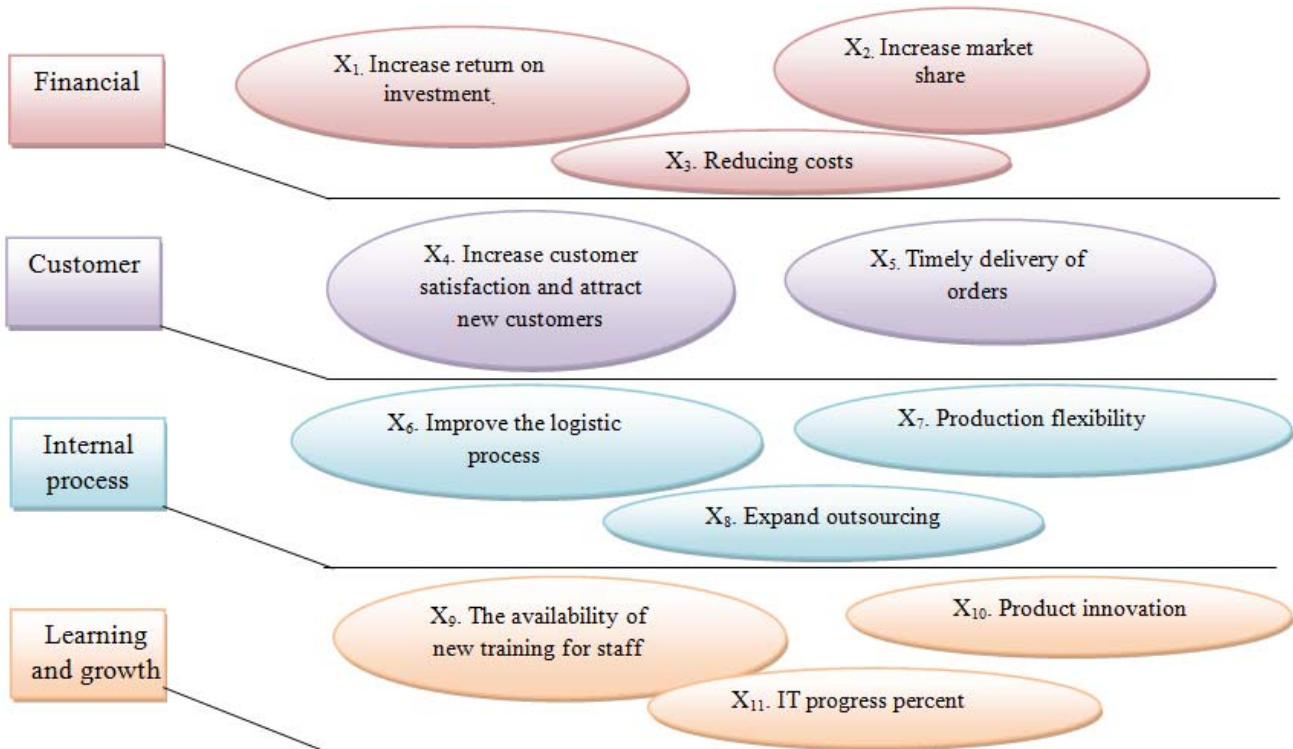

Fig.3. plan of strategy map of Electric Vehicle Co. East

4. Fuzzy analysis hierarchical process (FAHP)

Process of fuzzy analysis hierarchy process which widely used in Multi Criteria Decision Making,was proposed by saaty in 1971 and In order to solve design requirements and the allocation of scarce military resources(Saaty, 1980) . Since then, AHP has been one of the most extensive and most widely used multi-criteria decision making methods used in many applications. However, previously, this method was successful in many cases but beside of this and in real world, representation of accurate size of factors is very difficult and priority option has always been associated with uncertainty. To resolve this problem and to remove the possible ambiguities in some of the judgments, there have implementation of fuzzy methods to handle uncertainty (Heo et al., 2010).

In order to do this and for achieving proper result, in this paper, we use fuzzy analysis hierarchy process method (FAHP). Process of hierarchical BSC decision making, has been illustrated in Fig. 4.
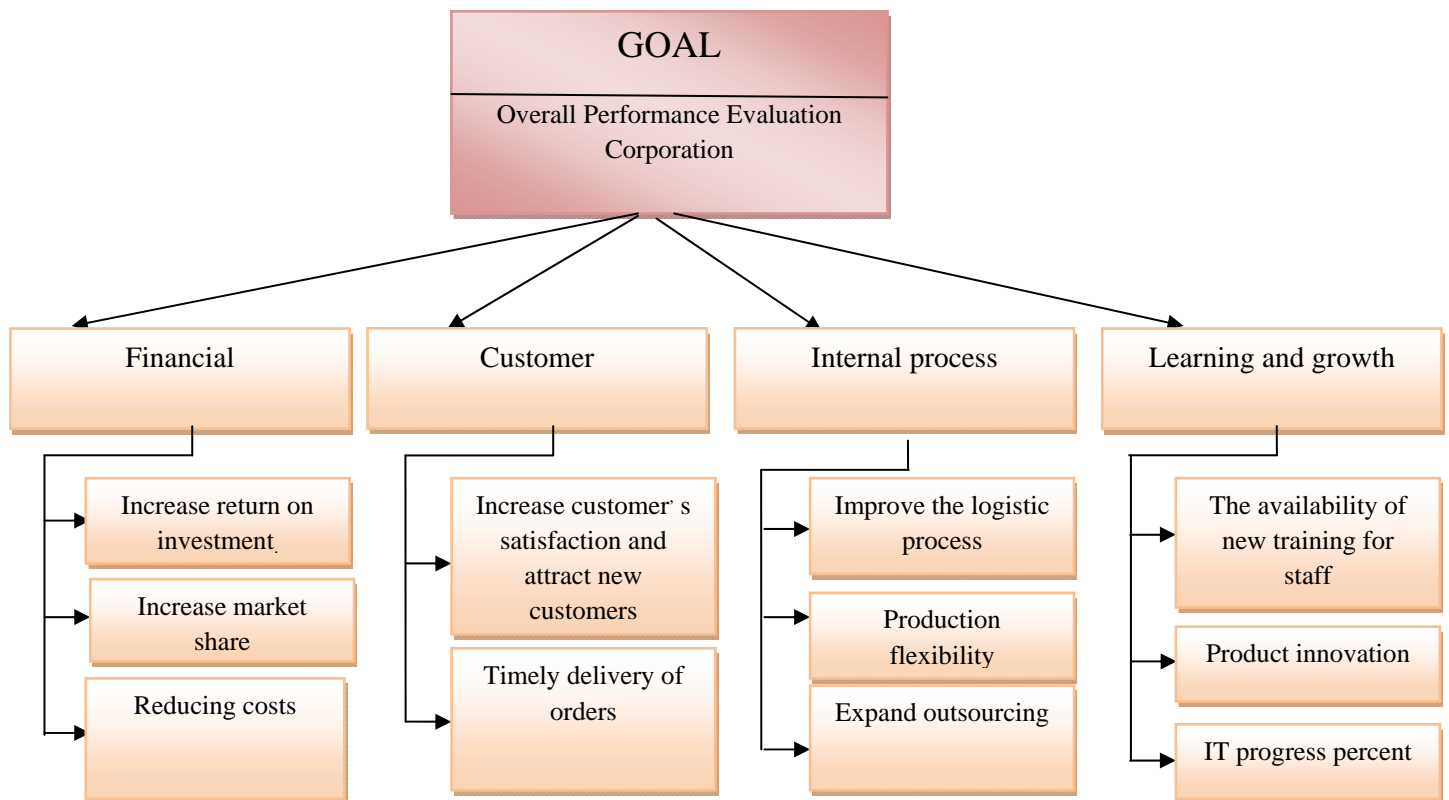

Fig. 4. process of hierarchical BSC decision making

There are many methods in terms of fuzzy analysis hierarchy process (FAHP) for handling uncertainties. These methods represent systematic procedure in item selection by use of theory of fuzzy setting and analysis hierarchical (Bozbura et al., 2007). The proposed model of this paper has originally been developed by Chang (1996) and it uses triangular numbers as shown in Table 2.

Table 2
Linguistic terms for the fuzzy ratings

Linguistic terms	Triangular fuzzy numbers	Reverse triangular fuzzy numbers
Equal preference	(1,1,3)	(1/3,1,1)
Rather weak	(1,3,5)	(1/5,1/3,1)
Rather good	(3,5,7)	(1/7,1/5,1/3)
Strong preference	(5,7,9)	(1/9,1/7,1/5)
Absolute preference	(7,9,9)	(1/9,1/9,1/7)

The following summarizes the steps of FAHP method,

First step: For each row of a matrix of paired comparisons, s_k, which is a triangular number is calculated as follows,

$$S_k = \sum_{j=1}^{n} M_{kj} \times \left[\sum_{i=1}^{m} \sum_{j=1}^{n} M_{ij} \right]^{-1} \tag{1}$$

where K represents row number and i and j are the options and the index and

$$\sum_{j=1}^{n} M_{kj} = \left(\sum_{i=1}^{n} l_i , \sum_{i=1}^{n} m_i , \sum_{i=1}^{n} u_i \right), \left[\sum_{i=1}^{m} \sum_{j=1}^{n} M_{ij} \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i} , \frac{1}{\sum_{i=1}^{n} m_i} , \frac{1}{\sum_{i=1}^{n} l_i} \right)$$

Second step: Let M_1 and M_2 be two triangular fuzzy numbers, large degree of m_2 on m_1 is calculated as fallow,

$$V(M_2 \geq M_1) = \begin{cases} 1 & \text{if} \quad m_2 \geq m_1 \\ 0 & \text{if} \quad l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & \text{otherwise} \end{cases}$$

Third step: To compare two triangular number we use the following,

$$V(M_1 \geq M_2, \dots, M_k) = \min[V(M_1 \geq M_2), \dots, V(M_1 \geq M_k)]$$

$$d(A_i) = \min\{V(S_i \geq S_k)\}, k = 1,2,\dots,n \quad k \neq i$$

Then, the weight vector is obtained and they are normalized as follows,

$$w' = (\acute{d}(A_1), \acute{d}(A_2), \dots, \acute{d}(A_n))^T , w = (d(A_1), d(A_2), \dots, d(A_n))^T$$

Table 3
Corresponding weights for each strategy and the corresponding weight of each aspect

Aspects and strategies	Weight corresponding to each aspect (%)	Weight corresponding to selection each strategy(%)
Financial	38.7059	
X$_1$ Increase return on investment		14.5943
X$_2$ Increase market share		13.7309
X$_3$. Reducing costs		10.3807
Customer	22.9432	
X$_4$. Increase customer satisfaction and attract new customers		12.5781
X$_5$ Timely delivery of orders		10.3651
Internal process	19.9588	
X$_6$. Improve the logistic process		7.9980
X$_7$. Production flexibility		7.5169
X$_8$. Expand outsourcing		4.4439
Learning and growth	18.3921	
X$_9$. The availability of new training for staff		7.5679
X$_{10}$. Product innovation		6.5001
X$_{11}$. IT progress percent		4.3241

Table 4

Penetration of each strategy in the perspective

Aspects and strategies	Penetration of each strategy in the aspect (%)
X_1 Increase return on investment	37.7056
X_2 Increase market share	35.4749
X_3. Reducing costs	26.8194
X_4. Increase customer satisfaction and attract new customers	54.8227
X_5 Timely delivery of orders	45.1772
X_6. Improve the logistic process	40.0725
X_7. Production flexibility	37.6620
X_8. Expand outsourcing	22.2653
X_9. The availability of new training for staff	41.1475
X_{10}. Product innovation	35.3418
X_{11}. IT progress percent	23.5106

5. Conclusion

The first step at assessing one organization function is to select the assessment model proportion with dimensions in which basis decision makers will measure their units. While each assessment method has its own special weakness and strength, combining different models for developing the assessment process can assist decision makers to examine organizations functions more accurately. In this article, we have used a hybrid method to evaluate the performance of firm from auto industry based on a combination of FAHP and BSC methods. The proposed study used 4 main aspects of BSC which including financial, customer, internal processes, learning and growth. We have also used fuzzy methods to handle uncertainty. The results showed that increase return on investment, in the view point of managers and share holders has the highest importance weight, and progress of IT percent has the lowest importance weight. The results showed that in terms of financial, customer, internal process, learning and growth, respectively, the indicators of increase return on investment, increase customer satisfaction, improvement the logistic process and availability of new and appropriate training for staff have the highest importance weights.

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