Using Topsis Method with Goal Programming for Best selection of Strategic Plans in BSC Model

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Abstract: Strategic planning is expressly significant for organization's success and competitive advantage making in an increasingly competitive business environment. Implementation of applicable strategies plays an important role for organizations' success. Balanced scorecard is a suitable tool for designing operative strategies. However, one of the balanced scorecard difficulties is the selection in strategic plans' performance. In this issue paper, was demonstrated a model for selection and ranking of strategic plans in Balanced Scorecard using Topsis method and Goal Programming model. So first using the view and consensus of organization's managers and experts' opinions, measures of four perspectives and objectives are settled in BSC. And then using experts' opinions and taking the relative importance of decision makers' opinions into consideration, by using Goal Programming model and Topsis method, the implementations of strategic plans are selected in BSC model. The results are revealed that the introduced methods are more reliable and acceptable and the experts were verified the model for selecting of strategic plans in BSC in operation. The initiated methods were used in a study and derived results from it were analyzed from various points of view. In this article Initiative is called strategic plans. [Journal of American Science 2010;6(3):136-142]. (ISSN: 1545-1003).

Keywords: Balanced scorecard model, MADM, MODM, Goal Programming, Topsis

1. Introduction

Organizations have always found it difficult to balance pressing operational concerns with long-term strategic priorities. The tension is crucial: World-class processes won't prompt to success without the right strategic direction, and the best strategy in the world will get nowhere without strong operations to execute it [1]. Considering the importance of strategic planning in organizations and producing the competitive advantage in them and actually, now a day the organization is moving in a competitive, and complex environment and there is a transaction among them. The senior managers and all those looking for comprehensive picture of present situation of the company and a clear understanding of present situation of the company and a clear understanding of its future image needs some information more than just Standards in financial operation to assess the strategic operation and long-term view of the company and also to achieve operational strategies.

Miscellaneous types of tools are offered for this process, Balanced Scorecard is a proper tool for evaluating and designing of operational strategies. This tool was introduced by Kaplan and Norton in 1992, for the first time [2-6].BSC is a conceptual frame work and its function is to translate strategic objectives of a company into a set of operational attributes. These indices are usually selected from four financial, customer, internal processes and learning and development perspectives [3, 7]. Many attributes were used for the advancement of the company in the direction of its perspective. Some other attributes are used for evaluation of company development in accessing to long-term objectives. Furthermore, BSC helps the managers to identify the lagging and leading attributes in their company. The framework of balances evaluation model is shown in the figure 1[3].

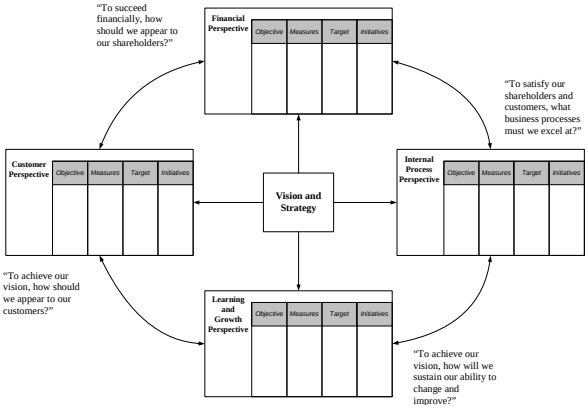


Figure1. Balanced Scorecard Model (Source: Kaplan & Norton 1992)

People mostly use one of two following methods for making decision:

Trial & Error method

Modeling method

In the trial & error method decision maker face the reality, so he/she selects one of the alternatives and witness the results. If decision errors are great and cause some problems, he/she changes the decision and selects other alternatives. In modeling method, decision maker models the real problem and specifies elements and their effect on each other and gets through model analysis and prediction of a real problem[8].

Multi-criteria decision making (MCDM) addresses to making decision in the aspect of multiple and conflicting criteria. In fact, there are two types of criteria: objectives and attributes. Accordingly, the MCDM problems can be broadly aligned into two categories:

•Multi-objective decision making (MODM)

•Multi-attribute decision making (MADM)

The main difference between MODM and MADM is that the former concentrates on continuous decision spaces, primarily on mathematical programming with several objective functions, the latter focuses on problems with discrete decision spaces.

2. Material and Methods

Multiple attribute decision making

Hwong & Yoon describe multiple decisions making as follows: multiple decision making is applied to preferable decisions (such as assessment, making priority and choice) between available classified alternatives by multiple attribute (and usually opposite)[9].

Deciding group face the common factors especially in MADM:

1- Alternatives
2- Multiple attributes
3- Dimensionless units
4- Attributes weight
5- Attributes quality
6- Relative importance of decision makers' opinions.

MADM methods are classified as to following groups:

1) *Compensatory methods*: If a production has high expenditure but good quality, in this case high expenditure is compensated by high quality [9]. These models are: ELECTRE, MDS, MRS, TOPSIS, SAW, LINEAR ASSIGNMENT and etc.

2) *Non compensatory methods*: When the attributes are separated e.g. for taking driving license tree non compensative important factors are brought up. These are: normal eye test, driving rule test and practical driving examination, which one's strength in one of the tests doesn't compensate the others. These models are: DOMINANCE, LEXICOGRAPH, ELIMINATION, PERMUTATION and etc[10].

Multi-Objective Decision Making

Multi-objective decision making is recognized as the continuous kind of the MCDM. The main features of MODM problems are that decision makers need to obtain multiple objectives while these multiple objectives are non-commensurable and conflict with each other.

An MODM model considers a vector of decision variables, objective functions, and constraints. Decision makers attempt to maximize (or minimize) the objective functions. Since this problem has rarely a unique solution, decision makers are expected to choose a solution from among the set of efficient solutions (as alternatives), which will be explained later on in this section. Generally, the MODM problem can be formulated as follows:

$$Max: f(x)$$
$$s.t: x \in X = \left[x \in R^n \middle| g(x) \le b, x \ge 0\right]$$

Where $f(x)$ represents n conflicting with objective functions, $g(x) \le b$ represents is an n-vector of decision variables, $x \in R^n$.

Goal Programming

Goal programming was initially nominated by Charnes and Cooper (1961) and has been further advanced by Lee (1972), Ignizio (1976 and 1983), and Charnes and Cooper (1977). The method requests' decision makers to determine goals for each objective that they want to achieve. A preferred solution is then defined as the one that minimizes the deviations from the goals[11].

Experts Group and Strategic Plans Weights

Every MODM and MADM problem has some objective and attributes that should be recognized in problem by a decision maker in due courses. All MCDM methods need information that should be acquired based on relative importance of the objective. Objective weights can be assigned to objective directly by decision maker group or by scientific methods. These weights specify relative importance of every objective and attribute.

Usually groups are grouped based on their different levels in social status, knowledge and work experience. So every factor in special subject that cause increase or decrease of idea weight should be considered. In this regard assigning different weight

to person's opinions regarding to their knowledge and experience in relation with that subject seems necessary. We use hierarchical objectives for determination of strategic plans weights that you can see in the figure below [12].

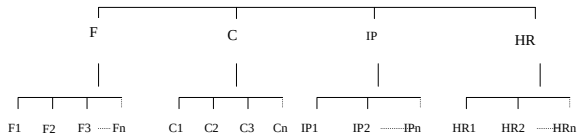


Figure4.1- set of hierarchical objectives

For this process, we have to determine the weights of perspectives and sub perspectives using of expert opinions. The final weights of sub perspectives (Financial, Customer, Internal Processes and Learning & Growth) were determined by using the geometric average method. The method for calculation is shown in below.

$$TW_{Cij} = \sqrt{W_{Ci} . W_{Cij}} \quad (1)$$

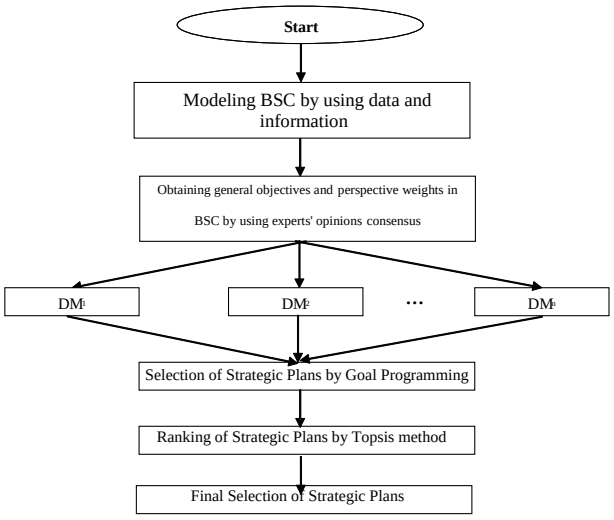
TW_{Cij} : Final weights of objective

W_{Ci} : Weights of perspective

W_{Cij} : Weights of objective

TW_{Cij}: Final weights of objective are equal the strategic plan weights [12].

Best Selection Algorithm of Strategic Plans in Bsc
The algorithm is shown in following figure.



In this method, decision makers (DM) set goals for each objective that they wish to gain. And they determine the constraints for model. Zero-one Goal programming to choose strategic plans is established. And then by using Topsis method strategic plans are ranked.

Step 1: first we collect data and information containing general objectives, measures, quantitative targets and strategic plans in four perspectives and form the framework of BSC model.

Step 2: calculating the measures of aspect and general objectives is BSC using group decision making.

First, we choose the members of the decision making group (the experts) who has been significant in formation about the strategic problems and Initiatives. And then we calculate the measure of the experts' viewpoint about the four perspectives of BSC. After that we calculate the measures of perspectives from the experts view point. In the some way, we can calculate the measure of the general objectives in four perspectives of BSC.

Step 3: we should calculate the final measure of the general objective using the geometrical average.

Step 4: strategic plans are selected by MODM models (Goal programming).

In this article, we are used the zero-one Goal programming to selection of strategic plans. The model of zero-one Goal programming is like the formula below.

$$\text{Max } G_1 : W_1 I_1 + W^2 I^2 + \dots \text{ Wn In}$$
$$\text{Min } G_2 : C_1 I_1 + C^2 I^2 + \dots \text{ Cn In}$$
$$\text{S. t: gi(x)} \begin{bmatrix} \leq \\ \geq \\ \equiv \end{bmatrix} ; I = 1, 2, \dots, m \quad (2)$$
$$xi \in \{0,1\} , J = 1, \dots , n$$

First objective (G1): the first objective (G1) is to maximize the importance of the strategic plan.
Here, W is the measure or the importance of the strategic plan. The importance of the strategic plan was obtained using consensus of experts by group decision making.
The second objective (G_2): Minimize the cost of strategic plan implementation.
The limitations: There are cost and logical limitations.
"W" is the sign for the importance of the strategic plan.
"I" is the sign for the strategic plan.

"C" is the sign for cost of strategic plan implementation.

Step 5: strategic plans are ranked by MADM models (Topsis).

This method was demonstrated in 1981 by Hwang and Yoon. In this method *m* alternative is computed by *n* attribute, and we can consider every problem as a geometrical system consisting of *m* point in *n* dimensional space.

This technique is founded based on the concept that selected alternative should have the least distance with a positive idea solution (the best possible state) and the most distance with a negative idea solution (the worst possible state)[9].

5.1. Transform decision matrix into the dimensionless matrix with using of relation:

$$n_{ij} = \frac{a_{ij}}{\sqrt{\sum_{j=1}^{m} a_{ij}^2}} \qquad (3)$$

5.2. Construct the Weighted Normalized Decision Matrix:

$$V = N_D.W_{n\times n} = \begin{vmatrix} V_{1i},\ldots & V_{1j},\ldots. & V_{1n} \\ \vdots & \vdots & \vdots \\ V_{m1},\ldots & V_{mj},\ldots & V_{mn} \end{vmatrix}$$

(4)

5.3. Determine the Ideal and Negative-Ideal solutions:

$$A^+ = \left\{\left(\max_i v_{ij} \mid j \in j_1\right),\left(\min_i v_{ij} \mid j \in j_2\right) \mid i = 1,2,\ldots,r\right.$$

$$A^- = \left\{\left(\min_i v_{ij} \mid j \in j_1\right),\left(\max_i v_{ij} \mid j \in j_2\right) \mid i = 1,2,\ldots,m\right.$$

(5)

5.4. Calculate the Separation Measure:

$$d_{i^+} = \left\{\sum_{j=1}^{n}\left(v_{ij} - v_j^+\right)^2\right\}^{1/2}, \quad i = 1,2,\ldots,m \qquad (6)$$

$$d_{i^-} = \left\{\sum_{j=1}^{n}\left(v_{ij} - v_j^-\right)^2\right\}^{1/2}, \quad i = 1,2,\ldots,m$$

5.5. Calculate the Relative Closeness for the Ideal Solution:

$$cl_{i^+} = \frac{d_{i^-}}{\left(d_{i^+} + d_{i^-}\right)}, \quad 0 \le cl_{i^+} \le 1, \quad i = 1,2,\ldots,m \qquad (7)$$

3.6. Rank the Preference Order:

The best (optimal) alternative can be decided according to the preference rank order of cli+ [12].

3. Results

A case study was conducted in electronic and computer research center of the university which is active in the field of producing industrial high capacity monitoring systems. Four experts consist of director manager, commercial manager, financial manager and production manager were selected and their opinions of four BSC's perspectives and four strategic objectives were taken for each perspective and the result were as follows:

Table1. Balance Scorecard model for electronic and computer research center of the university

Financial			
Objectives	**Measures**	**Target**	**Initiatives**
Income increasing	0.797	0.817	I1-Marketing Research
Profit increasing	0.133	0.153	I2- Marketing
Maximize of Investment Utilization	0.004	0.004	I3- Inventory Control
Cost decreasing	0.066	0.026	I4- ABC
Customer			
Increasing of customer satisfaction	0.27	0.236	I5-After sales Services
Increasing of Market share	0.027	0.024	I6- Marketing Research
Customer Supporting	0.541	0.505	I7-CRM
Increasing of added value for customers	0.162	0.236	I8-Value Engineering
Internal Processes			
Objectives	**Measures**	**Target**	**Initiatives**
On time delivery	0.07	0.06	I9- Time & Motion Study
Product development	0.873	0.886	I10- QFD
Products Quality	0.004	0.001	I11- ISO 9000
Continues improvement	0.052	0.054	I12- TQM
Learning & Growth			
Increasing of employees satisfaction	0.209	0.244	I13- increasing of personnel's' salary
Increasing of employees productivity	0.049	0.031	I14- personnel's' evaluation system
Personnel's Motivation	0.697	0.698	I15- Reward System
Increasing of informational skills	0.045	0.028	I16- MIS

Step 1: by using expert's opinion the framework from BSC model is formed to liken table 1.

Step 2: by using the consensus of expert's opinion, obtain the importance of BSC's perspectives and objectives, which are related to each perspective. Then by using the following geometrical average of the final weight, calculate (financial, customer, internal process and human resources) perspectives:

Table2. Final weight of objectives

Final weight of financial perspective objectives		Final weight of customer perspective objectives		Final weight of internal processes perspective objectives		Final weight of human resources perspective objectives	
O1	0.262750209	O4	0.26553440	O7	0.25466189	O10	0.242216096
O2	0.265570823	O5	0.264367619	O8	0.24651501	O11	0.241994263
O3	0.247798418	O6	0.260530249	O9	0.244923131	O12	0.23384371

Finally, we solve the problem through using the model of zero-one goal programming. The model of Goal programming (The form of problem) is as follows:

Max G1: 0.262750209 I1 +0.265570823 0.256572961 I3+0.247798418 I4+0.265534401 I5+0.264367619 I6+0.258108369 I7+0.260530249 I8+0.254661897 I9+0.24651501 I10+0.24772033 I11+0.244923131 I12+0.242216096 I13+0.241994263 I14+0.237078527 I15+0.23384371 I16

Min G2: 5 I1+7 I2+3 I3+2 I4+4 I5+5 I6+2 I7+3 I8+4 I9+3 I10+3 I11+10 I12+20 I13+4 I14+3 I15+6 I16

S.T:

5 I1+7 I2+3 I3+2 I4+4 I5+5 I6+2 I7+3 I8+4 I9+3 I10+3 I11+10 I12+20 I13+4 I14+3 I15+6 I16<=50

I1+I6=1

$x_i \in \{0,1\}$, J = 1, … , n

Final weight of four attributes (1- importance, 2- Gap, 3- cost, 4- time) was calculated for priority of strategic plans performance.

1- Importance attribute: importance attribute is the degree of the weight or importance which each strategic plan has for the organization and this importance (weight) are defined by experts' and managers' opinions.

2- Gap attribute: the conception of the gap is in this manner that whatever the gap of the present situation be more than the desirable situation in the organization, its importance is more for the organization, and you should perform that strategic plan as soon as possible; in fact, gap is the distance between measure and target in BSC model.

3- Cost attribute: each organization has some budgetary limits and financial sources, so performance cost of each strategic plan should be defined.

4- Time attribute: performance time of each strategic plan is different from the others and shortness of strategic plan performance time causes the organization to obtain its target faster and vice versa [12].

Regarding to Topsis method and by using of experts opinion, the decision matrix is constructed:

Table3. Decision matrix based on Topsis method

	Importance	*Gap*	*Cost*	*Time*
I1	*0.262750209*	*40*	*-5*	*-24*
I2	*0.265570823*	*10*	*-7*	*-14*
I3	*0.256572961*	*15*	*-3*	*-12*
I4	*0.247798418*	*5*	*-2*	*-16*
I5	*0.265534401*	*2*	*-4*	*-12*
I6	*0.264367619*	*20*	*-5*	*-24*
I7	*0.258108369*	*5*	*-2*	*-10*
I8	*0.260530249*	*4*	*-3*	*-14*
I9	*0.254661897*	*15*	*-4*	*-18*
I10	*0.24651501*	*4*	*-3*	*-10*
I11	*0.24772033*	*4*	*-3*	*-12*
I12	*0.244923131*	*25*	*-10*	*-24*
I13	*0.242216096*	*4*	*-20*	*-12*
I14	*0.241994263*	*20*	*-4*	*-16*
I15	*0.237078527*	*10*	*-3*	*-10*
I16	*0.23384371*	*15*	*-6*	*-24*

And then the decision matrix regarding to the relation (2) is normalized.

Table4. Normalized decision matrix

	Importance	*Gap*	*Cost*	*Time*
I1	*0.065396216*	*0.202020202*	*0.05952381*	*0.095238095*
I2	*0.065895426*	*0.050505051*	*0.08333333*	*0.055555556*
I3	*0.063662809*	*0.075757576*	*0.03571429*	*0.047619048*
I4	*0.061485603*	*0.025252525*	*0.02380952*	*0.063492063*
I5	*0.065886388*	*0.01010101*	*0.04761905*	*0.047619048*
I6	*0.065396216*	*0.101010101*	*0.05952381*	*0.095238095*
I7	*0.064043786*	*0.025252525*	*0.02380952*	*0.03968254*
I8	*0.064644721*	*0.02020202*	*0.03571429*	*0.055555556*
I9	*0.063188621*	*0.075757576*	*0.04761905*	*0.071428571*
I10	*0.061167154*	*0.02020202*	*0.03571429*	*0.03968254*
I11	*0.061466227*	*0.02020202*	*0.03571429*	*0.047619048*
I12	*0.060772165*	*0.126262626*	*0.11904762*	*0.095238095*
I13	*0.060100476*	*0.02020202*	*0.23809524*	*0.047619048*
I14	*0.060045433*	*0.101010101*	*0.04761905*	*0.063492063*
I15	*0.058825703*	*0.050505051*	*0.03571429*	*0.03968254*
I16	*0.058023056*	*0.075757576*	*0.07142857*	*0.095238095*

Therefore, the attributes weights regarding to Entropy method is determined:

Table5. Attributes weights

	Importance	*Gap*	*Cost*	*Time*
wj	*0.001389561*	*0.497898424*	*0.40950427*	*0.091207742*

And afterwards the Relative Closeness for the Ideal Solution is calculated:

Table6. Relative Closeness for the Ideal Solution

cl1	cl2	cl3	cl4	cl5	cl6	cl7	cl8
0.883923	*0.654922*	*0.584136*	*0.498085*	*0.446556*	*0.618544*	*0.498614*	*0.476164*
cl9	**cl10**	**cl11**	**cl12**	**cl13**	**cl14**	**cl15**	**cl16**
0.568673	*0.476552*	*0.476356*	*0.58096*	*0.054881*	*0.636157*	*0.528703*	*0.532151*

Finally the performance of strategic plans by the Goal programming model is selected and with using Topsis method is ranked. The results are shown as follows:

Table7. Final ranks & selection of strategic plans

	Strategic plans	**Selection**	Ranking
I1	Marketing researches	Reject (0)	1
I2	Marketing	Accept(1)	2
I3	Inventory Management	Accept(1)	5
I4	ABC	Accept(1)	11
I5	After sales Services	Accept(1)	15
I6	Marketing researches	Reject (0)	4
I7	CRM	Accept(1)	10
I8	Value engineering	Accept(1)	14
I9	Time & Motion Study	Accept(1)	7
I10	QFD	Accept(1)	12
I11	ISO 9000	Accept(1)	13
I12	TQM	Reject (0)	6
I13	Increasing of personnel's salary	Reject (0)	16
I14	Personnel's evaluation system	Accept(1)	3
I15	Reward System	Accept(1)	9
I16	MIS	Accept(1)	8

4. Discussions

In view of the above remarks, Balanced Scorecard is a most important tool for evaluating and designing of operational strategies. One of the BSC problems in performance to choose the strategic plans (Initiatives) by considering the limitations of budget and time to achieve the Strategic objectives. Since there is no proper method of selecting the strategic plan in the performance of BSC, the model presented solves this problem by using zero-one goal programming and TOPSIS method. Whereas BSC is a conceptual model, using mathematical models and multi-criteria decision making models (MCDM) can present better results for selecting strategic plans. As the relative importance of decision maker's opinions (people who evaluate) is not considered, the presented model solves this problem by considering the relative importance of decision maker's opinions. Indeed the experts were ranked and selected strategic plans performance after comparison of the goal programming and TOPSIS method result. The produced result is more reliable and accepted. (Tables and calculations have been presented in detail in [12].

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