Ranking of Strategic Plans in Balanced Scorecard by Using Electre Method

Javad Dodangh, Majid Mojahed and Vahid Nasehifar

Abstract—In a growing competitive business environment, many organizations have taken by adoption the strategic planning approach to an effort for business excellence. Implementation of proper strategies plays a vital role for organizations' success. Balanced scorecard is a suitable tool for designing operational strategies. However, one of the balanced scorecard problems is the selection in strategic plans' performance. In this paper, was settled a model for selection of strategic plans in Balanced Scorecard using Electre method. So first using the consensus of organization's managers and experts' opinions, measures of four perspectives and general objectives are determined in BSC. And then using experts' opinions and taking the relative importance of decision makers' opinions into consideration, by using Electre 2 , the performances of strategic plans are selected in BSC model. The results are shown that the introduced method is more reliable and acceptable and the experts were verified the model for selecting of   strategic plans in BSC in operation. The introduced method was used in a study and extracted results from it were analyzed from different points of view. In this article Initiative is called strategic plans.

Index Terms—Balanced Scorecard, Initiatives, MCDM, ELECTRE.

I. INTRODUCTION

Organizations have always found it hard to balance pressing operational concerns with long-term strategic priorities. The tension is critical: World-class processes won't lead to success without the right strategic direction, and the best strategy in the world will get nowhere without strong operations to execute it [2]. Considering the importance of strategic planning in organizations and creating the competitive advantage in them and indeed, today the organization is moving in a competitive, and complex environment and there is a transaction among them. The senior managers and all those seeking a comprehensive picture of pa present situation of the company and a clear understanding of pa 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 a strategic operation and long-term view of the company and also to achieve operational strategies.

Miscellaneous kinds of tools are offered for this process, Balanced Scorecard is a suitable tool for evaluating and designing of operational strategies. This tool was introduced by Kaplan and Norton in 1992, for the first time [1, 3, 4].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, 5]. 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].
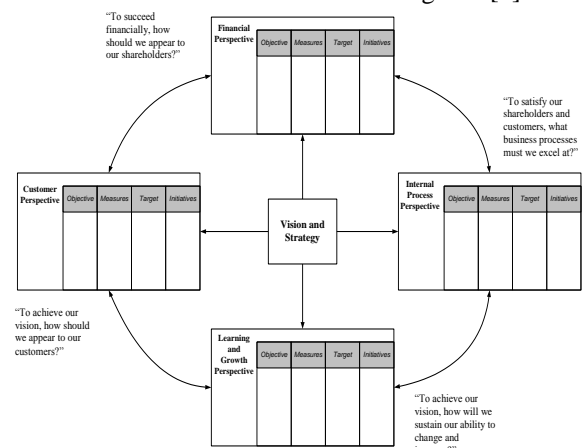

Figure 1.Balanced Scorecard model, Source:[1]

DECISION MAKING METHODS

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

Trial & Error method

Modeling method

In a trial & error method decision maker face the reality, so he chooses one of the alternatives and witness the results. If decision errors are great and cause some problems, he 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 [6].

3. 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)

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[2] - Elimination Et Choice Translating Reality

between available classified alternatives by multiple attribute (and usually opposite) [7].

Deciding group face the common factors, especially in MADM:

Alternatives

Multiple attributes

Dimensionless units

Attributes weight

Attributes quality

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 [8]. 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. [9] These models are: DOMINANCE, LEXICOGRAPH, ELIMINATION, PERMUTATION and etc.

II. METHODOLOGY

Every MADM problem has some attributes that should be recognize in problem by decision maker in due courses. All MADM methods require information that should be gained based on relative importance of the attribute. This information usually has serial or main scale. Attribute weights can be allocated to criteria directly by decision maker group or by scientific methods. These weights specify relative importance of every attribute.

Usually groups are classified based on their different levels in social status, knowledge and work experience. So every factors in special subject that cause increase or decrease of idea weight should be considered. In this regard allocating different weight to person's opinions regarding to their knowledge and experience in relation with that subject seems necessary.[9, 10]

This paper is designed to select and consider suitable four criteria and sixteen alternatives respectively. The way of data collection that is applied for this phase is Delphi method. By using Comparison Matrix, the weights of criteria have been computed. After computing weights of criteria, Consistency must be specified. If the Consistency is less than 0.1, then we can apply ELECTRE method and rank alternatives. Otherwise, revision of pair wise comparison must be done. Ranking of strategic plans in balanced is shown in following algorithm.[11]

III. CASE STUDY

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:[12]

By using expert's opinion we form the framework from BSC model like TABLE I.

So by using the consensus of expert's opinion, obtain the importance of BSC's perspectives and objectives which are related to each perspective. [13]

Then by using the geometrical average the final weight, is calculated (financial, customer, internal process and human resources) perspectives: [14]

TABLE I

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

TABLE I (CONTINUE OF TABLE I)

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

STEPS OF ELECTRE METHOD:

Step 1: Calculate the normalized decision matrix.

$$N_{ij} = \frac{R_{ij}}{\sqrt{\sum_{i=1}^{16} R_{ij}^2}} \quad ; \quad i=1, 2\ldots 16 \ ; \ j=1, 2\ldots 4$$

	Importance	Gap	Cost	Time
I1	0.260572074	0.631037292	0.18430245	0.36148514
I2	0.263369306	0.157759323	0.25802342	0.210866332
I3	0.254446034	0.236638984	0.11058147	0.18074257
I4	0.24574423	0.078879661	0.07372098	0.240990093
I5	0.263333186	0.031551865	0.14744196	0.18074257
I6	0.262176076	0.315518646	0.18430245	0.36148514
I7	0.255968714	0.078879661	0.07372098	0.150618808
I8	0.258370517	0.063103729	0.11058147	0.210866332
I9	0.252550812	0.236638984	0.14744196	0.271113855
I10	0.244471461	0.063103729	0.11058147	0.150618808
I11	0.245666789	0.063103729	0.11058147	0.18074257
I12	0.242892778	0.394398307	0.36860489	0.36148514
I13	0.240208184	0.063103729	0.73720978	0.18074257
I14	0.23998819	0.315518646	0.14744196	0.240990093
I15	0.235113204	0.157759323	0.11058147	0.150618808
I16	0.231905203	0.236638984	0.22116293	0.36148514

Step 2: Calculate the weighted normalized decision matrix.

$$V_{ij} = N_{ij} \times W_{ij} \quad ,$$

We assumed that "W" is a diagonal matrix which values of its main diameter are W= {0.001389, 0.497898, 0.409504, 0.091207} and the rest values are zero.

	Importance	Gap	Cost	Time
I1	0.000362081	0.314192473	0.075472638	0.032970243
I2	0.000365968	0.078548118	0.105661694	0.019232642
I3	0.000353568	0.117822177	0.045283583	0.016485122
I4	0.000341477	0.039274059	0.030189055	0.021980162
I5	0.000365918	0.015709624	0.060378111	0.016485122
I6	0.00036431	0.157096237	0.075472638	0.032970243
I7	0.000355684	0.039274059	0.030189055	0.013737601
I8	0.000359022	0.031419247	0.045283583	0.019232642
I9	0.000350935	0.117822177	0.060378111	0.024727683
I10	0.000339708	0.031419247	0.045283583	0.013737601
I11	0.000341369	0.031419247	0.045283583	0.016485122
I12	0.000337514	0.196370296	0.150945277	0.032970243
I13	0.000333784	0.031419247	0.301890553	0.016485122
I14	0.000333478	0.157096237	0.060378111	0.021980162
I15	0.000326704	0.078548118	0.045283583	0.013737601
I16	0.000322246	0.117822177	0.090567166	0.032970243

Step 3: Determine the concordance and discordance set.

$$S_{kl} = \{ J \mid N_{kj} \geq N_{lj} \} \quad ; \quad (k, l = 1, 2, 3, 4, 16; k \neq l) \quad ,$$

When this condition is true then we put "1" in its place. And also we will apply for discordance set as followed:

$$D_{kl} = \{ J \mid N_{kj} < N_{lj} \} \quad ; \quad (k, l = 1, 2, 3, 4, 16; k \neq l) \quad ,$$

For instance, we determined S1l, D1l, S16l, and D16l as a sample.

	J=1	J=2	J=3	J=4
S1,2	-	1	1	-
S1,3	1	1	-	-
S1,4	1	1	-	-
S1,5	-	1	-	-
S1,6	-	1	1	1
S1,7	1	1	-	-
S1,8	1	1	-	-
S1,9	1	1	-	-
S1,10	1	1	-	-
S1,11	1	1	-	-
S1,12	1	1	1	1
S1,13	1	1	1	-
S1,14	1	1	-	-
S1,15	1	1	-	-
S1,16	1	1	1	1

D1,2	1,4
D1,3	3,4
D1,4	3,4
D1,5	1,3,4
D1,6	1
D1,7	3,4
D1,8	3,4
D1,9	3,4
D1,10	3,4
D1,11	3,4
D1,12	0
D1,13	4
D1,14	3,4
D1,15	3,4
D1,16	0

	J=1	J=2	J=3	J=4
S16,1	-	-	-	1
S16,2	-	1	1	-
S16,3	-	1	-	-
S16,4	-	1	-	-
S16,5	-	1	-	-
S16,6	-	-	-	1
S16,7	-	1	-	-
S16,8	-	1	-	-
S16,9	-	1	-	-
S16,10	-	1	-	-
S16,11	-	1	-	-
S16,12	-	-	1	1
S16,13	-	1	1	-
S16,14	-	-	-	-
S16,15	-	1	-	-

D16,1	1,2,3
D16,2	1,4
D16,3	1,3,4
D16,4	1,3,4
D16,5	1,3,4
D16,6	1,2,3
D16,7	1,3,4
D16,8	1,3,4
D16,9	1,3,4
D16,10	1,3,4
D16,11	1,3,4
D16,12	1,2
D16,13	1,4
D16,14	1,2,3,4
D16,15	1,3,4

J=1   J=2   J=3   J=4

Step 4: Calculate the concordance matrix.

$$I_{kl} = \sum_{j \in S_{k,l}} W_j \quad ; \quad \sum_{j=1}^{7} W_j = 1 \qquad 0 \leq I_{kl} \leq 1 \quad ,$$

J1	J2	J3	J4	J5	J6	J7	J8
-	0.907	0.499	0.499	0.498	0.999	0.499	0.499
0.093	-	0.001	0.590	0.499	0.093	0.499	0.590
0.501	0.999	-	1.000	0.999	0.501	0.498	0.999
0.501	0.410	0.410	-	0.907	0.501	0.907	0.907

0.502	0.501	0.093	0.093	-	0.502	0.001	0.093
0.502	0.907	0.499	0.499	0.498	-	0.499	0.499
0.501	0.501	0.502	1.000	0.999	0.501	-	0.999
0.501	0.501	0.502	0.093	0.907	0.501	0.093	-
0.501	0.907	0.498	0.499	0.907	0.501	0.498	0.498
0.501	0.501	0.501	0.091	0.999	0.501	0.091	0.999
0.501	0.501	0.501	0.091	0.999	0.501	0.000	0.999
0.091	0.498	0.498	0.498	0.498	0.589	0.498	0.498
0.091	0.091	0.091	0.091	0.589	0.091	0.000	0.589
0.501	0.907	0.498	0.589	0.907	0.999	0.498	0.498
0.501	0.999	0.501	1.498	0.999	0.501	0.589	0.999
0.091	0.907	0.498	0.498	0.498	0.091	0.498	0.498

1.000	0.306	0.028	0.053	0.010	0.028	0.053	-
1.000	0.200	0.077	0.400	0.042	0.400	0.077	0.077
1.000	0.167	0.306	0.053	0.000	0.444	0.053	0.000
1.000	0.167	0.306	0.053	0.000	0.444	0.053	0.000
1.000	0.384	0.897	1.025	0.769	0.641	1.025	0.897
1.000	0.694	0.907	0.961	0.854	0.801	0.961	0.907
1.000	0.017	0.096	0.192	0.035	0.000	0.192	0.096
1.000	0.000	0.167	0.064	0.000	0.333	0.064	0.000
1.000	0.000	0.231	0.307	0.154	0.200	0.307	0.231

Step 5: Calculate the discordance matrix.

$$NI_{k,l} = \frac{\max\limits_{j \in D_{k,l}} |V_{kj}-V_{lj}|}{\max\limits_{j \in J} |V_{kj}-V_{lj}|} \ ,$$

J9	J10	J11	J12	J13	J14	J15	J16
0.064	0.128	0.128	0.000	0.070	0.064	0.128	0.000
0.192	0.256	0.256	0.500	0.012	0.333	0.256	0.167
0.000	0.014	0.000	0.400	0.000	0.200	0.014	0.000
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.342	0.053	0.053	0.605	0.053	0.474	0.211	0.342
0.096	0.192	0.192	0.250	1.441	0.096	0.192	0.000
0.286	0.000	0.000	0.571	0.000	0.429	0.143	0.286
0.306	0.019	0.010	0.583	0.010	0.444	0.167	0.306
-	0.077	0.077	0.400	0.042	0.200	0.077	0.000
0.306	-	0.000	0.583	0.000	0.444	0.167	0.306
0.306	0.010	-	0.583	0.000	0.444	0.167	0.306
0.769	0.897	0.897	-	0.140	0.769	0.897	0.512
0.854	0.907	0.907	0.583	-	0.854	0.907	0.747
0.000	0.096	0.096	0.250	0.035	-	0.096	0.000
0.167	0.000	0.000	0.500	0.000	0.333	-	0.167
0.154	0.231	0.231	0.400	0.084	0.200	0.231	-

J9	J10	J11	J12	J13	J14	J15	J16
0.499	0.499	0.499	1.000	0.909	0.499	0.499	1.000
0.093	0.499	0.499	0.502	0.909	0.093	0.499	0.093
1.000	0.909	1.000	0.502	1.000	0.502	0.909	1.000
0.501	0.909	0.909	0.502	0.909	0.502	0.411	0.502
0.502	0.001	0.093	0.502	0.502	0.502	0.001	0.502
0.499	0.499	0.499	0.502	0.909	0.499	0.499	1.000
0.502	1.000	1.000	0.502	1.000	0.502	0.502	0.502
0.502	0.909	0.909	0.502	0.909	0.502	0.502	0.502
-	0.499	0.499	0.502	0.909	0.411	0.499	1.000
0.501	-	0.999	0.502	1.000	0.502	0.502	0.502
0.501	0.909	-	0.502	1.000	0.502	0.411	0.502
0.498	0.498	0.498	-	0.909	0.499	0.499	0.590
0.091	0.498	0.589	0.091	-	0.093	0.001	0.093
0.999	0.498	0.498	0.502	0.907	-	0.499	1.000
0.501	0.999	0.999	0.501	0.999	0.501	-	0.502
0.498	0.498	0.498	0.501	0.907	0.000	0.498	-

Step 6: Determine the concordance dominance matrix So we calculate matrix of I.

$$\bar{I} = \sum_{k=1}^{16} \sum_{l=1}^{16} I_{kl}/m(m-1) \ ; \quad (m=16,\ \text{is dimension}$$

of matrix),

$$f_{kl} = 1 \xrightarrow{if} I_{kl} \geq \bar{I},$$
$$f_{kl} = 0 \xrightarrow{if} I_{kl} < \bar{I},$$

Step 7: Determine the discordance dominance matrix So we calculate matrix of G.

$$N\bar{I} = \sum_{k=1}^{m} \sum_{l=1}^{m} NI_{kl}/m(m-1),$$
$$g_{kl} = 1 \ if\xrightarrow{} NI_{kl} \leq N\bar{I},$$
$$g_{kl} = 0 \xrightarrow{if} NI_{kl} > N\bar{I},$$

Step 8: Determine the aggregate dominance matrix We also compute matrix of H. "P is means personnel"

$$h_{k,l} = f_{k,l} \cdot g_{k,l}$$

J1	J2	J3	J4	J5	J6	J7	J8
-	0.058	0.128	0.192	0.070	0.000	0.192	0.128
1.000	-	0.256	0.320	0.192	0.333	0.320	0.256
1.000	0.000	-	0.000	0.000	0.200	0.077	0.000
0.000	0.000	0.000	-	0.000	0.000	0.000	0.000
1.000	0.211	0.342	0.101	-	0.474	0.101	0.053
1.000	0.087	0.192	0.288	0.105	-	0.288	0.192
1.000	0.143	0.286	0.000	0.000	0.429	-	0.000

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	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
A1	0	1	0	0	0	1	0	0	0	0	0	1	1	0	0	1
A2	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0
A3	0	1	0	1	1	0	0	1	1	1	1	0	1	0	1	1
A4	0	0	0	0	1	0	1	1	0	1	1	0	1	0	0	0
A5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
A7	0	0	0	1	1	0	0	1	0	1	0	1	1	0	0	0
A8	0	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0
A9	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	1
A10	0	0	0	0	1	0	0	1	0	0	1	0	1	0	0	0
A11	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0
A12	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
A13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A14	0	1	0	1	1	1	0	0	1	0	0	0	1	0	0	1
A15	0	1	0	1	1	0	1	1	0	1	1	0	1	0	0	0
A16	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Step 9: Eliminate the less favorable alternative and rank them.

Finally in ELECTRE method, the bests are A1, A3, A14 (in equal level) and they were followed by A12, A15 (in equal level), A6, A7, A9 (in equal level), A4 and A16, A10, A11 (in equal level), A2, A8 (in equal level) and finally A5 and A13.

So the result is:

STRATEGIC PLANS	RANK
I1	1
I3	1
I14	1
I12	2
I15	2
I6	3
I7	3
I9	3
I4	4
I16	5
I10	6
I11	6
I2	7
I8	7
I5	8
I13	9

IV. CONCLUSION

The trust of the matter is one of the BSC problems in execution 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 Electre 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 and the produced result is more accepted. (Tables and calculations have been presented in detail in [15].

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