Proceedings of 2013 International Conference on
Technology Innovation and Industrial Management
29-31 May 2013, Phuket, Thailand

IMPLEMENTING BALANCED SCORECARD OF GOVERNMENT MIS DEPARTMENT－USING AHP AND FUZZY AHP METHODS

Yi-Hui Liang, Department of Information Management, I-Shou University, Taiwan (R.O.C.)
german@isu.edu.tw

ABSTRACT

The purpose of this study is to examine the role of the bal-anced scorecard in Government MIS Department. The frame of Government MIS Department performance applying the balanced scorecard methodol-ogy, analytic hierarchy process (AHP) and fuzzy AHP is developed by review the studies of balanced scorecard and information systems. Then, this study adopted 13 valid questionnaires in the Taiwan's Gov-ernment MIS Department to test the framework of the balanced scorecard. This study only adopts the Taiwan's Government MIS Department to vali-date the proposed measurement system. Future studies may aim other industries to evaluate Government MIS Department.

Keywords: Fuzzy theory, AHP, Balanced scorecard

INTRODUCTION

Since Executive Yuan, Republic of China implemented performance reward and performance management plan in 2003, this plan followed the Balanced Scorecard (BSC) spirit. However, Executive Yuan then consider the business properties, organi-zational culture, and management and check, so as to authorize each government department to set up its own performance evaluation process and evaluation indicators [1]。Until now, Executive Yuan does not force government departments to set up their own performance evaluation process and evaluation indicators [2].

Performance appraisal system is the most effective tool used for government reengineering. Performance appraisal aims to help people achieve their strategies, missions, visions and goals. Wu (2000)[3] supposed that good performance appraisal systems can enable government departments to allocate reasonable resources, priori-tize resource investment, further improve departmental effectiveness and efficiency, and organizational members adopt identical methods to pursue their goals, encourage their morale, and cause them to focus on organizational vision.
Balanced Scorecard (BSC), which was developed by Kaplan & Norton [4] in 1992, is a useful and popular method of identifying business performance using lag-ging and leading indicators based on the foundation of visions and strategies. Bal-anced Scorecard implies that organizational performance is evaluated not only utiliz-ing financial indicators, but also simultaneously non-financial indicators.

Satty's (1980) [5] analytical hierarchy process (AHP), which is a multi-criteria technique, is considered appropriate for solving complex decision problems [6]. The AHP is utilized in two manners with BSC: (1) choosing metrics at the beginning of the process and (2) understanding the relative importance of the metrics to a firm's managers and employees [7]. Clinton *et al.* (2002) [7] supposed the AHP is a single method that offers a means of selecting proper metrics, and this method is capable to satisfy each requirement of metric choice and scorecard construction. The AHP is based on theory and offers information on the relative weight of the BSC performance indicator [8][9].

Zadeh (1965) [10] developed fuzzy theory for handling problems involving fuzz-iness and vagueness. Lee *et al.* (2010) [11] posited that traditional BSC failed to con-solidate diverse performance indicators. Lee *et al.* (2010) [11] also suggested the fuzzy AHP method as a solution to this problem.

BSC can help managers of government organizations holistically evaluate infor-mation technology (IT) investments, as well as the performance of information sys-tem (IS) departments. This study builds a Framework for evaluating government MIS departments based on BSC. The study summarizes how to combine the BSC and fuzzy AHP to serve as a decision tool for government organization. The tool can be used not only to assess the contribution of a specific government MIS department, but also analyze the performance and direct the activities of government MIS depart-ments.

METHODOLOGY

1. Balanced Scorecard

Current strategic management suggests that there should be a strong linkage be-tween strategic plans and performance measures. Kaplan and Norton (1992)'s work [4] and determinants framework can provide this linkage. Kaplan and Norton (1992) [4] developed BSC to reform the traditional management system and as a means to evaluate corporate performance from four different perspectives, including financial, customer, internal business process and learning and growth, to measure performance. BSC suggests that systems for evaluating business performance should not only con-sider financial lagging indicators, but also customer, internal business process and learning and growth leading indicators.

Kaplan and Norton (1996) [12] indicated that BSC objectives and indicators based on vision and strategies can maintain a balance between short and long term objec-tives, financial and non-financial measures, lagging and leading indicators, and inter-nal and external performance perspectives. Kaplan and Norton (2004) [13] suggested strategy maps as a main means of describing and communicating strategies. Strategy maps clarify how to convert intangible assets, such as intangible activities contrib-uting to learning and growth, to improve organizational processes, increase customer satisfaction, and obtain better tangible outcomes, such as return on investment.

2. Research Structure and Select research variables

This study builds a Framework for evaluating government MIS departments based on BSC, AHP and fuzzy AHP.

This study adopted the dimensions and indicators which developed by Martinsons et al. (1999) [14], Liang, Hsieh, and Wang (2008)[15], and related government MIS experts to develop my proposed the dimensions and indicators. The research varia-bles are showed as Table 1.

Table 1. Research Variables

Dimension		Indicator	
Use orien-tation	1.	Build and maintain the good image and reputation with end users.	A1
	2.	Have the opportunity to develop IT.	A2
	3.	Maintain a good relation with user communities.	A3
	4.	Satisfy end user requirement	A4
	5.	Perceived the preferred IS products and services provider by end users.	A5
Business value	1.	Manage the good image and reputation.	B1
	2.	Make sure IS projects to offer business value.	B2
	3.	Control cost.	B3
	4.	Be onerous to offer the suitable IS products and services to the third party.	B4
Inner pro-cess	1.	Expect and affect the demands from end users and managers.	C1
	2.	Plan and develop IT efficiently.	C2
	3.	Operate and maintain IT applications efficiently.	C3
	4.	Obtain and test new hardware and software.	C4
	5.	Offer to satisfy the end user trainings with effective cost.	C5
	6.	Manage the IS problems effectively.	C6
Future readiness	1.	Expect and prepare the IS problems.	D1
	2.	Train and develop regularly to improve IS skills.	D2
	3.	Promote regularly IS applications mix.	D3
	4.	Increase regularly IS hardware and software.	D4
	5.	Implement cost-effective and new technological research-es which are suitable for organizations.	D5

3. The AHP and Fuzzy AHP methods

Saaty (1980) [5] developed the AHP method to resolve problems regarding choice and weight prioritization encountered during Multiple-Criteria Decision Making. The AHP method utilizes the pairwise comparison of alternatives to combine each deci-sion-maker evaluation into a final decision [11]. Zadeh (1965) [10] introduced fuzzy theory to address the vagueness of human thinking, which was oriented to the ration-ality of uncertainty

because of imprecision or fuzziness. Many studies have combined fuzzy theory with the AHP to compensate for problems introduced because of vague-ness [11][16].

The analytical steps of the AHP and fuzzy AHP methods for implementing balanced scorecard of Government MIS Departmentare showed as followings.

First, the analytical steps of the AHP method are illustrated as followings.

Step 1: Construct hierarchical framework of the BSC performance evaluation criteria

Step 2: Built pairwise comparison matrix A

Step 3: Using AHP method to calculate the weight

If get the weightmatrix W in pairwise comparison matrix A, standardize geomet-rical mean of row vectors, multiply element in every row, get geometrical mean and normalize it.

Step 4: Consistency Check

Second, the analytical steps of the fuzzy AHP method are illustrated as follow-ings.

Step 1: Construct hierarchical framework of the BSC performance evaluation criteria

From the four BSC perspectives, the hierarchical framework of the BSC perfor-mance evaluation criteria is constructed.

Step 2: Using AHP method to calculate the weight

If get the weightmatrix W in pairwise comparison matrix A, standardize geomet-rical mean of row vectors, multiply element in every row, get geometrical mean and normalize it.

Step 3: Construct Positive Reciprocal Matrix

Every evaluation member use fuzzy AHP evaluation scale to express relative weight between each dimensions and criteria, and construct fuzzy Positive Reciprocal Matrix.

Step 4: Consistency Check

The check methods are as follows:

4.1 Consistency Index (C.I.)

According to Consistency Index (C.I.), C.I=0 indicate that evaluation has perfect consistency; C.I>0 indicate that evaluation has consistency; C.I. <0.1 indicate that evaluation has evaluation has tolerant bias.

4.2 Consistency Rate (C.R.)

Saaty (1980) [5] supposed that Consistency Rate (C.R.) to evaluate the con-sistency of pairwise comparisons in a matrix among criterions. Under the condition of different rank of matrix, it produce different random index (R.I.). Under the condition of the same rank of matrix, the ratio of C.I. to R.I. is called C.R.. When C.R≤0.1, the consistency level is acceptable.

Step5: Calculate fuzzy weight value

Utilize the Lambda-Max method which Csutora and Buckley (2001) [17] pro-posed, calculate the fuzzy weight of evaluation criterions. The steps of calculation are as follows:

5.1 When α=1, use α-cut to get median Positive Reciprocal Matrix. Then, calculate the weight use AHP method to get the weight matrix.

5.2 When α=0, use α-cut to get minimum positive reciprocal matrix and maximum positive reciprocal matrix. Then, calculate the weight use AHP meth-od to obtain the weight matrix.

5.3 In order to make sure that calculated weight value is fuzzy number, there-fore, adjusted the coefficient.

5.4 After obtained adjusted coefficient, calculate minimum positive reciprocal weight matrix and maximum positive reciprocal weight matrix of every measurement dimension.

5.5 Combing adjusted minimum, maximum and median values to get the fuzzy weight in kth evaluation member and kth measurement dimension.

5.6 Utilize average method to integrate the fuzzy weight of evaluation members and measurement dimensions.

RESULTS

1. Survey Candidates

Based on previous studies on applying the BSC approach to information systems, this study used the 21 indicators as performance evaluation indicators to construct the research model and develop the questionnaire items based the model. The 20 indica-tors are showed in Table 1.

Next, take the central engineering government department as the example, and cal-culate the weights of all dimensions and indicators of the model using the AHP and Fuzzy AHP methods. The questionnaire was distributed among Director and Vice Director of the direct department, 7 Director of first-class independent unit, 3 Section Manager of the direct department, and Director of Information Technology, and a total of 13 valid questionnaires were returned and censored 2 invalid questionnaires (refusing answer, incomplete answer, or don't passing the consistency check).

2. Results of the AHP and fuzzy AHP methods

The results of using the AHP and Fuzzy AHP methods demonstrated that the im-portance weights of all dimensions were ordered as follows: internal process, user orientation, business value, and future readiness. Additionally, the results of using the AHP and Fuzzy AHP methods demonstrated that the top three importance weights of performance evaluation indicators were top three indictors are "Control cost," "Satis-fy end user demand," "Operate and maintain information technologies efficiently". However, from rank 4 to 20 performance evaluation indicators, the results of using the AHP method are different with the Fuzzy AHP method. Totally, the results of using the AHP method are slightly different with the Fuzzy AHP method. Theoretically, the Fuzzy AHP method is better than the AHP method. The result of this study is showed in Table 2.

Table 2. The results of using the AHP and Fuzzy AHP methods

Dimension	AHP weight	Fuzzy AHP weight	Indicator	AHP weight	AHP rank	Fuzzy AHP weight	Fuzzy AHP rank
User orientation	0.273	0.277	1. Build and maintain the good image and reputation with end users.	0.045	9	0.046	11
			2. Have the opportunity to develop IT.	0.032	13	0.037	15
			3. Maintain a good relation with user communities.	0.050	8	0.053	8
			4. Satisfy end user requirement	0.110	2	0.098	2
			5. Perceived the preferred IS products and services provider by end users.	0.037	12	0.043	12
Business value	0.239	0.239	1. Manage the good image and reputation.	0.044	10	0.050	10
			2. Make sure IS projects to offer business value.	0.042	11	0.050	9
			3. Control cost.	0.119	1	0.100	1
			4. Be onerous to offer the suitable IS products and services to the third party.	0.030	15	0.040	13
Inner process	0.328	0.328	1. Expect and affect the demands from end users and managers.	0.065	5	0.055	7
			2. Plan and develop IT efficiently.	0.062	7	0.060	5
			3. Operate and maintain IT applications efficiently.	0.070	3	0.064	3
			4. Obtain and test new hardware and software.	0.031	14	0.032	16
			5. Offer to satisfy the end user trainings with effective cost.	0.063	6	0.062	4

			6. Manage the IS problems effectively.	0.066	4	0.055	6
Future readiness	0.156	0.156	1. Expect and prepare the IS problems.	0.024	20	0.029	18
			2. Train and develop regularly to improve IS skills.	0.026	18	0.030	17
			3. Promote regularly IS applications mix.	0.030	16	0.029	19
			4. Increase regularly IS hardware and software.	0.025	19	0.028	20
			5. Implement cost-effective and new technological researches which are suitable for organizations.	0.028	17	0.040	14

CONCLUSIONS

The AHP method is a powerful technique that offers great promise for using the balanced scorecard for practical [6]. However, the decision makers are often uncertain in assigning the evaluation score in using the AHP method. The fuzzy AHP method can conquer this problem. Government organizations and other non-profit organiza-tions use the fuzzy AHP method is liable lead to better balanced scorecard conse-quences.

For Taiwan's information and electronic industries, the framework and methodolo-gy supply, the framework and fuzzy AHP method can serve as a useful modeling instrument in analyzing coupled improvement problems. Identifying the dimensions and performance evaluation indicators offers an important piece of information which would assist managers in Taiwan's government organizations and other non-profit organizations to better understand the main facets of MIS department performance and adopt the right action to enhance the total performance. The framework and fuzzy AHP method not only aid the companies in Taiwan's government organizations and other non-profit MIS organizations to respond to the changes much faster, but also supplies the management teams to move forward with confidence.

This study has some limitations. First, drastically changing environments influ-ences dependency relationships of dimensions and indicators and the accuracy of the proposed model. Second, compared to Miller & Doyle (1987) [18] and Saunder & Jones (1992) [19], the proposed IS evaluation dimensions and indicators more focus non-profit organizations characteristics.

REFERENCES

1. Directorate-General of Personal Administration, Executive Yuan, performance reward and performance management plan (2005)
2. Chu, H.L., Cheng, C.J.: An Empirical Investigation of the Governmental Performance Management System: Using the Balanced Scorecard and the Analytic Hierarchy Process. Journal of Management, 24, 689-705 (2007)
3. Wu, A.: The new direction for performance evaluation. The Chinese BAS Monthly. 530, 43-52 (2000)
4. Kaplan, R.S., Norton, D.P.: The Balanced Scorecard-Measures: That Drive Performance. Harvard Business Review. 70, 72-79 (1992).
5. Saaty, T.L.: The Analytic Hierarchy Process. McGraw-Hill, New York (1980)
6. Yüksel, İ., Dagdeviren, M.: Using the fuzzy analytic network process (ANP) for Balanced Scorecard (BSC): A case study for a manufacturing firm. Expert systems with application. 37, 72-79 (2010)
7. Clinton, D.B., Webber, S.A.: Hassell, J.M.: Implementing the balanced scorecard using the analytic hierarchy process. Management Accounting Quarterly. 3, 1-11 (2002)
8. Searcy, D.L.: Alignment the balanced scorecard a firm's strategy using the analytic hierar-chy process. Mangement Accounting Quarterly. 5, 1-10 (2004)
9. Liedtka, S.L.: Analytic hierarchy process and multi criteria performance management sys-tems. Cost Management, 19, 30-38 (2005)
10. Zadeh, L.A.: Fuzzy Sets. Information and Control. 8, 338-353 (1965)
11. Lee, A.H.I., Chen, W.C., Chang, C.J.: A fuzzy AHP and BSC approach for evaluating per-formance of IT department in the manufacturing industry in Taiwan. Expert systems with application. 34. 96-107 (2010)
12. Kaplan, R.S., Norton, D.P.: The Balanced Scorecard : Translating Strategy into Action. Harvard Business School Press**,** Boston: MA. (1996)
13. Kaplan, R.S., Norton, D.P.: Strategy Maps: Converting Intangible Assets into Tangible Outcomes. Harvard Business School Press**,** Boston: MA. (2004)
14. Martinsons, M., Davison, R., Tse, D.: The balanced scorecard: a foundation for the strate-gic management of information systems. Decision Support Systems. 25. 71-88 (1999)
15. Liang, Y.H., Hsieh, H.C., Wang, C.Y.: A Study of Implementing Balanced Scorecard of Government MIS Department-A Case Study of Engineering Department of Govern-ment. Electronic Commerce Studies. 64. 425-445 (2008)
16. Cebeci, U.: Fuzzy AHP-based decision support system for selecting ERP systems in textile industry by using balanced scorecard. Expert Systems with Applications. 36. 8900-8909 (2009)
17. Csutora, R., Buckley, J.J.: Fuzzy Hierarchical Analysis: The Lambda-Max Method. Fuzzy Sets and Systems. 120. 181–195 (2001)
18. Miller, J., Doyle, B.A.: Measuring the Effectiveness of Computer-Based Information Sys-tems in the Financial Service Sector. MIS Quarterly. 11. 107-124 (1987)
19. Saunders, F.A., Jones, J.W.: Measuring Performance of the Information Systems function. Journal of Management Information Systems. 8. 63-82 (1992)