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## **An Analytical Network Process Approach for Evaluating Banking Performance Based on Balanced Scorecard**

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### **ABSTRACT**

The study proposed an Analytical Network Process (ANP) approach for banking performance evaluation based on Balanced Scorecard (BSC). This research we summarized the evaluation indexes synthesized from the literature relating to banking performance. Afterwards, for screening these indexes, twenty-three indexes fit for banking performance evaluation were selected through expert questionnaires. The ANP is a relatively new MCDM method which can deal with all kinds of interactions systematically. An analytic network process that borrows the idea of stochastic transiting process is employed to identify the interdependence between these two groups of elements. The model first calculates the relative importance of the BSC performance for the performance evaluation of banks with respect to each of those success main factors. Finally, the relative importance of those BSC performance and weights of their corresponding BSC indexes will be involved to the model for evaluating the performance of banks. It shows that the proposed ANP evaluation model of banking performance using the BSC framework can be a useful and effective assessment tool.

**Key words:** OR in banking, banking performance, balance scorecard, analytical network process

### **INTRODUCTION**

Many different theories and methods of performance for conducting an evaluation have been applied in various organizations for many years. These approaches include ratio analysis, total production analysis, regression analysis, delphi analysis, balanced scorecard, analytic Hierarchical Process (AHP), Data Envelopment Analysis (DEA) and others. Each method has its own basic concept, aim, advantages and disadvantages (Dessler, 2000). Which one is chosen by management or decision makers for assessing performance depends on the status and type of the organization. However, all the successful enterprises have some common features, including a specific vision, positive actions and an effective performance evaluation. BSC is an extensive and thorough performance evaluation tool to adequately plan and control an organization so it can attain its goals (Davis and Albright, 2004; Lawrie and Cobbold, 2004; Pinero, 2002). The BSC breaks through the traditional limitations of finance, examining an organization's performance from the four main perspectives of finance, customer, internal business process and learning and growth (Kaplan and

Norton, 1992). It emphasizes both the aspects of the financial and non-financial, long-term and short-term strategies and emphasizes internal and external business measures. Several studies have been conducted incorporating the four perspectives of the BSC in performance appraisal. To achieve the best possible result from a more effective performance, it is crucial to improve the banking relationship by matching the needs of the clients to the delivery process of client services (Nist, 1996). Therefore, the BSC is also utilized as a framework to develop evaluation indicators for banking performance (Davis and Albright, 2004; Kim and Davidson, 2004; Kuo and Chen, 2008).

ANP (Saaty, 1996) is a comprehensive decision-making technique that has the capability to include all the relevant criteria, which have some bearing, in arriving at a decision. Contrary to AHP, ANP provides a more generalized model in decision-making without making assumptions about the independency of the higher-level elements from lower-level elements and also of the elements within a level. Despite all these merits, the applications of ANP are not very common in a decision-making problem. However, in recent years, there has been an increase in the use of ANP in multi-criteria decision-making problems. In the selection of a provider, the criteria are of both the types, subjective and objective. These criteria also have some interdependencies, which cannot be captured by the popular AHP method (Wen-Hsien and Wen-Chin, 2009). Therefore, instead of using the commonly used AHP approach for solving such types of problems, we recommend the use of an ANP-based model for the selection of a provider. Furthermore, the ANP approach is used to decide the relative weights of the criteria. It improves the visibility of decision-making processes and generates the priorities between the decision alternatives.

## **BALANCED SCORECARD**

The concept of BSC was proposed by David Norton, the CEO of Nolan Norton Institute and Robert Kaplan, a professor at Harvard University (Kaplan and Norton, 1992; Hung-Yi *et al.*, 2009). The BSC is a popular tool that is applied by many businesses to assess their performance in diverse aspects of their organization. The BSC measures organizational performance from four perspectives, including financial, customer, internal business process and learning and growth, in relation to the four functions of accounting and finance, marketing, value chain and human resource. These measures, both financial and non-financial, from all four perspectives serve as the common language to help align the top management and employees toward with the organization's vision. The BSC provides managers with the instrumentation tools they need to navigate towards future competitive success (Kaplan and Norton, 1992, 1996a, b). The essential tenet of the BSC is that standard financial measures must be balanced with non-financial measures (Norton *et al.*, 1997; Hung-Yi *et al.*, 2009).

There has been generally accepted in practice that since the introduction of the BSC by Kaplan and Norton a combination of financial and non-financial measures in a performance measurement system is favorable for both profit and non-profit organizations (Ballou *et al.*, 2003; Hung-Yi *et al.*, 2009; Sinclair and Zairi, 2001). Banks can save both time and money if they recognize which measures are most suitable for their needs. Non-financial measures such as intangibles like customer relationships may account for more than half of the total assets of a company. An important principle of the BSC is to achieve success on key non-financial measures before actualizing success on key financial measures. When considered in non-financial measures to other measures, these metrics can lead organizations to administer performance effectively and forecast their future profitability (Anonymous, 2006; Mouritsen *et al.*, 2005; Hung-Yi *et al.*, 2009).

The BSC provides insights into corporate performance not only for managers seeking ways to improve performance, but also for investors wanting to gauge the organizations' ongoing health. For banks the benefits of using BSC are numerous: (1) can be used as a framework to assess and develop a bank's strategy: (2) can be used to develop strategic objectives and performance measures to transform a bank's strategy into action: (3) it provides a way to measure and monitor the performance of key performance drivers that may lead to the successful execution of a bank's strategy and (4) it is an effective tool to ensure that a bank continuously improves its system and process (Frigo *et al.*, 2000; Hung-Yi *et al.*, 2009).

Davis and Albright (2004) presented an empirical analysis that explores the effect of the BSC on a banking institution's financial performance. Kim and Davidson (2004) used the BSC framework to assess the business performance of Information Technology (IT) expenditures in the banking industry using the t-test and regression models. Kuo and Chen (2008) applied the four perspectives of the BSC to construct key performance appraisal indicators for the mobility of the service industries through the fuzzy Delphi method. Leung *et al.* (2006) proposed a tailor-made performance measurement model using the analytic hierarchy process and the analytic network process for implementing the BSC.

## **SUCCESS MAIN FACTORS**

These factors are divided into three categories: strategic, operational and technical.

**Strategic factors:** The new type of business would consist of finely tuned integration of business, technology and processes (El Sawy *et al.*, 1999). Therefore, one critical issue is re-engineering of the business processes, which also includes technological processes. The development of integrated, customized financial services is becoming an active area of competition between financial sector organizations (Amiri *et al.*, 2009).

**Technical factors:** Technical factors include Integration of technology, Systems security and Upgrading existing infrastructure (Franco and Klein, 1999; Turban *et al.*, 2000; Regan and Macaluso, 2000). Storey *et al.* (2000), Sudha *et al.* (2007) and Mahmood *et al.* (2003) state that technology failures lead to loss of custom, often forever. Shortcomings in technological infrastructure are often the biggest hurdle in adoption of the banking channels and its integration with other channels (Shah *et al.*, 2003).

**Operational factors:** According to Jayawardhena and Foley (2000), banks must continually invent new products and services in light of changes brought by the Internet and other services (Mirza *et al.*, 2009); also make existing products more suitable for online delivery (Sarлак *et al.*, 2009). Similarly, Riggins (1999) identified a number of success factors of Internet banking in the context of the Australian banking industry. Operational factors include; good customer services, simplifying and integrating basic services, developing the will to innovate rapidly, online decision support tools for personal financial management and the creation of an online 'virtual' community for financial services and bundling of products/services (Jayawardhena and Foley, 2000; Orr, 2004; Ahangar, 2011; Chirico and Presti, 2011; Haque *et al.*, 2009). Commercial banks in Iran have been quick to realize the importance of e-banking to competitive advantage. Since the 2001, they have continuously innovated through technology-enhanced products and services, such as multi-function

Automatic Teller Machines (ATMs), electronic share application, tele-banking, TV-banking, electronic transfers, electronic cash cards and Internet-based e-banking (Sarлак *et al.*, 2009).

### HIERARCHICAL FRAMEWORK OF EVALUATING BANKING PERFORMANCE BASED ON BSC

Figure 1 depicts the performance evaluation model that takes into consideration the interdependence of success main factors and the BSC performance. From the four BSC perspectives and expert questionnaires were used for screening the indexes fit for the banking performance evaluation. Twenty three evaluation indexes were selected by the experts' team. There are twenty four evaluators such as experts familiar with banks that perform the above comparisons in process. statistical population is 100 people at this research. The hierarchical framework of the BSC performance evaluation criteria (i.e., tree factors as control element, four dimensions and 23 indexes) for banking is shown in Fig. 1.

### ANALYSIS AND RESULTS

The Analytical Network Process (ANP) (Saaty and Takizawz, 1986) approach is employed to deal with this interactive environment. It is capable of handling interdependence among different layers of elements by obtaining the composite weights for developing a “supermatrix”. Traditional Analytical Hierarchy Process (AHP) assumes that the system elements are not correlated and are unidirectionally influenced by a hierarchical relation. However, the ANP approach eliminates these limitations and allows a feedback relationship between the elements at different layers and interdependence between elements at the same layer through the development of a “supermatrix” (Saaty, 1996). To elicit preferences of various elements, the respondent compares two elements at a time with respect to the “control” element residing at another layer.

The fundamental requirement for developing the supermatrix in the ANP is the control element for these pairwise comparisons that can be the element at the upper or lower layers of the network structure. For ANP, like AHP, pairwise comparisons of the elements at each layer are conducted with respect to their relative importance towards their control element.

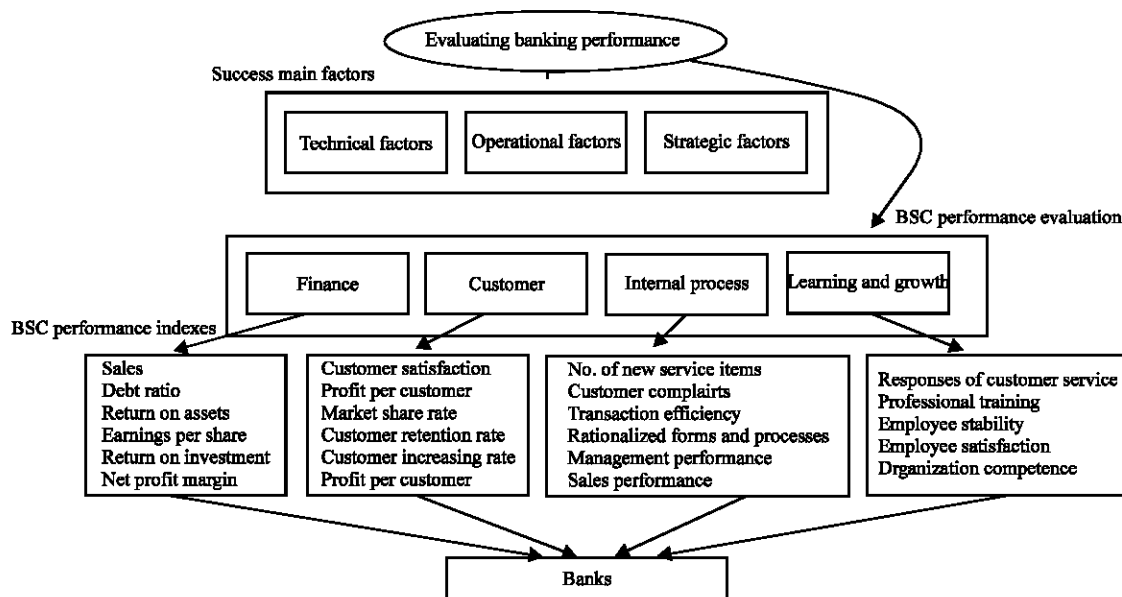


Fig. 1: Hierarchical framework of evaluating banking performance

Table 1: Pairwise comparison for BSC performance with respect to the technical factors

Technical factors	Finance	Customer	Internal process	Learning and growth	Relative weights
Finance	1	5	1/3	1/4	0.237
Customer	1/5	1	1/3	1/6	0.059
Internal process	3	3	1	1/4	0.2518
Learning and growth	2	6	4	1	0.4516

For the purpose of pairwise comparison, we construct the scale of measure from 1 to 7, denoting indifferent to absolutely important, respectively. Reasonably, the reciprocal scale of measure from 1 to 1/7 will denote indifferent to absolutely unimportant, respectively.

We now conduct the pairwise comparison of the BSC performance with respect to some specific control factors that influence them. We wish to find their relative weights of importance ( $w$ ), on each of the specific control factors. Ideally, we can make a perfect comparison provided that the relative weights of importance for these performances are already known. That means the number  $c_{ij} = w_i/w_j$ , indicating the strength of performance  $I$  when compared with performance  $j$ . But practically, the evolve process is exactly the reverse. The relative weights of importance of these performances are unknown and will be derived from the subjective judgment of pairwise comparison. For example, Table 1 depicted the results of comparison of BSC performance of finance, customer, internal process and learning and growth with respect to the Success main factors of Technical factors (Sudha *et al.*, 2007).

Once the pairwise comparisons are completed, we noted that the diagonal of this comparison matrix  $C$  consists of ones. The relative weight vector must satisfy the  $Cw = \lambda w$  provided that we can make a perfect comparison and create a  $n \times n$  comparison matrix. Once again, in practical situation, the comparison is made by subjective judgment. Based on the theory of matrix, the small variations of the comparison of  $c_{ij}$  will keep the largest eigenvalue close to  $n$ , consequently, the relative vector of weight  $w$  is computed as the unique solution of  $Cw = \lambda_{\max} w$  where  $C$  is the comparison matrix and  $\lambda_{\max}$  is the largest eigenvalue of  $C$ . There are several algorithms available for approximating vector  $w$  (Saaty, 1996). However, in this paper, a two-stage algorithm proposed by Meade and Sarkis (1998) is used in the process for averaging over normalized columns and is employed to approximate vector  $w$  (Sheu and Lee, 2007). This is represented as:

$$w_i = \frac{1}{n} \sum_{j=1}^n \frac{c_{i,j}}{\sum_{i=1}^m c_{i,j}} \tag{1}$$

From the data in Table 1, the decision-maker gives more relative weight of importance to the behavior of decision making than other behaviors with respect to the performance influencing factor of technical factors of the bank.

The pairwise comparisons of BSC performance with respect to other two success main factors are conducted in a similar way. The results of these comparisons are summarized in Table 2. As we can see, the relative weights of importance of those behaviors are inconsistent when different performance success main factors are considered.

Similarly, the pairwise comparisons of these success main factors with respect to each specific control BSC performance are conducted. The comparison of the success main factors that affect performance with respect to the behavior of decision-making is illustrated in Table 3. The relative weight vectors of these success main factors are obtained from applying Eq. 1 is written in the rightmost column of Table 3.

Table 2: Relative weights of BSC performance with respect to success main factors

	Technical factors	Operational factors	Strategic factors
Finance	0.237	0.074	0.046
Customer	0.059	0.285	0.337
Internal process	0.2518	0.234	0.235
Learning and growth	0.4516	0.407	0.383

Table 3: Pairwise comparison for success factors with respect to finance

Finance	Technical factors	Operational factors	Strategic factors	Relative weights
Technical factors	1	3	6	0.597
Operational factors	1/3	1	4	0.318
Strategic factors	1/6	1/4	1	0.085

Table 4: Relative weights of success main factors with respect to BSC performance

	Finance	Customer	Internal process	Learning and growth
Technical factors	0.597	0.507	0.570	0.662
Operational factors	0.318	0.396	0.109	0.268
Strategic factors	0.085	0.097	0.321	0.070

Table 5: Initial supermatrix for ANP approach

	Finance	Customer	Internal process	Learning and growth	Technical factors	Operational factors	Strategic factors
Finance					0.237	0.074	0.046
Customer					0.059	0.285	0.337
Internal process					0.2518	0.234	0.235
Learning and growth					0.4516	0.407	0.383
Technical factors	0.597	0.507	0.570	0.662			
Operational factors	0.318	0.396	0.109	0.268			
Strategic factors	0.085	0.097	0.321	0.070			

The pairwise comparisons of success main factors with respect to other two BSC value for performance evaluation are conducted in a similar way. The results of these comparisons are summarized in Table 4.

The next step is to form the “supermatrix” which allows a solution for the effects of interdependence between the elements at different layers of the model (Sheu and Lee, 2007; Etaati *et al.*, 2011). Table 2 and 4 are now combined to form the initial “supermatrix” as shown in Table 5. As the model represented in Fig. 1, the relationships of elements in the same layer are assumed to be insignificant.

The corresponding area in the “supermatrix” is assigned a value of zero (Sheu and Lee, 2007). In the long run, the “supermatrix” converges to the stable values given in Table 6, which will be used in further application.

Evaluators only have to conduct the comparison with respect to the performance and the transition operation is unnecessary. The pairwise comparisons of sales, debt ratio, return on assets, earnings per share, return on investment and net profit margin with respect to the BSC performance factors of decision-making are depicted in Table 7. Eq. 1 is again applied.

Finally, the relative importance of each BSC performance and the relative weights of its associated BSC indexes are summarized in Table 8. The numerals in parentheses are the product

Table 6: Long-term supermatrix for ANP approach

	Finance	Customer	Internal process	Learning and growth	Technical factors	Operational factors	Strategic factors
Finance	0	0	0	0	0.119	0.119	0.119
Customer	0	0	0	0	0.227	0.227	0.227
Internal process	0	0	0	0	0.24	0.24	0.24
Learning and growth	0	0	0	0	0.414	0.414	0.414
Technical factors	0.584	0.584	0.584	0.584	0	0	0
Operational factors	0.273	0.273	0.273	0.273	0	0	0
Strategic factors	0.143	0.143	0.143	0.143	0	0	0

Table 7: Pairwise comparison of BSC performance with respect to finance

Finance	Sales	Debt ratio	Return on assets	Earnings per share	Return on investment	Net profit margin	Relative weight
Sales	1	1/6	1/2	3	2	5	0.191
Debt ratio	6	1	4	3	2	4	0.327
Return on assets	2	1/4	1	1/3	4	5	0.206
Earnings per share	1/3	1/3	3	1	1/2	3	0.134
Return on investment	1/2	1/2	1/4	2	1	2	0.102
Net profit margin	1/5	1/4	1/5	1/3	1/2	1	0.041

Table 8: Relative importance of BSC performance and their associated BSC performance indexes

Finance	0.119	Customer	0.227	Internal process	0.24	Learning and growth	0.414
Sales	0.191(0.023)	Customer satisfaction	0.071(0.016)	No. of new service items	0.139(0.033)	Responses of customer service	0.219(0.091)
Debt ratio	0.327(0.039)	Profit per customer	0.206(0.047)	Customer complaints	0.23(0.055)	Professional training	0.143(0.059)
Return on assets	0.206(0.025)	Market share rate	0.178(0.04)	Transaction efficiency	0.148(0.036)	Employee stability	0.178(0.074)
Earnings per share	0.134(0.016)	Customer retention rate	0.066(0.015)	Rationalized forms and processes	0.356(0.085)	Employee satisfaction	0.144(0.06)
Return on investment	0.102(0.012)	Customer increasing rate	0.261(0.059)	Management performance	0.08(0.019)	Organization competence	0.316(0.131)
Net profit margin	0.041(0.005)	profit per customer	0.217(0.049)	Sales performance	0.047(0.011)		

of the relative weight of the BSC performance indexes with the relative importance of its associated BSC performance.

Table 9 depicts the result of the comparison of the performance for the four banks with respected to the BSC performance indexes of sales. After this comparison, the Eq. 1 is applied again to calculate their normalized relative performance as presented in the most right column in Table 9.

Consequently, the performance index for each of these four banks based on the BSC performance indexes can be available by using the following Eq. 2:

$$P_k = \sum_i \sum_j w_i w_j r_{ijk} \tag{2}$$

In which:



- $W_i$ : The relative weight of factor I
- $W_{ij}$ : The relative weight of BSC indexes j that resides in evaluating factor I
- $r_{ijk}$ : The performance evaluation for banking performance k of the BSC indexes j that resides in factor I (Sheu and Lee, 2007)

Higher values of  $p_k$  indicate that the bank is doing a better performance on implementing these BSC indexes. The data in Table 10 described the calculating results for this study. The final ranking with respected to BSC performance indexes is: R-bank >P-bank >S-bank >M-bank.

Table 9: The performance comparison of the four banks with respected to BSC performance index of sales

Sales	M bank	P bank	S bank	R bank	Relative score
M bank	1	2	1/5	3	0.247
P bank	½	1	2	1/4	0.149
S bank	5	½	1	1/3	0.272
R bank	1/3	4	3	1	0.332

Table 10: The performance indices for the four banks

		M bank		P bank		S bank		R bank			
BSC performance	Indexes	Score	Score (w)	Score	Score (w)	Score	Score (w)	Score	Score (w)		
Finance	0.119	Sales	0.191	0.247	0.006	0.149	0.003	0.272	0.006	0.332	0.008
		Debt ratio	0.327	0.312	0.012	0.215	0.008	0.221	0.009	0.252	0.010
		Return on assest	0.206	0.114	0.003	0.298	0.007	0.314	0.008	0.274	0.007
		Earnings per share	0.134	0.227	0.004	0.312	0.005	0.128	0.002	0.333	0.005
		Return on investment	0.102	0.182	0.002	0.272	0.003	0.252	0.003	0.294	0.004
		Net profit margin	0.041	0.222	0.001	0.169	0.001	0.312	0.002	0.297	0.001
Customer	0.227	Customer satisfaction	0.071	0.221	0.004	0.268	0.004	0.193	0.003	0.318	0.005
		Profit per customer	0.206	0.118	0.006	0.287	0.013	0.291	0.014	0.304	0.014
		Market share rate	0.178	0.309	0.012	0.192	0.008	0.301	0.012	0.198	0.008
		Customer retention rate	0.066	0.229	0.003	0.341	0.005	0.229	0.003	0.201	0.003
		Customer increasing rate	0.261	0.332	0.020	0.281	0.017	0.168	0.010	0.219	0.013
		Profit per customer	0.217	0.183	0.009	0.346	0.017	0.228	0.011	0.243	0.012
Internal process	0.24	No. of new service items	0.139	0.307	0.010	0.243	0.008	0.157	0.005	0.293	0.010
		Customer complaints	0.230	0.164	0.009	0.276	0.015	0.332	0.018	0.228	0.013
		Transaction efficiency	0.148	0.346	0.012	0.279	0.010	0.134	0.005	0.241	0.009
		Rationalized forms and processes	0.356	0.225	0.019	0.224	0.019	0.312	0.027	0.239	0.020
		Management performance	0.080	0.337	0.006	0.172	0.003	0.264	0.005	0.227	0.004
		Sales performance	0.047	0.186	0.002	0.224	0.003	0.338	0.004	0.252	0.003
Learning and growth	0.414	Responses of customer service	0.219	0.196	0.018	0.275	0.025	0.184	0.017	0.345	0.031
		Professional training	0.143	0.304	0.018	0.206	0.012	0.226	0.013	0.264	0.016
		Employee stability	0.178	0.337	0.025	0.309	0.023	0.198	0.015	0.156	0.011
		Employee satisfaction	0.144	0.105	0.006	0.346	0.021	0.264	0.016	0.285	0.017
		Organization competence	0.316	0.297	0.039	0.164	0.021	0.351	0.046	0.188	0.025
				0.239		0.254		0.246		0.260	

## CONCLUSIONS

An analytic network process that borrows the idea of stochastic transiting process is employed to identify the interdependence between these two groups of factors. The model first determinate the relative importance of the BSC for the performance evaluation of banks as well as the relative intensity of the factors that success main them. The relative weights of the BSC indexes in each BSC performance are determined in a similar way (Sheu and Lee, 2007).

When comparing the performance of M-Bank with that of the other three banks, as shown in Table 10, it is evident that M-Bank has the poorest performance value in the "finance" dimension while this is the most important BSC factors according to the experts. As far as the evaluation indexes within the "finance" dimension are concerned, M-Bank has the lowest performance value in the "return on assets" index. This implies that increasing its return on assets must be considered a crucial factor in that bank's growth strategy. Therefore, in addition to retaining its existing customers, M-Bank should also develop sales and/or provide more and improved promotions to attract new customers in order to keep up with the other three banks. Based on the performance analysis, it is evident that the other reason for M-Bank being ranked lowest is due to the fact that its performance values from a customer perspective are poor. Therefore, for M-Bank to improve its performance, it must put more emphasis on finance factors and customer satisfaction. Finally, exploring more cases and conducting more empirical studies are recommended to further validate the usefulness of the proposed performance evaluation model.

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