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A BSC-DEA approach to measure the relative efficiency of service industry: A case study of banking sector

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A B S T R A C T

Performance evaluation plays an important role in determining faults and difficulties of any organization as well as attempting to increase capabilities and improve activities. Data envelopment analysis (DEA), as a non-parametric method, has been one of the most important and significant management tools for measuring output or efficiency. In this paper, we propose a method to utilize balanced score card (BSC) as a tool for designing performance evaluation indices of an organization. The integrated BSC-DEA has been applied as an empirical case for a major private bank organization and the results are analyzed.

1. Introduction

Measuring the efficiency of any organization either private or governmental has become an interesting issue among interested researchers. The process normally focuses on different parts of an organization plans, processes as well as human resources by an adequate performance evaluation system for development and stability in today's competition field (Littler et al., 2000). The results of performance evaluation could help us monitor deviation from goals and targets. There are different reasons for measuring the relative efficiency in banking sector such as:

1. Control and supervision of branches which must be surveyed regarding their status utilizing appropriate standards
2. The performance of managers of the bank branches must be rewarded by a proper punishment and encouragement system for creating responsibility feeling.
3. Performance measurement enables us to set up some standards.
4. It can be created a safe competition among branches by evaluation of branches and determine their faults and powers.

The performance evaluation system has been significantly changed compared to past. The main focus of modern evaluation is on growth, development and improvement of assessed capacity. That is, the new measuring systems are mostly aimed at strategic implementation to detect the critical success factors (CSF) for the present and the future strategic planning. If the CSF factors are improved, the company will implement and execute its strategy. These systems are mostly focused on internal factors which lead to be changed to external ones. Instead of concentrating on duty performances, the

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way of implementation process according to environmental circumstances and the way of implementation of strategy is concerned. BSC is considered as a new performance measurement system which surveys the organization on four perspectives of learning of personal, internal processes, customer and finance. Measuring output efficiency has constantly been one of the significant discussions in management. That is, the major objective of each organization is efficient productivity of existing sources. Applying advanced techniques and determining opportunities and potential and practical limits require enough knowledge about the present situation of the organization which leads us to implement DEA methods.
In this research, we present an integrated BSC & DEA model, in which the inputs and the outputs are extracted by using BSC and they are measured by DEA model. Therefore, by integrating BCS model, in addition on focusing on financial factors as past perspective, we utilize three future perspectives indices for the growth and the importance of DMU capacities to take effective steps. This paper is organized as follows. In section two and three we explain both BSC and DEA approaches and their integration are developed in section 4. In the section 5, two methods of integrated BSE-DEA are explained and finally the results of implementation of the mentioned model in 24 branches of Saman bank located at Tehran city are explained and analyzed.

2. Introduction of data envelopment analysis

Charnes, Cooper and Banker are believed to be the first people who introduced DEA method (Charnes & Cooper, 1978; Banker et al. 1985). Data envelopment analysis measures the efficiency of decision-making departments of organization regarding the various inputs and outputs. During the past few years, there have been tremendous efforts on developing various DEA methods. (Andersen & Petersen, 1993). Lin and Hong (2006) used DEA for measuring the relative efficiency of major international airports. In their DEA implementation, they use five inputs of the number of employees, the landing band length, the parking size, the airlines stations and the terminal spaces. Using the three outputs of the number of passengers, the cargo and number of trips, they implement DEA and extract the ranking of various airlines in four groups. Tseng, et al. (2008) performed a comprehensive study on the performance evaluation of major international airports in the world. Roghanian and Foroghi (2010) used a robust DEA to measure the relative efficiency of Iranian regional airlines.
Giokas (2008) used DEA for measuring the relative efficiencies of major Greek banks by considering nine inputs and eight output factors. Bergendahl and Lindblom (2008) implemented DEA method for a bank located in Sweden. In their empirical analysis, they chose 88 independent investment banks for a time period from 1997 to 2001 and evaluated their relative efficiencies. Ramanathan (2007) in an assignment used DEA to measure the relative efficiencies of various Arab countries located in Persian Gulf. In his study, the information of 55 major banks of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and Emirates for a time period from 2000 to 2004 were utilized. The report indicated that15 banks were identified as efficient units and the relative efficiencies of other banks were compared using these 15 banks. Adler and Golany (2001) also used DEA for western European airlines and divided the airlines into two efficient and inefficient units. Sadjadi and Omrani (2008, 2010) proposed a robust form of DEA method to reduce the effects of uncertainty in input and output data. One of the primary concerns on DEA is the determination of the most productive scale size (MPSS). The concept of MPSS was first discussed by Banker et al. (1985). They defined the MPSS as producing size which has the most production average compared each produces unit that has the same false combination of input and output for DMU. The performance evaluation must be continually performed in an organization to achieve continues improvement. During the process of BSC some important factors which influence the efficiency of an organization such as inflation, the condition of competitors and the strategy of organization are determined. One important issue which must be always taken into account is the effect of each parameter on MPSS.

3. Introduction of balanced scorecard model

Kaplan and Norton (1993) are believed to be the first who introduced the idea of BSC as a new method for measuring the performance of a system. The idea of BSC is to focus on non-financial

items affecting the efficiency of an organization. In the past, financial factors were only considered for performance evaluation. However, BSC developed the indices toward four outlooks of growth and learning, internal processes, customer and finance and intends to balance financial goals as the result of past performance (past view indices) and three other indices (future view indices). (Abran and Buglione, 2003). **Fig 1** demonstrates the details of the financial and non-financial parameters.

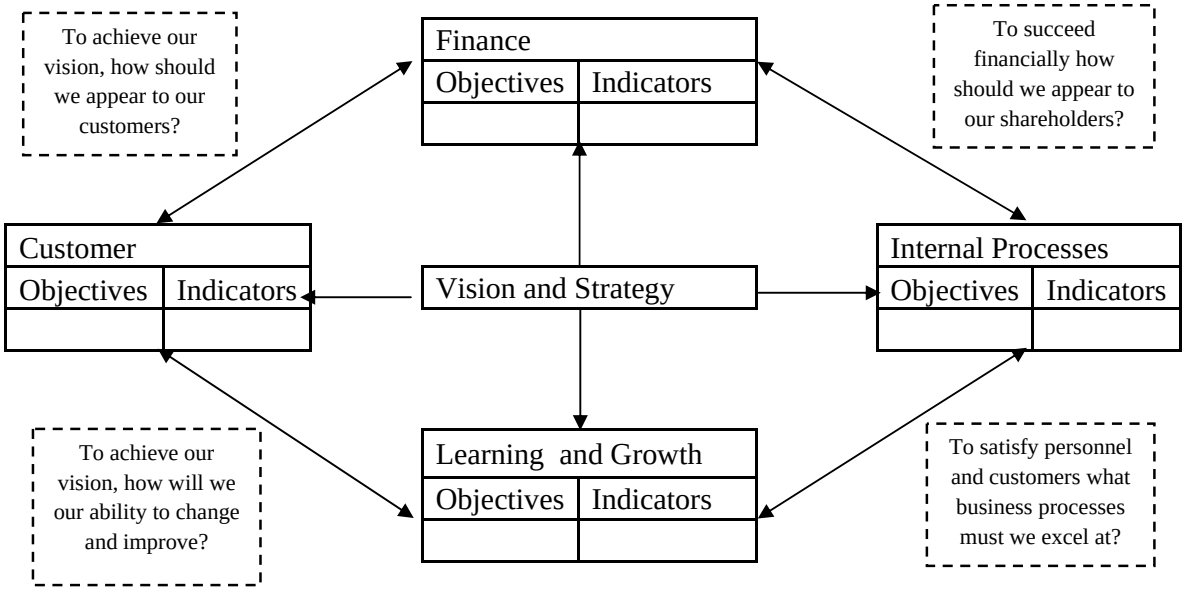

Fig 1: Four perspectives of balanced scorecard

Kaplan and Norton also found that there is a cause and effect relationship among goals and indices of these four perspectives. A proper scorecard creates cause and effect relationship between the current activities and the success of the organization in a long time for a prolonged period. Since the development of organization depends on its intangible assets, the balanced scorecard is a significant tool for their control and management. Note that to achieve the financial outcomes (in financial perspective), the customers must be esteemed (in customer perspective) which is attained only by matching the operational processes with the customers' requirements (internal processes perspective).
It is possible to achieve operational elevation and create valuable processes merely by creating appropriate work environment for the personnel and encourage them and reinforce creativity, learning and development in the organization (Growth and learning perspective). (McPhail et al. 2008; Greatbanks & Tapp, 2007; Davis & Albright, 2004; Huang, 2009; Hung-Yi et al. 2009).
The idea of using integrated BSC-DEA has been used for different organizations. Banker et al. (2004) used integrated BSC-DEA method for over 50 local exchange carriers operating in the US, based on operating data collected for the period 1993–1997. They used return on asset as a financial performance indicator and three non-financial performance indicators, number of access lines per employee, percentage of digital access lines and percentage of business access lines, for the US telecommunications industry. They found that managers must trade off contemporaneous ROA when increasing the percentage of business access lines.
Chen (2008) applied investment risk for performance evaluation of different banks located in Taiwan. He considered the management risk as the fifth perspective in balanced scorecard and determined performance evaluation indices of banks in 5 perspectives of financial, customer, internal processes, growth and learning and risk and then evaluated the output data by using DEA.
Harel et al. (2006 and 2008) in two different works implemented BSC-DEA model for evaluating R & D projects. In the first work, they proposed a methodology for R&D portfolio analysis in which

effectiveness, efficiency, and balance considerations were integrated. The methodology is based on relative evaluation of entities which includes projects or portfolios. Harel et al. (2008) added uncertainty perspective in addition to traditional perspectives of BSC and implemented their proposed BSC-DEA model to for ranking 50 projects.

Valderrama et al. (2008) also integrated BSC-DEA model for evaluating R & D projects. In this model, innovation perspective considered as fifth perspective and five separate models were defined.

Asosheh et al. (2010) used integrated BSC-DEA model for evaluating information technology (IT) projects where uncertainty perspective was added to BSC model as an additional perspective. The uncertainty perspective includes various measures such as processes risks, human resource risks and technology risks.

4. An Integrated BSC-DEA model

As we explained earlier, one of the major reasons for the success of any organization is the proper implementation of the strategy which could be achieved using BSC-DEA. One of the power points of BSC is compiling indices; hence, using BSC for compiling indices is created according to the strategy of organizations and can increase its capability along with DEA. Identifying various performance evaluation models and determining the accurate and appropriate usage of the methods in the organization is one of the significant problems in performance evaluation discussion, since inaccurate selection of a method could lead to an unpleasant situation and vice versa.

To create a systematic relationship between these two methods we summarize the advantages and disadvantages of both methods in Table 1.

Table 1

Proposed differences between DEA and BSC method

compatibility	BSC	DEA
Way of comparison	Comparison with an ideal virtual unit	Proportional comparison the same units
view	Multiple view	Input/output
Mathematical ranking	Weak	strong
Applicable process	Self assessment of organization	Technical efficiency
Accuracy of measurement	Moderate	high
Presenting of improvement method	Moderate	high
Ranking	Does not support	has
Future view	Has	Doesn’t have
Regarding to organization strategy	Has	has

From Table 1 we can find the following facts:

1. DEA has input and output, but BSC has got multi-viewpoint evaluations.
2. In DEA technique, there is no future view, but BSC focuses on future view based on financial perspective which is the result of the past performance and three perspectives of the growth and the learning, the internal processes and the customer.
3. The DEA technique does not apply the strategy of the organization while BSC method uses the strategy of the organization for decision making.
4. It is more difficult to analyze each involving index in BSC while analyzing the DEA results is easier.

As we can observe, an integrated BSC-DEA model could improve the overall capabilities of both models and it could also reduce the faults of each one.

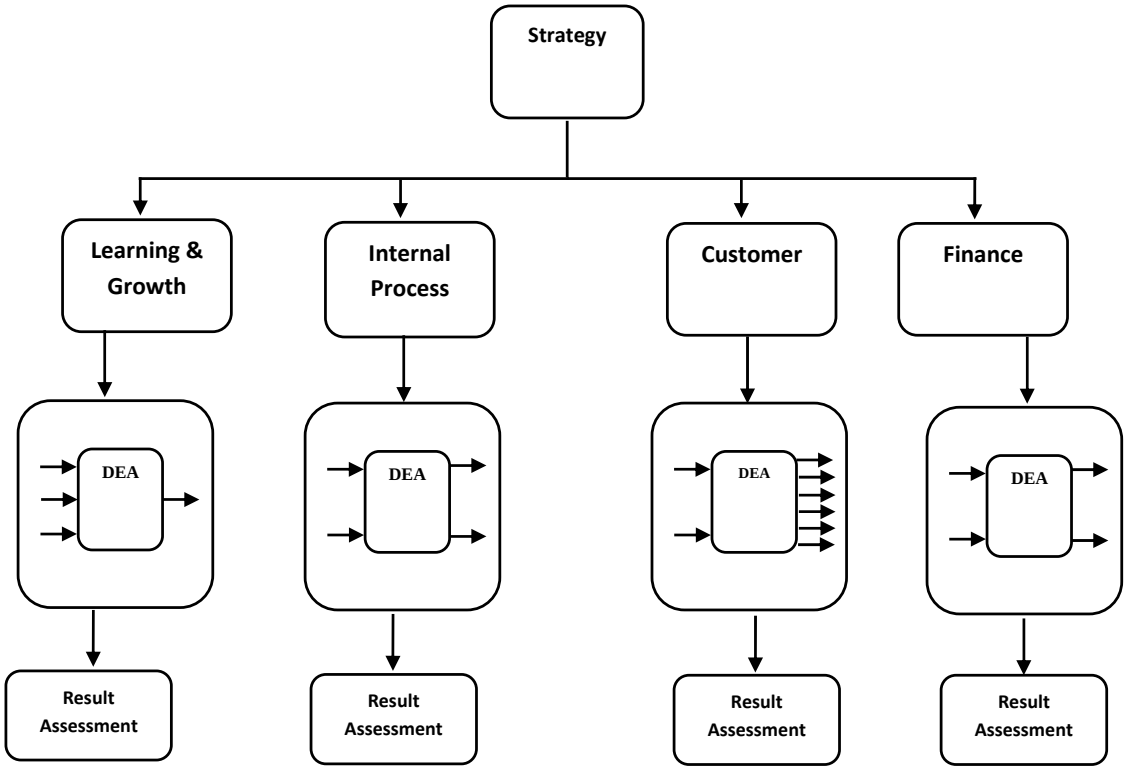

Fig 2: Proposed Integrated BSC-DEA model

Fig 2 shows the details of the proposed BSC-DEA which includes four major strategies of learning & growth, internal process, customer and finance. These factors are the major indices of BSC part and the input/output parameters of DEA model are defined within each BSC index. This process needs to be executed continuously to help us reach MPSS goals. The input and the output parameters for the DEA model within learning perspective are defined in Table 2.

Table 2
Inputs and outputs of learning perspective

Input	Output
Returned fund	Incentive
Cash deficit	
Removed facility	

In Table 2, the first two indices are obvious, but the third index presents the number of facility files which are normally created but it could be deleted by a male-function of either a personnel or a software package. These indices represent the skill of personnel of a branch. In internal processes perspective, there are two inputs and two outputs defined in Table 3. The first input parameter, time efficiency, indicates how effectively an employee could serve a customer. ATM productivity is another input parameter which demonstrates the ability of bank to provide online services for different customers. We use two groups of parameters which include the number of issued cards and the information technology facilities such as internet, telephone.

Table 3
Inputs and outputs of internal process perspective

Input	Output
Time efficiency	Number of issued cards
ATM productivity	Internet, telephone and sms bank

The input and the output indices associated with customer perspective are demonstrated in Table 4.

Table 4
Inputs and outputs of customer perspective

Input	Output
Closed deposit	Number of issued cheques
New customer	Foreign exchange
	Letter of credit
	Bill of exchange
	Bank statement
	Foreign draft

The first input parameter in Table 4, closed deposit, represents the customer's fidelity. The second input parameter, new customer, represents better quality services that a bank provides for banking market. Output indices show the number of affairs which are carried out between a branch and its customers. The high indices for each branch shows that the customers of that branch are mostly intended to receive services. Finally, the input and the output indices for financial perspective are shown in Table 5.

Table 5
Inputs and outputs of finance perspective

Input	Output
Expenditures	Income
Deposits	Deferred debt
	Facility

4.1. Experimental Results

We have implemented the proposed method of this paper on an Iranian bank located in Tehran/Iran called Saman. For this study, 24 branches of Saman bank have been selected and the information were clustered based on different seasons year 2008 and 2009. We have used analytical hierarchy analysis (AHP) to rank four different BSC parameters and the results are summarized in Table 6.

Table 6
Weight of 4 aspects by AHP model

Index	Finance	Customer	Internal Process	Learning and growth
Weight	0.400	0.330	0.189	0.081

The relative efficiencies of various units have been calculated using CCR model and the results are summarized in Table 7. As we can observe from Table 7, the financial performance of branch 15 is calculated to be one but the overall performance is calculated to be 0.385 due to weak performance of this unit on other perspectives such as learning and growth with 0.057, internal process with 0.296

and customer performance with 0.188, respectively. As a result, the overall performance was remained as 0.522.

Table 7
The results of CCR implementation

DMUs	Learning and Growth	Internal Process	Customer	Finance	Total Efficiency
Branch 1	0.826	0.769	1.000	0.646	0.810
Branch 2	0.728	1.000	0.469	0.908	0.776
Branch 3	0.322	0.285	0.729	0.512	0.462
Branch 4	0.237	0.572	0.677	0.579	0.516
Branch 5	0.438	0.239	0.699	0.962	0.585
Branch 6	0.253	0.682	0.250	0.652	0.459
Branch 7	0.434	0.298	0.361	0.536	0.407
Branch 8	0.338	0.445	0.568	0.725	0.519
Branch 9	0.325	0.391	0.168	0.539	0.356
Branch 10	0.190	0.469	0.275	0.298	0.308
Branch 11	0.146	0.472	0.087	0.660	0.341
Branch 12	0.056	0.334	0.260	0.782	0.358
Branch 13	0.461	0.343	0.268	0.522	0.399
Branch 14	0.032	0.382	0.058	0.881	0.338
Branch 15	0.057	0.296	0.188	1.000	0.385
Branch 16	0.130	0.254	0.223	0.621	0.307
Branch 17	0.241	0.451	0.373	0.539	0.401
Branch 18	0.106	0.695	0.037	0.571	0.352
Branch 19	0.143	0.305	0.245	0.512	0.301
Branch 20	0.080	0.596	0.022	0.650	0.337
Branch 21	0.027	0.438	0.191	0.692	0.337
Branch 22	0.122	0.449	0.135	0.731	0.359
Branch 23	0.045	0.439	0.111	0.477	0.268
Branch 24	0.319	0.176	0.224	0.791	0.378

Note that in the proposed BSC-DEA, an output for a unit is an input for another unit and when the overall performance for financial unit, for instance, is calculated to be one we cannot necessarily claim that this unit performs efficiently since the performance of the previous units could be low. There are also other branches with relatively good performance in one or two units and poor performance on other units. Therefore, we could expect a weak overall performance on those units. As we can observe from Table 7, there is no unit where all perfectives perform efficiently. To survey more accurately according to the overall efficiency column, the efficiency of branch 15 is 0.385, although it shows a good practice in financial perspective, it has fault in perspectives of learning and growth (0.057), internal processes (0.296) and customer (0.188) leading to the overall efficiency of 0.522. Branch 5 has total efficiency of 0.585 and has relatively done good performance in perspectives of finance (0.962) and customer (0.699), but it performs poorly in both perspectives of growth and learning (0.438) and internal processes (0.239). Therefore, the overall efficiency has been influenced by inefficiencies of these two perspectives. Table 8 shows the average efficiency of branches in the four mentioned perspectives. As we can observe from Table 8, the finance perspective has the highest rate of efficiency and the learning and growth has the least rate of efficiency among four BSC perspective factors. It appears that most banks could perform relatively better in terms of financial operations but they need to learn more about their job. We could also conclude that there are no strong causes and effects relationships among these four BSC perspectives.

Table 8
Average efficiency of branches in 4 perspectives

Perspectives	Average Efficiency by CCR model
Learning and Growth	0.252
Internal Process	0.449
Customer	0.317
Finance	0.658

We also identify suitable targets for achieving the most appropriate conditions for continuous improvement of any branch using MPSS. For instance, consider branch 1, since this unit is the most efficient one in terms of customer perspective we choose it as MPSS according to this criteria. Table 9 compares the actual data with MPSS result for this branch during the first season.

Table 9
Actual data versus MPSS index for branch 1 (customer perspective in the first season)

	Input		Output					
	New customer	Closed deposit	Foreign draft	Bank statement	Bill of exchange	Letter of credit	Foreign exchange	Number of issued cheques
Actual data	766	1021	435	180	26	87	518	32415
MPSS Result	766	1021	435	180	26	87	518	32415

Table 10
Actual data versus MPSS index for branch 1 (customer perspective in the second season)

	Input		Output					
	New customer	Closed deposit	Foreign draft	Bank statement	Bill of exchange	Letter of credit	Foreign exchange	Number of issued cheques
Actual data	702	0.462	465	24	48	67	442	36747
MPSS Result	702	0.462	465	24	48	67	442	36747

As we can observe from Table 9 and Table 10, branch 1 is considered to be the most efficient unit in terms of customer perspective and the actual data are used for MPSS. Now we can perform our survey for other units. Consider branch 5, where the relative efficiency is calculated as 0.962 in terms of finance perspective. The MPSS index for this perspective is calculated based on this efficient unit and the results for the first seasons are summarized in Table 11.

Table 11
Actual data versus MPSS index for branch 5 (finance perspective in the first season)

	Input		Output		
	Deposit	Expenditure	Facility	Deferred debt	Income
Actual data	615	12.84	750	38.33	3368.809
MPSS results	594	11.84	750	38.33	3368.809

As we can observe from Table 11, in order to build MPSS for finance perspective we need to make some changes on the input parameters on the actual data but the output data will remain unchanged. Similarly, we repeat the same procedure for branch 4 in order to build MPSS for internal process perspective with relative efficiency of 0.572. Table 12 summarizes the results for this branch.

Table 12
Actual data versus MPSS index for branch 4 (internal perspective in the first season)

	Input		Output	
	Time efficiency	ATM productivity	Number of issued cards	Internet, telephone and sms bank
Actual data	102.69	122.035	1235	643
MPSS results	76.6722	6.838	1371	47

As we can observe, using the proposed BSC-DEA method of this paper, we can determine suitable strategies for different branches of banks. The study of this paper focuses on the seasonal information but the continuous improvement could be better performed by using the monthly or even weekly updates of MPSS data.

5. Conclusion

We have presented a new BSC-DEA method for measuring the overall performance in bank industry. The proposed model of this paper has considered four major BSC factors and within each BSC perspective, some input/output parameters have been chosen for DEA implementation. The results of the model have been used to build MPSS for various units. The model has been implemented for a real-world case study of Iranian private bank and the preliminary results indicate that we could use this model for other financial sectors.

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