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Integrating balanced scorecard and the QEST for multidimensional organizational performance measurement: The case of a bank in Iran

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Abstract

This paper introduces a new method for organizational performance measurement. The model integrates the QEST (Quality factor + Economic, Social & Technical dimensions) and the BSC (Balanced Scorecard) models. Although the model is originally defined to measure performance in the banking industries, it can be used for almost any organization and any multi-attribute decision-making problem. It not only has a new look to the BSC perspectives but enables organizations to obtain a more reliable assessment. The model takes advantage of the QEST-3D and the BSC that lets the proposed model be easy to generalize. The research's motivation is to obtain performance measurement based on not only the values of the indicators but the proportion of the values of the leading indicators and the lagging ones obtained by BSC. The financial perspective is considered a lagging indicator, while the other indicators are considered leading. To obtain reliability analysis, the model has been tested in 17 branches of a bank in Kurdistan province for three recent years, as a real case. The results that are compared with what is obtained from the pre-qualified TOPSIS (The Technique for Order of Preference by Similarity to Ideal Solution) successfully illustrate the accuracy and practicality of the proposed model. The results show that based on the correct logic proposed in the proposed method for separating and analyzing the perspectives taken from the BSC, the strategy-oriented ranking made by the proposed method is more reliable and logical than the ranking performed by the TOPSIS.
Keywords: bank performance evaluation, Balanced Scorecard, QEST-nD model, multi-attribute decision-making, performance measurement.

1-Introduction

Measurement is a critical issue in identifying the organizational problem and improving organizational performance, although not well understood (Pavlov & Bourne, 2011).

So, Organizational Performance Measurement (OPM) is a challenging issue for a long time. Performance Measurement Systems (PMS) are established to analyze and classify OPM criteria. Thus, it is necessary to establish a good PMS with appropriate metrics for measurement purposes. However, organizations traditionally address the financial indicators to obtain performance evaluation for many years. This is not an efficient approach (Bourne et al., 2002), hence both researchers and practitioners

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are stimulated to design new systems that are capable of paying attention to all objectives and dimensions of the present environment (Yurdakul & Ic, 2005).

Thus, OPM becomes a multi-dimensional issue that has attracted the attention of decision-makers for a long time (Varmazyar et al., 2016). However, there have been only a few studies that have investigated the OPM, and to date, there is no consensus about what factors are significant (Taylor & Taylor, 2013), hence research gaps still exist. One of which is the dearth of systematic empirical research on the effective implementation of PMSs (Bourne et al., 2002; Nudurupati et al., 2011), especially for a bank as the financial service industry. So, the first research question here is how to come up with an effective approach that can empirically measure the performance of organizations in a multi-criteria and multi-dimensional manner.

An analysis of existing PMSs shows them to be not only multidimensional but also strategy-oriented (Dewi et al., 2021; Ferreira et al., 2018). The PPS (Performance Pyramid System) introduced by Lynch and Cross (1995) and the BSC (Balanced Scorecard) designed by Kaplan and Norton (1996) laid stress on the alignment between strategy and PMSs to prepare SPMS (Strategic Performance Measurement System), recently studied in (Baird et al., 2021; Dewi et al., 2021; Teichgräber et al., 2021). According to the literature, the BSC is a suitable widely adopted PMS that becomes more popular during the early 1990s. And there exist several MCDM (Multiple Criteria Decision Making) approaches for OPM based on BSC perspectives, addressed by Varmazyar et al. (2016) and Teichgräber et al. (2021). However, there is also evidence that many of the BSC implementations are not successful (Bourne et al., 2003). And this is the second research gap that leads to the second research question, which is how to successfully use the BSC to strategically measure organizational performance.

As a multidimensional Performance Measurement (PM) model, QEST (Quality factor + Economic, Social & Technical dimensions) has been developed essentially for providing a measurement of software projects using geometrical concepts. Although the structured shell of this open model can handle many dimensions, as defined in each context according to management objectives, its application is very limited. And no research has been done to use it to measure organizational performance as a general concept. However, it is capable of providing PM as a combination of the specific measures selected for each measuring dimension, which is an important property for the PMSs. The lack of application of such a useful model for effective OPM is the third gap of the research, which leads to the third research question on how to combine the BSC with QEST and design an integrated SPMS.

To answer the aforementioned research questions and fill the mentioned research gaps, in this paper a new method is introduced by integrating the BSC and the QEST model to provide a novel SPMS for banks as a critical financial service industry. The key idea is to simply take the financial perspective as a basic output indicator of an organization and adapt all of the BSC perspectives with a QEST-3D model. The idea is following the BSC's foundations; however, it is fully neglected in the literature to date. The main motivation is to introduce a new look to fourfold indicators considered by the BSC. The financial perspective is considered a lagging indicator among the BSC perspectives, while customers, internal business process, and learning and growth perspectives are, on the other hand, considered leading indicators (Varmazyar et al., 2016). This means that it is not correct to consider the role of financial perspective as similar to the role of non-financial ones. In other words, the non-financial indicators play the role of fundamental indicators for the financial one. This may systematically decrease the number of the indicators and, therefore, makes the model installation to be easier. On the other hand, the organizational evaluation and assessment are taking place based on not only the values of indicators but also the proportion that exists between the values of input and output parameters. This is the key idea behind the proposed model that is not previously addressed to the best of authors' knowledge, while it is essential for measuring performances. Accordingly, the contributions of the paper can be summarized as follows:

a) A novel integrated strategy-based MADM (Multiple Attribute Decision-Making)-oriented OPM is designed and tested using an extensive case study at branches of a bank in Iran.
b) This is the first to use the QEST-3D model to generally design an efficient SPMS based on the BSC financial and non-financial perspectives. In the method, the performance scores are developed based on not only the values of the indicators but also the proportion of the values of the input indicators and the output ones.
c) Having a new look at the four basic perspectives of the BSC, the research is the first to divide

the organizational performance measures into two categories as (1) leading and (2) lagging indicators to empirically design a novel creative SPMS. Such a classification leads to a simpler more reliable PMS.

d) Although the model is tested concerning measuring the performance of bank branches, it is a general model and can be used to measure the performance of any organization with any number of strategically important dimensions. This is because the model is designed generally based on a reliable mathematical approach that can be used as a new general MADM model.

e) According to the final qualitative step of the model, the decision maker's opinion is directly considered in the model, which is essential in the SPMSs and the decision-making process (Golpîra, 2018).

The remainder of the paper is as follows. Section 2 presents a literature review and section 3 analytically outlines the proposed model. Section 4 discusses the case study, and the performance of the model is discussed in section 5. Finally, the concluding remarks and the model limitations as well as some future directions for further research are mentioned in section 7.

2-Literature review

2-1-Bank branches performance measurement

Bank branches' PMs range from simple ratio and standard regression analyses to more complex frontier approaches, each with its strengths and weaknesses (Quaranta et al., 2018). However, the indicators that these approaches generate fail to capture the multidimensional nature of bank branches' performance (Sherman & Gold, 1985). Assessing the performance of selected Czech and Slovak banks, Gavurová et al. (2017) compared several methods and evaluated the process and outcome differences of bank PMSs. They showed that all methods have roughly the same results and an almost perfect correlation had been found not only among the methods of multi-criteria evaluation but also among the investigators. Beheshtinia and Omidi (2017) proposed a hybrid MCDM technique for the PM of banks in Iran showing that the return on investment, debt ratio, and lower energy consumption criteria are the most important ones. Combining the strength of the existing methods, Quaranta et al. (2018) developed a three-step procedure for bank branches performance measurement and tested the method on 23 branches of an Italian regional bank. Using regression-AHP (Analytic Hierarchy Process)-VIKOR (Vise Kriterijumska Optimizacija I Kompromisno Resenje) integrated methodology, Ic et al. (2020) developed a financial performance evaluation model for banks aiming at measuring and comparing the performances of banks based on their financial ratios. Employing a panel data regression framework (Robin et al., 2018) examined the financial performance of the commercial banks in Bangladesh in terms of profitability measures before, during, and after a period of financial liberalization.

Over the past several decades, substantial effort has also been made to measure bank efficiency using the DEA (Data Envelopment Analysis) (Zhuo et al., 2020). Considering simultaneous processes within the framework of two-stage DEA, Zhou et al. (2018) proposed a PM model based on the slack-based measure and tested the model in 27 main commercial banks in Ghana. Using a novel data set covering 14 banks operating in the Egyptian market from 1997 to 2013, Jreisat et al. (2018) evaluated the productivity change of the Egyptian banking sector using a nonparametric DEA-oriented approach. Vidyarthi (2018) used the same approach to examine the impact of intellectual capitals and its sub-components on the bank's efficiency parameters for 38 listed Indian banks within a multivariate panel data framework during the period from 2004–2005 to 2015–2016. Chao et al. (2018) measured the profitability and marketability efficiency of non-homogenous Taiwanese banks after the adoption of International Financial Reporting Standards using DEA. Kaffash and Torshizi (2018) reviewed the classic and new DEA models and their applications in the banking field. Kundu and Banerjee (2021) introduced the concept of policy efficiency of banks by using a three-stage analysis through non-radial DEA with Slack-Based Measure (SBM) to obtain efficiency scores of the banks for both the operational efficiency and policy efficiency paradigms. Since the DEA is a good approach to use for clustering (Golpîra & Hajebi, 2015) and benchmarking (Golpîra & Najafi, 2011), Tsolas et al. (2020) suggested a practical methodology to support better practice benchmarking, with an application to the banking sector. They developed a two-stage hybrid model employing Artificial Neural Network (ANN) via integration with DEA to classify the sampled branches of a Greek bank into predefined efficiency classes. Azad et al. (2020) also studied the use of the network DEA to provide a good benchmarking insight into the Bangladesh banking sector. The reason for emphasizing on the DEA is that the use of mathematical optimization algorithms can provide reliable results for any decision-making problems with multiple dimensions in an acceptable time (Golpîra, 2020a, 2020b; Golpîra et al., 2021).

2-2-General performance and strategic performance measurement approaches

More generally, researchers have developed many tools for OPM. BSC is a prominent innovation in the context of SPMS. While several papers address these issues, they require considerably more attention. Neely (1999), Neely et al. (2000), Bourne et al. (2003), Neely (2005), Pun and White (2005), Neely et al. (2007), Taticchi et al. (2010), Nudurupati et al. (2011), Taticchi et al. (2012), Sorooshian et al. (2016), and Van Looy and Shafagatova (2016), Heinicke (2018), Lucianetti et al. (2019), Treinta et al. (2020), Rojas-Lema et al. (2020), De Waele et al. (2021), Munik et al. (2021), and Amos et al. (2021) provided in-depth reviews and analysis on a large set of PMSs, some with special emphasize on strategic ones such as BSC in non-profit and profit organizations as well as small and medium-sized enterprises. Considering an extensive literature review, Fainshmidt et al. (2016) studied the positive impact of dynamic capabilities on performance through meta-analytic results. Pidun and Felden (2011) documented the dominance of PMSs that rely on key performance indicators. Jamil and Mohamed (2011) reviewed the literature of PMSs of small-medium enterprises and develop a new modified PMS framework that is capable to effectively measure their performance. Sparrow and Cooper (2014) established the future research agenda for organizational effectiveness. Carneiro-da-Cunha et al. (2016) investigated the evolution of the concepts and models in the field of OPM. Accordingly, only some more recent researches with particular attention to the use of BSC in their implementation are reported in the following paragraphs.

Valenzuela and Maturana (2016) designed a three-dimensional SPMS for the typical wine industry in Chile. Yaghoobi and Haddadi (2016) introduced an overall OPM based on integrating two methodologies of BSC and AHP and examined it in Isfahan Telecommunications Company. Varmazyar et al. (2016) proposed a method based on BSC and four MCDM methods to evaluate the performance of project-based Research and Technology Organization and examined it in 12 centers of the Research Institute of Petroleum Industry. Cho et al. (2017) explored the dynamics of workforce diversity, diversity management, and organizational performance in social enterprises. Alani et al. (2018) analyzed and explored the effectiveness of using BSC as a strategic management tool in the evaluation of the performance and thereby the quality services of a University. Quezada et al. (2019) presented a method to measure the performance of a company by combining SWOT (Strengths-Weakness-Opportunities-Threats) analysis and the BSC through the ANP (Analytical Network Process).

In another point of view, there are several models for OPM using several sets of indicators. Experts play an important role in aligning strategic objectives with the PMS by defining appropriate indicators and integrating them into the measurement model, particularly for tracking the evolution over the years (Rodrigues et al., 2018). A classical approach to a PMS is the model introduced by Sink and Tuttle (1989). Over time, there have been deficiencies in traditional PMSs focused on financial indices with a new trend in developing PMSs based on both non-financial and financial indicators. Medori and Steeple (2000) outlined some of the advantages and disadvantages of using non-financial measures in the PM. Golpîra and Veysi (2012) presented a quantitative framework by considering more than four basic factors. Braithwaite et al. (2017) identified and compared frameworks and performance indicators for Economic cooperation and development health systems of eight countries. In this way, Buglione and Abran (1999) presented geometrical and statistical three-dimensional frameworks for a software PM called QEST.

QEST initially combines three dimensions of economics, social, and technical profit from the graph representation of regular triangle-based tetrahedron. Unlike PMSs and BSC, only a few references are studying the QEST in the literature and, therefore, there exists little knowledge about the model and its applications. Buglione and Abran (2002) proposed a multidimensional measurement model that can handle, concurrently, distinct but related areas of interest, each represents a specific dimension of performance, referred to as QEST-nD. Abran and Buglione (2003) introduced some candidate PMSs for improving the performance of the BSC and their drawbacks. They finally introduced a model to establish a combination between BSC and QEST-nD model. They discussed the two options for integrating the BSC and QEST: 1) BSC (QEST-nd), and 2) QEST-nD (BSC).

Reviewing the aforementioned literature reveals that the QEST-3D is not intended in the SPMSs as the method for evaluating and ranking the organizations. However, there exists an extensive literature on SPMSs. The main motivation of this study is to extend the idea of QEST-3D to obtain a new SPMS that addresses the values of the indicators as well as the proportion of the values of the input indicators and the output ones obtained by BSC. This paper introduces a new SPMS based on the integration of the BSC model and QEST approach. Unlike the model presented by Abran and Buglione (2003), in this research, the financial perspective is considered as a lagging output one. This makes the indices of this perspective to be different from the other indices, which is reasonable regarding the BSC logic. Thus, the indicators under this perspective are not directly considered in the performance calculation process and the model is developed based on the three other perspectives. This contribution is very significant for large organizations not only from the time point of view but also from the cost point of view. Afterward, the results obtained in this step are compared with the financial outputs of the organizations. Qualitative analysis is performed based on the proportion that exists between performance scores of the organizations as their effort-cost regarding indices and the financial performance of the organization. The higher effort cost should result in higher financial performance. If this is not the case, the organization's rank is lower. Since the financial perspective is essentially given as the output perspective that is located at the top of the strategy map, this key idea has no conflict with the BSC logic. However, the model is essentially defined on the OPM, it can be used to deal with almost any similar decision-making problem as a new MADM model. Santos et al. (2017) reviewed the recent researches in the field of using a mix of OR (Operations Research) techniques, including qualitative system dynamics, DEA, and MCDA (Multiple Criteria Decision Analysis), in OPM. In this regard, Yurdakul and Ic (2005) developed a PMS to obtain an overall performance score by measuring the success of a company in its operational activities. The model measures the performance score of a company in critical dimensions and combines it to attain a ranking score. In this way, performance scorecards are developed using a set of key performance dimensions and their sub-components that are consequently weighted using the AHP (Analytic Hierarchy Process) approach. And, finally, the weights and performance scores are combined using the TOPSIS (The Technique for Order of Preference by Similarity to Ideal Solution). To test the reliability and practicability of the proposed model, presented in section 3, in this paper, a similar approach is established on the data of the real case and, then, a full comparative analysis is obtained at the end of section 4.

3-Model presentation

In this section, the model is presented in which it integrates the BSC to the QEST-3D. According to the nature of the model, the section contains these two models and the adoption and linking steps that finally resulting in the proposed model.

The four basic perspectives of the BSC, i.e. financial, customers, internal process, and learning and growth, are presented in figure1. Besides, the 13 practical steps that are divided into two phases to enable organizations implementing the BSC to develop its strategy map are presented in table 1 (Niven, 2002).

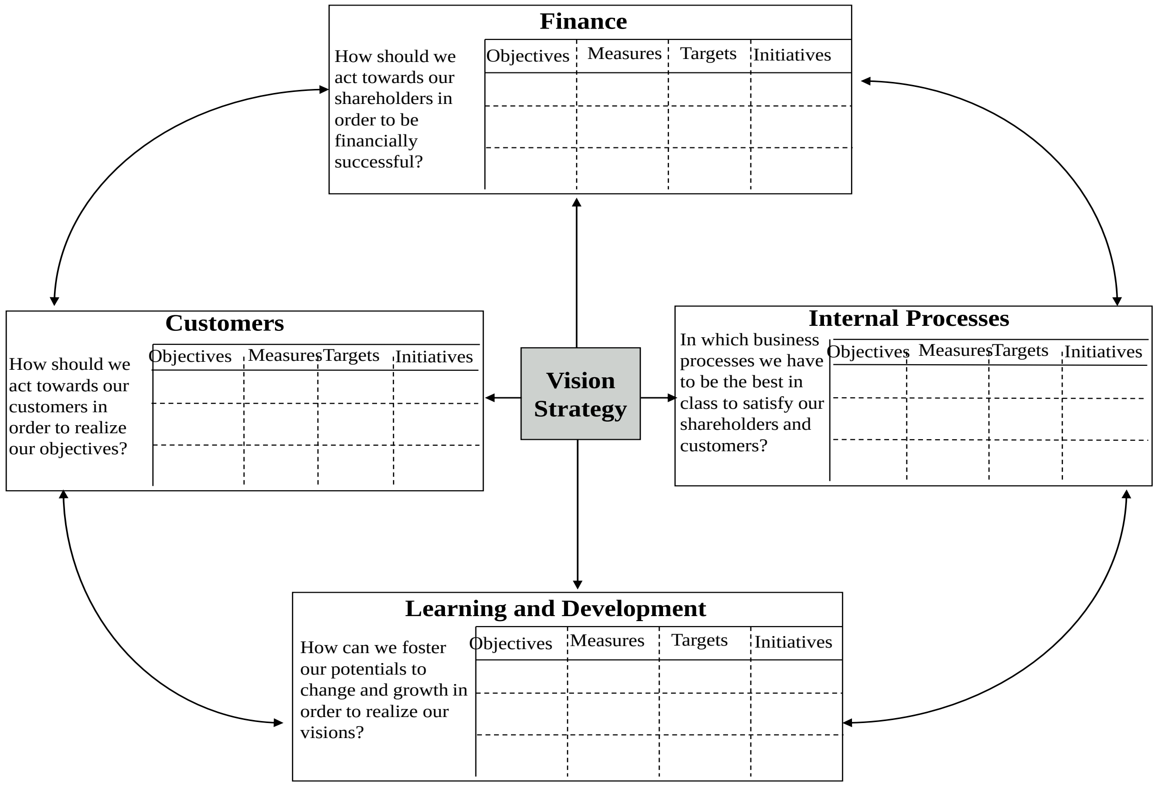

Fig1. The methodology of the BSC

Table 1. BSC project phases and steps

Planning phase (Phase 1)		Development phase (Phase 2)	
Step 1:	Develop objectives for the BSC	Step 1:	Gather the background material
Step 2:	Determine the appropriate organizational unit	Step 2:	Develop mission, vision, and strategy
		Step 3:	Conduct executive interview
Step 3:	Gain executive sponsorship	Step 4:	Develop objectives and measures
Step 4:	Build the BSC team	Step 5:	Develop cause and effect linkages
Step 5:	Formulate the project plan	Step 6:	Establish targets
Step 6:	Develop a communication plan	Step 7:	Develop the BSC implementation plan

After implementing the basic steps of BSC the selected indexes in every outlook are calculated as the input set of the QEST-3D mode after the normalization step. To do this, equation (1) is used for positive indicators and equation (2) is used for the negative ones.

$$n_{ij} = \frac{r_{ij}}{\max r_{ij}} \quad (1)$$

$$n_{ij} = \frac{r_i^{min}}{r_{ij}} \quad (2)$$

where r_{ij} is the value of the j^{th} indicator of the i^{th} alternative/organization. The weight of each indicator of each perspective is obtained using experts' opinions and paired comparisons matrix. The total score of each alternative/organization in each basic perspective of the BSC is calculated using the weights and the normalized data. In the next step, the performance is calculated using the QEST-3D model. The basics of a multidimensional pyramid are organized from indices of each perspective. Performance scores are calculated from the ratio of the size of the lower part of the pyramid to the total volume of the pyramid. The list of $n+1$points describes the dimension of the resulting square matrix, which is determined by the total size of the pyramid using equation (3) as the generic Grand Measure (GM) of the nD resulting simplex.

$$GM = \left| Det \begin{bmatrix} a_{11} & \cdots & a_{1n} & 1 \\ \cdots & \cdots & a_{xn} & 1 \\ a_{n+11} & \cdots & a_{n+11} & 1 \end{bmatrix} \right| \Big/ n! \tag{3}$$

Since this nD simplex has a vertex in the following points:

$$\begin{cases} (1,0,0,\ldots,0) \\ (0,1,0,\ldots,0) \\ \vdots \\ (0,0,0,\ldots,1) \end{cases} \tag{4}$$

adopting equation (3) to the reference matrix may result in equation (5).

$$GM = \left| Det \begin{bmatrix} 0 & 0 & \cdots & 0 & 1 \\ 1 & 0 & \cdots & 0 & 1 \\ 0 & 1 & 0 & \cdots & 1 \\ \cdots & \cdots & 1 & 0 & 1 \\ 0 & 0 & \cdots & 1 & 1 \end{bmatrix} \right| \Big/ n! = \left| 1/n! \right| \tag{5}$$

At the next step, the size of the lower part of the pyramid is calculated, which is obtained using the volume of the upper part of the pyramid and its total volume. Calculating the volume of the upper part of the pyramid needs to address a new set of points, which indicates this part of the pyramid. These points have a distance from the origin equal to $(1-p_1),\ldots,(1-p_n)$. Using equation (3) obtains the Upper Measure (UM) of the simplex as shown in equation (6). It is obvious that the Lower Measure (LM) of the simplex, which is calculated by the volume of the lower part of the pyramid, can be directly obtained from equation (7). Accordingly, the performance of 17 branches of the ABC bank regarding the perspectives has calculated for the three years. The results are shown in section 4, embedded in tables 5-7.

$$UM = \left| Det \begin{bmatrix} 0 & 0 & \cdots & 0 & 1 \\ 1-p_1 & 0 & \cdots & 0 & 1 \\ 0 & 1-p_2 & 0 & \cdots & 1 \\ 0 & 0 & 1-p_3 & \cdots & 1 \\ 0 & 0 & \cdots & 1-p_n & 1 \end{bmatrix} \right| \Big/ n! = \left| \frac{(1-p_1)\ldots(1-p_n)}{n!} \right| = \frac{\prod_{i=1}^{n}(1-p_i)}{n!} \tag{6}$$

$$LM = GM - UM = \frac{1-\prod_{i=1}^{n}(1-p_i)}{n!} \tag{7}$$

Finally, the performance value can be calculated as the ratio between LM and GM that is shown in equation (8).

$$P = LM \big/ GM = \frac{1-\prod_{i=1}^{n}(1-p_i)}{n!} \times \frac{n!}{1} = 1-\prod_{i=1}^{n}(1-p_i) \tag{8}$$

The value of P is organized as the value of organizational total performance and the organizations can be compared simply.

4-Case study

As a means to illustrate the effectiveness and applicability of the proposed model and its results, in this section, a real case study of a bank named ABC bank (bank name has been changed to protect its confidentiality) is considered. This bank, located in Kurdistan, Iran. It has 17 branches all over Sanandaj city. The data collected for 3 years are represented in tables 2-4. Since the strategy maps are not the same for these three years, the indicators, denoted by $I^{X+/-}_{p,year}$ (p denotes the p^{th} indicator, $year$ is the indicator of the reference year, $X+/-$ is for denoting the perspectives, i.e. *F, L, C,* and *P* stand for financial, learning and growth, customers, and Internal process, that can be positive or negative), need not be the same for different years.

Table 2. Indices for perspectives for the year 2018

Year 2018	Indices for perspectives											
Branches of ABC bank	$I^{F+}_{1,18}$	$I^{F+}_{2,18}$	$I^{F+}_{3,18}$	$I^{L+}_{1,18}$	$I^{L+}_{2,18}$	$I^{L+}_{3,18}$	$I^{C+}_{1,18}$	$I^{C+}_{2,18}$	$I^{C+}_{3,18}$	$I^{P+}_{1,18}$	$I^{P+}_{2,18}$	$I^{P+}_{3,18}$
1	0.33	0.82	0.91	3.52	3.50	4.33	0.008	9417.0	0.99	0.04	0.04	8.86
2	0.12	0.81	0.93	3.00	3.50	4.50	0.007	3013.3	0.97	0.02	0.01	3.75
3	0.16	0.8	0.87	2.66	2.83	3.50	0.020	1477.0	1.02	0.03	0.03	3.07
4	0.29	0.9	0.92	3.60	3.20	4.20	0.014	633.3	0.97	0.03	0.02	3.28
5	0.21	0.85	0.90	2.92	3.50	3.50	0.018	717.0	1.00	0.03	0.02	5.06
6	0.04	0.91	0.92	2.25	3.00	4.17	0.010	693.3	1.04	0.04	0.00	3.46
7	0.09	0.85	0.93	2.25	3.50	4.50	0.021	2003.0	1.01	0.04	0.01	4.50
8	0.17	0.93	0.91	3.42	3.83	3.67	0.025	1847.0	0.95	0.05	0.00	7.36
9	0.18	0.86	0.82	3.30	3.60	2.20	0.019	1153.3	0.99	0.05	0.01	4.81
10	0.16	0.74	0.90	3.30	2.80	4.00	0.019	3273.3	1.02	0.04	0.10	4.79
11	0.13	0.91	0.86	4.00	4.00	5.00	0.008	1113.3	1.00	0.05	0.02	5.80
12	0.15	0.77	0.87	3.60	3.80	5.00	0.002	3033.3	1.00	0.04	0.01	5.01
13	0.21	0.89	0.79	3.90	3.80	4.40	0.021	923.3	0.93	0.03	0.01	3.31
14	0.24	0.77	0.84	2.90	3.40	4.30	0.029	937.0	1.02	0.06	0.03	3.25
15	0.12	0.86	0.77	3.10	3.40	3.80	0.022	683.3	1.10	0.02	0.02	4.62
16	0.02	0.92	0.87	3.60	3.90	4.90	0.018	3300.0	0.97	0.01	0.00	8.79
17	0.06	0.83	0.87	2.80	3.60	3.80	0.022	1807.0	0.97	0.00	0.00	1.82

Table 3. Indices for perspectives for the year 2019

Year 2019	Indices for perspectives														
Branches of ABC bank	$I^{F+}_{1,19}$	$I^{F+}_{2,19}$	$I^{F+}_{3,19}$	$I^{F+}_{4,19}$	$I^{L+}_{1,19}$	$I^{L+}_{2,19}$	$I^{L+}_{3,19}$	$I^{C+}_{1,19}$	$I^{C+}_{2,19}$	$I^{C+}_{3,19}$	$I^{P+}_{1,19}$	$I^{P+}_{2,19}$	$I^{P+}_{3,19}$	$I^{P+}_{4,19}$	$I^{P+}_{5,19}$
1	0.01	0.05	0.36	0.14	3.52	3.50	4.33	0.007	9417.0	0.99	0.05	0.14	0.003	5475.0	0.05
2	0.20	0.22	1.68	0.07	3.00	3.50	4.50	0.014	3013.3	0.97	0.13	0.01	0.001	7904.0	0.13
3	0.20	0.17	1.25	0.00	2.66	2.83	3.50	0.021	1477.0	1.02	0.2	0.00	0.002	1058.0	0.20
4	0.22	0.11	0.29	0.00	3.60	3.20	4.20	0.009	633.3	0.97	0.14	0.01	0.000	252.3	0.14
5	0.18	0.11	1.32	0.12	2.92	3.50	3.50	0.015	717.0	1.00	0.12	0.01	0.005	1359.0	0.12
6	0.13	0.08	0.92	0.03	2.25	3.00	4.17	0.006	693.3	1.04	0.09	0.00	0.000	898.3	0.09
7	0.16	0.16	0.78	0.09	2.25	3.50	4.50	0.018	2003.0	1.01	0.09	0.11	0.002	1662.3	0.09
8	0.37	0.19	1.12	0.25	3.42	3.83	3.67	0.027	1847.0	0.95	0.12	0.00	0.001	983.0	0.12
9	0.14	0.13	1.33	0.22	3.30	3.60	2.20	0.017	1153.3	0.99	0.11	0.00	0.000	1015.3	0.11
10	0.14	0.16	0.72	0.14	3.30	2.80	4.00	0.018	3273.3	1.02	0.12	0.13	0.002	1444.3	0.12
11	0.34	0.14	1.09	0.09	4.00	4.00	5.00	0.008	1113.3	1.00	0.12	0.00	0.001	812.3	0.12
12	0.10	0.20	-0.01	0.17	3.60	3.80	5.00	0.017	3033.3	1.00	0.12	0.00	0.006	795.0	0.12
13	0.14	0.23	0.83	0.26	3.90	3.80	4.40	0.015	923.3	0.93	0.11	0.00	0.018	770.0	0.11
14	0.17	0.21	0.18	0.20	2.90	3.40	4.30	0.019	937.0	1.02	0.13	0.00	0.000	536.0	0.13
15	0.12	0.13	-3.56	0.11	3.10	3.40	3.80	0.018	683.3	1.10	0.18	0.14	0.000	538.3	0.18
16	0.10	0.40	-1.45	0.02	3.60	3.90	4.90	0.014	3300.0	0.97	0.06	0.01	0.005	4687.0	0.06
17	0.11	0.28	2.82	0.11	2.80	3.60	3.80	0.020	1807.0	0.97	0.09	0.00	0.001	1111.0	0.09

Table 4. Indices for perspectives for the year 2020

	Year 2020	Indices for perspectives												
		$I^{F+}_{1,20}$	$I^{F+}_{2,20}$	$I^{F+}_{3,20}$	$I^{F+}_{4,20}$	$I^{L+}_{1,20}$	$I^{L+}_{2,20}$	$I^{L+}_{3,20}$	$I^{C+}_{1,20}$	$I^{C-}_{2,20}$	$I^{C+}_{3,20}$	$I^{P+}_{1,20}$	$I^{P+}_{2,20}$	$I^{P+}_{3,20}$
Branches of ABC bank	1	0.07	21554	0.060	0.93	3.52	3.50	4.33	0.010	0.09	0.99	0.29	0.02	0.93
	2	0.12	11643	0.059	0.94	3.00	3.50	4.50	0.016	0.20	0.97	0.07	0.01	0.60
	3	0.08	6675	0.112	0.89	2.66	2.83	3.50	0.012	0.26	1.02	0.08	0.01	0.42
	4	0.05	-13000	0.135	0.95	3.60	3.20	4.20	0.012	0.11	0.97	0.07	-0.02	0.30
	5	0.06	23243	0.081	0.95	2.92	3.50	3.50	0.015	0.12	1.00	0.13	0.00	0.35
	6	0.05	-12680	0.114	0.93	2.25	3.00	4.17	0.006	0.12	1.04	0.13	0.02	0.45
	7	0.10	13811	0.078	0.94	2.25	3.50	4.50	0.015	0.20	1.01	0.09	0.00	0.46
	8	0.08	11343	0.066	0.93	3.42	3.83	3.67	0.026	0.11	0.95	0.04	-0.02	0.34
	9	0.05	21700	0.106	0.87	3.30	3.60	2.20	0.024	0.14	0.99	0.09	0.04	0.57
	10	0.07	18300	0.109	0.94	3.30	2.80	4.00	0.018	0.23	1.02	0.19	0.04	0.50
	11	0.08	10228	0.087	0.92	4.00	4.00	5.00	0.008	0.10	1.00	0.12	-0.01	0.27
	12	0.11	-5200	0.065	0.93	3.60	3.80	5.00	0.014	0.26	1.00	0.09	0.03	1.16
	13	0.14	-525	0.110	0.87	3.90	3.80	4.40	0.015	0.17	0.93	0.05	0.03	0.50
	14	0.07	-13260	0.110	0.91	2.90	3.40	4.30	0.015	0.15	1.02	0.10	0.01	0.37
	15	0.05	-12000	0.092	0.87	3.10	3.40	3.80	0.016	0.20	1.10	0.14	0.03	0.59
	16	0.09	-108662	0.001	0.92	3.60	3.90	4.90	0.010	0.14	0.97	0.01	0.01	2.22
	17	0.13	-14800	0.010	0.84	2.80	3.60	3.80	0.020	0.24	0.97	0.04	0.02	0.62

The results of testing the proposed model using the data in tables 2-4 by years studied in 17 branches of the bank and the leading perspectives of the BSC are shown in tables 5-7.

Table 5. Performance scores in each perspective for the year 2018

Branches of the bank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Internal process perspective	0.649	0.338	0.390	0.398	0.461	0.482	0.514	0.662	0.595	0.523	0.621	0.530	0.399	0.632	0.373	0.488	0.090
Learning and growth perspective	0.599	0.625	0.583	0.578	0.597	0.644	0.672	0.595	0.540	0.564	0.630	0.632	0.603	0.620	0.593	0.633	0.617
Customers perspective	0.503	0.485	0.641	0.562	0.614	0.542	0.649	0.678	0.622	0.630	0.507	0.443	0.628	0.736	0.682	0.606	0.649

Table 6. Performance scores in each perspective for the year 2019

Branches of the bank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Internal process perspective	0.425	0.379	0.301	0.198	0.263	0.138	0.333	0.190	0.166	0.384	0.186	0.250	0.396	0.179	0.418	0.277	0.157
Learning and growth perspective	0.599	0.625	0.583	0.578	0.597	0.644	0.672	0.595	0.540	0.564	0.630	0.632	0.603	0.620	0.593	0.633	0.617
Customers perspective	0.317	0.489	0.647	0.367	0.515	0.296	0.583	0.760	0.560	0.584	0.344	0.560	0.509	0.605	0.590	0.489	0.623

Table 7. Performance scores in each perspective for the year 2020

Branches of the bank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Internal process perspective	0.553	0.264	0.311	0.157	0.330	0.423	0.246	0.090	0.499	0.589	0.304	0.395	0.402	0.349	0.475	0.127	0.301
Learning and growth perspective	0.599	0.625	0.583	0.578	0.597	0.644	0.672	0.595	0.540	0.564	0.630	0.632	0.603	0.620	0.593	0.633	0.617
Customers perspective	0.440	0.572	0.587	0.471	0.514	0.433	0.569	0.611	0.613	0.616	0.429	0.600	0.536	0.537	0.591	0.473	0.632

Regarding the performance scores obtained for the three leading perspectives, i.e. internal process perspective, learning and growth perspective, and customers perspective, the performance scores obtained for the three studied years are calculated as shown in table 8.

Table 8. Sum of performance scores in each year obtained by the proposed model

Branches of the bank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Performance score for the year 2018	0.930	0.872	0.909	0.889	0.916	0.915	0.944	0.956	0.929	0.923	0.931	0.904	0.911	0.963	0.919	0.926	0.878
Ranking in the year 2018	5	17	13	15	10	11	3	2	6	8	4	14	12	1	9	7	16
Performance score for the year 2019	0.871	0.894	0.902	0.820	0.872	0.829	0.916	0.917	0.846	0.898	0.838	0.890	0.893	0.886	0.914	0.880	0.884
Ranking in the year 2019	13	7	4	16	12	17	2	1	14	5	15	8	6	10	3	11	9
Performance score for the year 2020	0.890	0.882	0.881	0.812	0.869	0.883	0.893	0.857	0.911	0.931	0.853	0.911	0.890	0.885	0.913	0.831	0.902
Ranking in the year 2020	6	11	12	17	13	10	7	14	4	1	15	3	8	9	2	16	5

To examine the applicability and reliability of the model and the results, the geometric-mean performance scores are calculated to compare with those resulted from the TOPSIS method introduced by Yurdakul and Ic (2005). To avoid technical details, the basics of the TOPSIS method are not explained, but the results are shown in table 9.

Table 9. Mean value of performance scores in comparison to the results obtained by the TOPSIS

Branches of the bank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Proposed method	0.897	0.883	0.897	0.840	0.885	0.875	0.917	0.909	0.895	0.917	0.873	0.902	0.898	0.911	0.915	0.878	0.888
Ranking	9	13	8	17	12	15	1	5	10	2	16	6	7	4	3	14	11
TOPSIS (Yurdakul & Ic, 2005)	0.458	0.467	0.549	0.390	0.516	0.337	0.590	0.681	0.549	0.572	0.411	0.466	0.592	0.572	0.510	0.374	0.545
Ranking	13	11	6	15	9	17	3	1	7	4	14	12	2	5	10	16	8

5-Analysis of the results

The results reported in table 9 specifically show the ranking suggested by the proposed model. Besides, the bank branches' performances obtained by adapting the TOPSIS are represented in the table to provide a better comparison to validate the model. At first glance, there is a significant difference between the rankings obtained from the approaches. However, the analysis represented in this section, reveals that this difference is reasonable given the logic of the proposed model and there are no conflicts with the ranking provided using the TOPSIS method. TOPSIS is based on the concept that the chosen alternative, as the best branch of ABC bank, should have the shortest geometric distance from the positive ideal solution and the longest geometric distance from the negative ideal solution. In return, the proposed model, logically, uses the financial indices as the lagging output indicators and addresses the other indicators as the leading input ones. Thus, the results are obtained based on not only the values of the indicators but also the proportion of the values of the input indicators and the output ones. This is the basic reason for the deviation between the results of the two models. In other words, in the proposed model, the higher the indicators do not necessarily mean that the alternative is better. Alternatively, it is necessary to have not only better values of indicators but also a proportion between the values of input and output parameters. To provide more details, the results are compared and the applicability of the model is revealed. From table 9, it can be seen that the inefficient alternatives within the last 25% performance scores are alternatives 16, 6, 11, and 4, respectively. These alternatives are either the worst alternatives introduced by the TOPSIS, but with a little difference in their ranks as 6, 16, 4, and 11. As can be seen, the worst alternative resulting from the proposed method is alternative 4, because, according to table 8, it has been one of the last 3 alternatives every three years. However, the worst alternative by applying the TOPSIS method is alternative 6, which has been ranked 11th, 17th, and 10th, respectively, by applying the proposed method in the 3 years studied, and has clearly been in a better position than alternative 4. For a better analysis of the situation, it is necessary to refer to the results in tables 5, 6, and 7. A closer look at the values obtained in these tables reveals the fact that, overall, alternative 4 ranked higher in the three input perspectives. However, the financial data in tables 2, 3, and 4 indicate that from a financial point of view as an output, in total, alternative 4 has smaller values. Therefore, alternative 4 has achieved less output by spending more input and therefore has worse performance than alternative 6, and the result of the proposed model is quite logical and correct. In both models, alternative 16 is better than alternative 6, and alternative 11 is better than alternative 4. In return, alternatives 16 and 6 are better than alternatives 11and 4 in the proposed model, while this is not the case in the ranking obtained by the TOPSIS. A closer look at the data obtained in tables 2, 3, and 4 reveals that alternative 6 is really better than alternative 11, concerning the logic behind the proposed model. Because, unlike alternative 6, alternative 11 is the best regarding the learning and growth perspective, while its financial score is not better than alternative 6 in all cases. This, given the considerable distance of some of the corresponding financial indices in the alternatives, means that, although it spends more on learning and growth, its achievement has not been as significant as expected. While this is not the case for alternative 6. In other words, the more proportion the 6th alternative holds. The results obtained in table 8 are also consistent with this analysis, so that alternative 11, despite being one of the first 5 alternatives in one-third of the studied periods, has been evaluated as one of the last 3 alternatives in two-thirds of the periods. The results also show the high sensitivity of the model to the values of financial perspective indices as the lagging output perspective. With the change in the values of the indices of this perspective and the relatively small change of the values of the indices related to the leading input perspectives, the location of the alternatives has changed. This is quite evident in table 8 by comparing the input values of the indices associated with the input perspectives from tables 2, 3, and 4. Therefore, the results obtained by the proposed method are more reliable, while the difference between the results of the models is not considerably large regarding the last 25% performance scores.

The same analysis can be performed for the first 30% performance scores regardless of alternative 15 that is the 3rd alternative in the ranking obtained by the proposed model, while it is the 10th one in the ranking obtained by the TOPSIS. This is because alternative 15 has significant values in almost all indices of leading input perspectives. However, from the financial point of view, this alternative has not been able to obtain high index values, commensurate with its inputs, and therefore has not been able to have a performance commensurate with its inputs. In the TOPSIS algorithm, on the other hand, since this comparative approach is not measured by considering financial indices as output and other indices as input, this arrangement has shown a significant change. Therefore, the existence of such a difference regarding alternative 15 is quite logical and shows the accuracy and acceptability of the results of the proposed model in the case of OPM. From the point of view of model sensitivity, table 8 provides enlightening data on alternative 15. Specifically, alternative 15 in 2018 compared to 2019 and 2020 has experienced a lower proportion in terms of its outputs and inputs, and this has caused the ranking of this alternative in 2018 significantly different from 2019 and 2020. This is a further confirmation of the accuracy of the proposed model based on the logic behind its modeling procedure.

In the case of alternative 7, which is the best alternative obtained by the proposed model, it is noticeable that although it has no input with the highest value, its performance is high enough regarding the output indicators, especially in the year 2018, e.g. for the index $I_{3,18}^{F+}$. While, alternative 8, although has the best score regarding $I_{1,20}^{C+}$ its financial score is not good. In the case of the year 2019, given the high-performance score regarding $I_{1,19}^{C+}$, it can achieve a good performance score regarding $I_{1,19}^{F+}$. Since both the alternatives, i.e. 8 and 7, has the same state in the case of the financial indicators at the year 2018, it is clear that in the case of 8th alternative, the financial performance score is not as much as the inputs spent to obtain it. While, for 7th alternative, the good performance score is achieved for $I^{F+}_{3,18}$ with no such efforts. In other words, the 7th alternative can obtain a better performance score, if it provides better input parameters. This means that the performance of the 7th alternative is higher than alternative 8. This ranking is successfully obtained by adopting the proposed method, while this is not the case by using the TOPSIS method. On the other hand, in the case of alternatives 9, 17, 5, and 2 the proportion of the performance scores is completely the same for the two methods regardless of the position of these alternatives in the ranking. Such a proportion is also obtained in the case of alternatives 1 and 12. Accordingly, the analysis prepared in this section illustrates the superiority of the proposed model as well as the logical sensitivity of the model to the input parameters. Some of the rankings are completely adapted with what is obtained using the prequalified TOPSIS model. Besides, in the case of the differences that exist between the results of the two models, the superiority of the results obtained by the proposed model has been analytically explained based on the logic behind the modeling process of the proposed model.

6-Conclusions

This paper proposes a new methodology of applying the integration of BSC and QEST-3D approaches to assess overall organizational performances and demonstrates this application through a real case study for the branches of a bank. The objective of this application is to use a systematic approach to provide a ranking of the alternatives/organizations based on not only the values of the indicators but also the proportion of the input and output indicators values. Although the input and output indicators used in the proposed model vary in different time intervals, regarding the strategy maps obtained by BSC, a model simply provides a reliable and applicable way to evaluate the organizations. In this model, based on strategy maps, provided for different years, the output and input indicators are set, the data are collected and the evaluation process is done using QEST-3D model.

The model considers three perspectives, i.e. customers, internal process, and learning and growth, of the BSC model as the set of leading input perspectives and the financial perspective as the lagging output one. It uses the first three perspectives in the first quantitative phase of the PM, which obtains the ranking. The financial indicators are used in the evaluation and analysis phase of the model. This may prepare an appropriate strategy to enhance the organizations' performance using the effective perspective and indicator to be strengthened. Furthermore, it makes the model interactive regarding the use of the decision maker's opinion, especially through the phases of the analysis of results.

The main feature of the proposed model in comparison with other MADM approaches is that, unlike other approaches, in this model by dividing the criteria into two categories of leading and legging, not only their values but also their proportion determines the order of alternatives. This feature is a positive feature in evaluating the performance of organizations based on their strategy map and therefore will have priority over other MADM-oriented methods. In addition, the mathematical and slightly strong framework behind this model will give it high reliability. The computational results make evident the superiority of the model as follows. (1) Integrating the BSC and QEST-3D models can be useful in the area of not only OPM but also MADM. (2) A correct overall PM should address all the key performance indicators of an organization including financial and non-financial indicators. However, it is not necessarily true to have a similar look at all the indicators. In this paper, the financial indicators are successfully considered as lagging output indicators and non-financial indicators are clustered as the leading input indicators. (3) According to the final qualitative step of the model, the decision maker's opinion is directly considered in the model, which is essential in the SPMS. (4) In the proposed method, the performance scores are developed based on the values of the indicators and the proportion of the values of the input indicators and the output ones.

Although the proposed procedure to evaluate the overall performances for consideration in organizational ranking can be applied in various fields a case study for organizational evaluation and comparison using the integrated model for 17 branches of a large bank in Iran is presented in the paper to demonstrate the applicability of the model. Despite the positive features of the model presented in this research, it is subject to limitations that can be considered by researchers in future research. (1) The proposed model is based on the basic BSC and is divided into two categories, written on a QEST-3D. However, it can be designed based on other variants of the BSC concerning the other additional perspectives through the QEST-nD. (2) In this research the reliability of the model is compared with the TOPSIS. One can compare the model with the other MADM approaches. (3) Since the proposed model divides the indices into output and input ones, given the popularity of the DEA in the case of OPM, another direction for future research is to compare the model with the DEA-oriented models introduced in the literature of the concept. (4) The model introduced in this paper is designed for the financial service industry. One can examine it in the other sectors as well.

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