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Proposing a new integrated model based on sustainability balanced scorecard (SBSC) and MCDM approaches by using linguistic variables for the performance evaluation of oil producing companies

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ABSTRACT

Using the balanced scorecard approach based on sustainable development parameters is a powerful and useful methodology to evaluate the sustainable performance of organization or company. In this paper, a new approach based on sustainability balanced scorecard (SBSC) and multi criteria decision making (MCDM) approaches is developed for evaluating the performance of oil producing companies in Iran. For reflecting the interdependent relationships among factors influencing the problem under consideration, analytical network process (ANP), a branch of the MCDM techniques, is employed. However, using the ANP method for calculating the preference ratings of alternatives is a time-consuming and bothersome process; therefore, COPRAS (COmplex PRoportional ASsessment) technique is adopted to prioritize the feasible alternatives in terms of linguistic variables. Based on this study, the results demonstrate the effectiveness of the proposed model. The performance evaluation model proposed by using a combination of the MCDM methods and the SBSC approach helps authorities to make an attempt for achieving a competitive advantage.

1. Introduction

Oil as one of the most important energy resources plays a significant role from economical and political points of view. However, oil provides about 40% of the energy required in the world. Iran is becoming a major supplier of oil to many different centuries and has a profound impact on the global energy equation.

Iran has a high production potential so that it is now producing approximately 4 million barrels per day and is capable of increasing its output by more than 6 million barrels per day. Likewise, the proved oil reserves in Iran rank third largest in the world at approximately 150 billion barrels as of 2007.[1] This product is the heart of the economy of Iran. The responsibility of extraction and production of crude oil is exclusively entrusted to the National Iranian Oil Company (NIOC). According to the survey conducted by Energy Information Administration, in 2006 NIOC generated some $46.9 billion in oil export revenue, comprising 80–90 percent of Iran's total exports and 40–50 percent of the government's budget.[2]

According to the key role of oil in the Iran's economy, it is necessary to develop the new approaches with a high potential to evaluate the performance of oil producing companies. This helps authorities to understand the strengths and weaknesses; as a result, the authorities can properly make a solution for developing the forthcoming strategies. Different methods have been developed to comprehensively evaluate the performance of organization. These methods usually offer some future measures and help managers to translate strategies into action.

The balanced scorecard (BSC) approach, introduced by Kaplan and Norton (1996), is well-known as one of the most popular methods in performance evaluation for mapping out strategies. This technique can translate the best strategies into tangible goals and measurements (Chen, Hsu, & Tzeng, 2011). In the system of the BSC method, not only financial parameters are considered as input factors, but also non-financial indicators are taken into account. However, this method ignores the important aspects of sustainable development in the process of performance evaluation; so that,

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[1] http://en.wikipedia.org.

[2] http://www.eia.doe.gov/emeu/cabs/Iran/Background.html.

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some studies have been conducted to develop a new methodology based on BSC for performance evaluation. A two-years research project "sustainability balanced scorecard (SBSC)" (2000–2002), accomplished by University of Lüneburg and St. Gallen methodology, was funded by the German Federal Ministry for Science and Education to operationalize corporate sustainability (Chai, 2009). They developed a new methodology to incorporate strategies and measure the environmental and social performance. Therefore, this method can cover all aspects of a performance assessment problem in order to obtain a more accurate and reliable model.

In this study, the SBSC approach is employed for calculating the performance of oil producing companies. Nevertheless, there are a large number of factors that would affect the performance of oil producing companies. These factors can be grouped into several classes. Then, decision analysis is conducted based on this new list of factors. The merit of using multi-criteria decision making (MCDM) techniques is to formulate a decision making problem where the evaluation criteria are in conflicting with each other.

The COPRAS technique, first developed by Zavadskas and Kaklauskas (1996), is a branch of the MCDM techniques that its effectiveness and value is demonstrated by different researchers (Chatterjee, Athawale, & Chakraborty, 2011; Kaklauskas et al., 2006; Kaklauskas et al., 2010; Kanapeckienė, Kaklauskas, Zavadskas, & Raslanas, 2011; Madhuri, Chandulal, & Padmaja, 2010; Medineckienė & Björk, 2011; Mulliner, Smallbone, & Maliene, 2013; Palevičius, Paliulis, Venckauskaite, & Vengrys, 2013; Podvezko, 2011; Stanujkic, Djordjevic, & Djordjevic, 2013; Tamošaitienė & Gaudutis, 2013). COPRAS-G method (Complex Proportional Assessment of alternatives with Grey relations) was suggested by Zavadskas, Kaklauskas, Turskis, and Tamošaitienė (2009) with attributes expressed in interval values, which are suitable for real situations of decision makers and the applications of the grey theory. COPRAS-G method used Tavana, Momeni, Rezaeiniya, Mirhedayatian, and Rezaeiniya (2013), Maity, Chatterjee, and Chakraborty (2012), Nguyen, Md Dawal, Nukman, and Aoyama (2014), Aghdaie, Hashemkhani Zolfani, and Zavadskas (2013), Hashemkhani Zolfani, Chen, Rezaeiniya, and Tamošaitienė (2012), Barysienė (2012), Chatterjee and Chakraborty (2012) and Popovic, Stanujkic, and Stojanovic (2012). COPRAS method is employed in this paper because of its unique advantages, including (1) COPRAS allows simultaneous consideration of the ratio to the ideal solution and the ideal-worst solution, (2) simple and logical computations, and (3) results are obtained in shorter time than other methods such as AHP and ANP (Fouladgar, Yazdani-Chamzini, Lashgari, Zavadskas, & Turskis, 2012).

However, the COPRAS technique is not capable of handling the inherent uncertainty involved in the process of modeling a decision making problem. Fuzzy logic is a mathematical tool for taking into account the uncertainty. Therefore, the fuzzy COPRAS method is developed to integrate the advantages of both fuzzy logic and the COPRAS method into a powerful technique for solving a decision making issue (Antuchevičienė, Zavadskas, & Zakarevičius, 2012; Chatterjee & Bose, 2013; Fouladgar, Yazdani-Chamzini, Lashgari, et al., 2012; Yazdani, Alidoosti, & Zavadskas, 2011; Zavadskas & Antucheviciene, 2007).

On the other hand, the assumption of independence of criteria is not always correct because in real world the criteria are often dependent on each other. Analytical network process (ANP) is an appropriate tool in order to model complex problems with all kinds of relationship, dependency and feedback in the model and draws a systematical figure of the decision making problem (Azimi, Yazdani-Chamzini, Fouladgar, Zavadskas, & Basiri, 2011).

The adaptation of the ANP technique in this paper is to formulate the interdependency relationships between criteria. This model can be known as the universal one because of using the information from both professional experts and clients.

The reasons for using an ANP-based decision analysis approach are: (1) ANP can measure all tangible and intangible criteria in the model (Saaty, 1996), (2) ANP is a relatively simple, intuitive approach that can be accepted by managers and other decision-makers (Presley & Meade, 1999), (3) ANP allows for more complex relationship among the decision levels and attributes as it does not require a strict hierarchical structure (Yazgan, Boran, & Goztepe, 2010), and (4) ANP is more adapted with real world problems (Fouladgar, Yazdani-Chamzini, Zavadskas, & Moini, 2012).

The novelty of this paper is pertaining to establishing a new integrated model for evaluating the performance of oil producing companies under sustainable development indicators in the term of linguistic variables. The model is developed based on a combination of two MCDM methods, taking not only financial and non-financial factors into account in the terms of linguistic variables, but also considers environmental and social parameters.

The remainder of this paper is organized as follows. The SBSC methodology is illustrated in next section. In Section 3, the ANP method is briefly presented. The fuzzy COPRAS technique is described in Section 4. In Section 5, the proposed model is introduced. The implementation of the proposed model is illustrated in Section 6. In the last section, conclusions are described.

2. Sustainability balanced scorecard (SBSC)

The balanced scorecard (BSC) was first introduced in early of the 1990s by Kaplan and Norton to develop business performance evaluation system. This methodology was introduced because of some weaknesses of the traditional performance evaluation that the current system overemphasizes financial parameters and other perspectives were neglected. The innovation of the BSC technique is to evaluate an organization from four perspectives, including financial, customer, internal process, and learning and growth perspectives. Fig. 1 shows the relationship among various factors of BSC. The BSC is a systemic approach, which helps integrating physical and intangible assets into a comprehensive model and builds a meaningful relationship among different criteria. The concepts of the BSC approach are widely applied to performance measurement. Table 1 lists a number of recent studies conducted with the BSC approach. According to recent survey of more than 1000 organizations, 80% of the organizations that regularly use the BSC reported improvements in operating performance and 66% of them also reported an increase in profits.[3]

However, the BSC technique ignores environmental and social aspects as essential pillars of a sustainable business; so that, new methods were developed for curing the problem. Figge, Hahn, Schaltegger, and Wagner (2002) believed that BSC can help to take all aspects relevant for achieving sustainability into account simultaneously and in a balanced manner. Since the BSC has high potential to integrate environmental and social aspects into the general management system, the BSC has been combined with sustainable parameters, called as the sustainability BSC (SBSC), to provide a meaningful instrument to the sustainability management (Chai, 2009). Fig. 2 shows a typical structure of the SBSC method. By integrating all three pillars of sustainable development, economic, social and environmental dimensions, into the business strategy, the corporate sustainability has been promoted (Hahn & Wagner, 2001). Therefore, the SBSC may not only help detect important strategic environmental and/or social objectives of the company but may also enhance the transparency of value-added potentials emerging from social and/or ecological aspects and prepare the implementation process of the strategy (Hsu, Hu, Chiou, & Chen, 2011).

[3] www.ameinfo.com.