



A hybrid MCDM and sustainability-balanced scorecard model to establish sustainable performance evaluation for international airports

Ming-Tsang Lu^a, Chao-Che Hsu^b, James J.H. Liou^{a,*}, Huai-Wei Lo^c

^a Department of Industrial Engineering and Management, National Taipei University of Technology, Taiwan

^b Department of Transportation Management, Tamkang University, 151 Ying-Chuan Rd. Tamsui, Taipei 251, Taiwan

^c Graduate Institute of Industrial and Business Management, National Taipei University of Technology, 1, Sec. 3, Zhongxiao E. Rd., Taipei 10608, Taiwan

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ABSTRACT

The SBSC (sustainability-balanced scorecard) is adapted for the evaluation of the performance of airports to ensure sustainable development. The approach aims to integrate this performance evaluation of sustainable development, and use qualitative and quantitative information with the sustainability-balanced scorecard. The multiple criterion decision making model was first used to estimate the key influences of international airport performance in relation to sustainability. We first used the DEMATEL (decision-making trial and evaluation laboratory) to establish a complex system illustrated as an influential-network-relationship-map. We next used the DANP (DEMATEL based on analytical network process) to confirm the influential weights. Then, we used a hybrid modified VIKOR to select and improve the performance gaps between the aspiration values and the current situation for the international airport. To demonstrate the proposed model, we applied it to three international airports in Taiwan as a case study. The outcomes indicate that airport image is the most crucial factor within the performance evaluation and that social perspective has the highest degree of net influence. The largest weighted gap when examining the aspiration value is public transport for the A₂ airports and transparency of finance for the A₁ and A₃ airports. The implications for management are discussed.

1. Introduction

Social responsibility and sustainable development have become important issues in recent years. There are many methods for performance evaluation of strategic control and techniques aimed at estimating the performance results of their implementation in an organization (Ülgen and Mirze, 2004; Dinçer, 2004). One performance approach that empowers systematic and periodic system control is the Balanced Score Card (BSC) structure established by Kaplan and Norton (1996, 1992).

The BSC evaluates an organization in terms of the performance factors enabling expression of its vision, for the formation of the strategic framework required for performance evaluation and the measurement of management systems. There are many kinds of methods that have been established to broadly estimate the performance of an organization. The BSC technique is one of the most widespread performance evaluation approaches, and it considers both non-financial elements and financial elements (Zhao and Li, 2015; Schauf et al., 2014). However, the technique neglects the most significant perspective, the evaluation of sustainable performance. Hence, many

researchers have revised the BSC, offering a hybrid method, the SBSC (sustainability balanced scorecard) approach to investigate sustainable performance. This method takes into account issues of sustainability by including social and environmental issues (Rabbani et al., 2014). Other studies have incorporated SBSCs into strategies for the sustainable performance evaluation management of an enterprise by inserting eco-efficiency factors along with the appropriate main financial and environmental factors (Möller and Schaltegger, 2005; Zhao and Li, 2015; Figge et al., 2002).

There has been little effort applied to the implementation or adaptation of the SBSC technique for the evaluation of sustainable performance related to international airport activities. Actually this application has not been addressed in prior studies. Thus, in this study, the SBSC framework is applied to determine the preliminary estimation indicators for improvement of the sustainable performance of an international airport. This includes many aspects, such as “financial”, “internal business process”, “learning and growth”, “environmental”, and “social” perspectives. Hence, the preliminary criteria followed by the SBSC can be used to measure and improve these international airports’ sustainable performance.

* Corresponding author.

E-mail address: jamesjliou@gmail.com (J.J.H. Liou).

Moreover, the hybrid MCDM (multiple criteria decision-making) approach is applied to determine estimation indicators from a series of exhaustive surveys asking for observational opinions. The hybrid method can overcome issues of uncertainty and ambiguity in the professionals' replies to yield the most reliable consensus of observations about the estimation indicators (Okan et al., 2012). Clearly, this adaption of sustainable performance evaluations for international airports includes multiple elements, making this an MCDM issue. Recently, several approaches have been offered to address the performance of international airports, such as DEA (data envelopment analysis), KPI (key performance indicator), AHP (analytic hierarchy process), IPA (Importance-performance analysis) and the balanced scorecard method (Olfat et al., 2016; Gupta et al., 2016; Rezaei et al., 2017; Zou et al., 2015; Pandey, 2016; Merkert and Assaf, 2015; Li et al., 2017; Dinçer et al., 2017). However, the SBC and KPI approaches have several shortcomings. First, owing to their consideration of only a single factor, they are not able to consolidate multiple performance factors. Moreover, they are deficient in terms of perceiving the significance weights of the sub-factors and key factors and therefore objectively evaluating performance.

To solve these deficiencies, we use an MCDM method with DEMATEL (decision-making trial and evaluation laboratory), DANP (DEMATEL based on analytical network process) and the modified VIKOR (DDANP-mV) method to estimate overall performance (Lu et al., 2013). Hence, the major contribution of this approach is the assembly of an SBSC structure for estimating the sustainable performance of international airports with hybrid MCDM models. To accelerate the sustainability of international airports, preliminary estimation indicators are determined follow by the application of the SBSC, which not only takes regular elements into account but also considers social and environmental issues expressed through linguistic variables. Essentially, this hybrid MCDM method is used to formulate estimation indicators from the perspective of professionals. The DANP technique is an effective technique that can be used to build the complex relations between elements and derive the weights of the elements without further investigation. The DEMATEL (decision-making trial and error laboratory) results and the concepts of the ANP (analytical network process) are applied to derive these influential weights, without the requirement of further pairwise comparisons as with the original ANP technique. To avoid the shortcomings of the traditional VIKOR technique, we applied a modified VIKOR technique, replacing the relative good with the aspiration values, so as to avoid the “stop-gap piecemeal” complication. This hybrid technique overcomes the limitations of the current decision prototypes and can be applied to benefit the investigation of the criteria that effect the SBSC for estimating the sustainable performance of international airports.

This remainder of the article is structured as follows. In the second section, we construct the evaluation criteria, and construct the sustainable performance evaluation model for completion of the sustainability balanced scorecard framework for international airports. In Section 3, we present the sustainable performance evaluation by these hybrid MCDM models for international airports. In Section 4, we present the case approach, its applications and an analysis of the outcomes. Finally, we present the conclusions in Section 5.

2. Identifying the sustainable performance of SBSC

Sustainable performance evaluations are used to systematically review the activities at international airports aimed at reaching a certain objective. When sustainable performance evaluations become part of the control and management system of an international airport they can effectively measure the sustainability of its performance and the usage of resources related to this purpose. However, traditional estimation metrics are limited for the assessment of overall performance and are often focused only on financial performance. Traditional performance evaluation methods are neither comprehensive nor effective for holistic

estimation measures (Wu and Hung, 2008).

The SBSC, which is derived from the traditional BSC, is defined by Figge et al. (2002) as overcoming the deficiencies of the conventional BSC by the incorporation of environmental, social and sustainability structures. As an enterprise performance estimation method, the BSC approach formulates a hierarchical system of strategic goals from four main aspects: financial, internal business process, customers, and learning and growth. The comprehensive estimation model integrates physical and intangible assets to construct a relation among different indicators. However, social, environmental, and sustainability perspectives have been ignored. Hence, the SBSC arrangement has been recommended to evaluate the performance of international airports after incorporating parameters related to sustainable development. In addition, this SBSC is designed not only to detect the strategic social and environmental purposes of a firm but also improve the value-added potential emerging from environmental and social perspectives. Some researchers have described the SBSC as an essential management strategy or tool to increase the consciousness of corporation responsibility (Tsalis et al., 2013). Others have used the SBSC to outline efficient strategies in which social, environmental and economic perspectives are amalgamated into a combined structure for sustainability estimation (Maria, 2012).

Owing to the high emissions and energy consumption of international airports, it is appropriate to examine their performance from the viewpoint of sustainability. Combining sustainability theory with the guidelines of GRI (Global Reporting Initiative) and the DJSI (Dow Jones Sustainability Index), the initial indicators for SBSC performance estimation by international airports comprise “financial”, “internal business process”, “learning and growth”, “environmental”, and “social” perspectives. In accordance with the theories of GRI and as noted on the DJSI, the initial indicators in the SBSC framework developed in the study should reflect social, environmental, and financial benefits while totally incorporating the perspectives of managers, shareholders and governmental authorities involved in the management international airports.

After many face-to-face interviews with experts and a review of the relevant literature, the indicators of sustainable performance for use in the estimation procedure are determined. Thus, 15 criteria influencing sustainable performance are determined. These criteria are then grouped into 5 SBSC perspectives: financial, internal business process, learning and development, environmental, and social. After identifying evaluation indicators, a hierarchical structure for evaluation of sustainable performance by international airports is formed. This hierarchy contains five key levels with the overall aim at the top level, the estimation indicators situated on this second level, and possible alternatives assigned to the lower levels. The structure of the evaluation indicators for international airports based on the SBSC approach is shown in Fig. 1.

The study implements the DEMATEL method to clarify the relationships between the various assessment criteria because this is a comprehensive technique for analyzing and establishing a fundamental model involving causal relationships between complex perspectives (Liou et al., 2011; Lu et al., 2013, 2015). It also establishes the correlations between the criteria and perspectives to establish the (INRM) influential-network-relationship-map (Huang et al., 2007; Tzeng et al., 2007; Ou Yang et al., 2008). It has been successfully applied in many situations, such as electronic health record adoption, safety issues, and mobile commerce (Liou et al., 2007, 2017; Lu et al., 2015). Moreover, it has helped to improve the competency of airport administrators, and enabled socially responsible investment and cost evaluation in the airport industry (Wu and Lee, 2007).

The indicators for estimating sustainable performance are selected based on a review of the sustainability balanced scorecard literature, expert opinions, interviews, and brain storming by administrators at international airports, as shown in Table 1.

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