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Determining the value of the port transport waters: Based on improved TOPSIS model by multiple regression weighting

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ABSTRACT

The determination of the value of sea area used for port transportation involves the distribution of economic interests between the Chinese government and the users of sea areas. This paper builds an evaluation index system for the value of port transport sea areas. It is the first of its type to introduce the multiple regression weighting TOPSIS method (Technique for Order Preference by Similarity to an Ideal Solution) to study the value of a port transport sea area. This method was applied in the determination and calculation of the value of port transport sea areas in coastal counties (cities, districts) in Zhejiang province.

The results show that various influencing and impact factors significantly affect the value of the sea area. These factors differ in their level of effect; the value and grade of the sea area for port transportation are closely linked with the order of quality relating to the sea area. The multiple regression weighting TOPSIS method has superior advantages with regard to the adaptability of its evaluation method and the accuracy of evaluation results, with calculated results showing growth at different levels compared with the criteria for the sea area use fee.

This research will play a very important role in these three fields: valuation system construction for government marine resources, ocean development and ocean management by the government.

1. Introduction

As China is a maritime country with large sea areas for port transportation and abundant resources and ports along its coastline, it has great potential to accelerate the development of the marine transportation industry. For a long time, free use of port transport sea areas has caused the disorder of marine development activities and aggravated marine pollution. To strengthen the management of seaport transportation, promote the rational development and sustainable use of sea areas, safeguard China's ownership of sea areas and protect the legitimate rights and interests of the users of sea areas, the Chinese government promulgated the “Law of the People's Republic of China on the Administration of the Use of Sea Areas” in 2001. This law clearly defines that “the government executes the regulation for paid use of sea areas; any entities and individuals are requested to pay the fee for use of a sea area to the marine administrative department in accordance with relevant provisions of the State Council”. The valuation for use of a port transport sea area is not only the fundamental work of the marine administrative department and government responsible for execution of the rule for paid use of the port transport sea area; it is also an important technical basis for the promotion of the market operation of port transport sea areas (Wang and Zheng, 2013). Under the conditions of the market economy, the value can reflect the value of the port transport sea area. In this regard, scientific theories and appropriate evaluation methods should be developed to ensure its impartiality and fairness.

Currently, the valuation process for the right to use port transport sea areas has become very complicated because the trading market for port transport sea areas is not yet mature in China and because of the mobility and openness of the sea area for port transportation as well as the particularity of the property right. The traditional discounted cash flow method (Wen et al., 2014), a method based on cost-benefit analysis, has brought many prominent problems regarding seriously subjective evaluation results, poor comparability and low creditability, etc. due to reasons such as low effectiveness and reliability or incorrect selection and improper use. To improve accuracy of the valuation of port transport sea areas, the State Oceanic Administration and the Ministry of Finance have jointly formulated the standard and regulation for the

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collection of fees for the use of sea areas. To reflect actual differences in the quality and economic benefits of the sea areas, the fee is based on different grades of port transport sea areas and on how the sea area is used (Liu and Zhang, 2007; Wang et al., 2008). The standard also clearly requires that the bidding or auction programs of the government should require that the minimum value of the targeted sea area should not be lower than the standard for compensation for use of a sea area of the same grade as regulated by the governments at both national and provincial levels. Hence, the charge for use of sea areas for port transportation is not only an economic instrument for the protection and rational development of marine resources but is also an effective method for maintaining and increasing the value of state-owned assets (Guangdong Finance Department, 2011).

Fees for the use of port transport sea areas have been executed by the coastal counties (cities, districts) in China, a standard formulated by the State Oceanic Administration and the Ministry of Finance in 2007. The use of an expert scoring method to determine the relevant weighting factors for setting these fees is easily subject to the effects of subjectivity. Furthermore, it has been seven years since this standard was enacted in 2007. There have been significant changes in terms of the scale of development of the marine economy in different areas, development status of regional economies, regional social development levels and conditions of resources and environment, and so on. Additionally, the fee for use of sea areas is same at different costal counties (cities, districts) of the same level. The above reasons make it impossible to reflect accurately the current criteria for fees for the use of sea areas in terms of the specific value differences of sea areas in different coastal areas or the time value for the right to use sea areas. This difficulty, to a certain extent, may restrict the implementation of the rule for paid use of port transport sea areas and affect the market-oriented allocation of marine resources.

The grades of sea areas and fees charged for use of sea areas were formulated by the Ministry of Finance and the State Oceanic Administration, who considered all possible factors that might affect the value of the sea areas, including the special natural and social attributes of sea areas and quantification of the marine economy and environment of sea areas. A rectification of the fee for the use of sea areas based on the above formulation could reflect the value of port transport sea areas along Chinese coastal counties (cities, districts) more accurately. Accordingly, this paper introduces the use of the TOPSIS model and a multiple regression measurement model from a critical perspective to determine the factors that may affect the value of port transport sea areas and the impact index weighting factor. The paper considers the use of the current criteria for charging a fee to use sea areas. It employs the TOPSIS model to calculate the value of port transport sea areas, improves it based on the method of interpolation to rank the quality level of port transport sea areas of China's coastal counties (cities, districts) of the same level and calculates the value of the sea areas accordingly. The paper provides a new approach to valuing resources and sea areas. Based on the research results of this paper, the approach can be directly used as the minimum value by marine administrative departments for transfers in port transport sea areas, thereby minimizing the blindness of market transactions, enhancing the management of China's sea area assets and safeguarding the added-value of resources at sea areas.

2. Methodology

TOPSIS is a common decision analysis tool for finite solution and multi-objective modeling (Hwang and Yoon, 1981). Based on index properties and data collected about alternatives, this method selects a group of the best indicators and data as the virtual positive ideal solution and a group of the worst indicators and data as the virtual negative ideal solution. Accordingly, the comparison of the solutions can dot pitch the Euclidean distance between the positive and negative ideal points. The resulting Euclidean distance then may be used to evaluate whether a solution is good. The only condition needed for the use of the TOPSIS method is that all utility functions should be monotonically increasing or decreasing. As the TOPSIS method is based on a simple working theory and is easily understood and applied, it soon attracted the attention of relevant economic and management departments and has been widely applied. Previous applications include a business model comparison (Zhou et al., 2012), evaluating transportation systems (Awasthi et al., 2011), competition in the tourism industry (Zhang et al., 2011), a product adoption process for the automobile market (Kim et al., 2011) and performance measurement for aviation firms (Aydogan, 2011). However, TOPSIS has not been seen applied in the assessment of the sea value of coastal areas. The traditional TOPSIS method also has some weaknesses (Yang and Li, 2003; Hua and Tan, 2004; Hu, 2002; Yang and Chen, 2011; Li et al., 2011), which mainly appear in the following two aspects.

First, the traditional TOPSIS method is normally intended for use as a subjective method for the design of all evaluation indicators and determination of the weight function, such as expert evaluation method or an analytic hierarchy process (AHP). This type of design of evaluation indicators and weighting methods to some degree can better reflect the experiences and opinions of experts. However, it involves many subjective factors in the designed indicator system and determined weight function, which are more dependent on the subjective judgment of decision-makers, rather than providing quantified evidence for the overall reasonableness of the indicator system and the subjective analysis of the weight function. Because it fails to reflect the actual evaluation indicators, it loses its rationality and fairness.

Second, the only condition needed for the use of the TOPSIS method is that all utility functions should be monotonically increasing or decreasing. Through the determination of the positive ideal solution and negative ideal solution, the positive and negative values of the actual specimens are introduced to the evaluation model to define clearly the relative order of importance and subordination of the targets of multiple specimens. Therefore, it is mainly used in the evaluation of preferred solutions from a variety of alternative solutions; however, it cannot determine the value of each targeted specimen, which, as a result, has limited the scope of application of TOPSIS.

3. Improvement of the TOPSIS algorithm

The value of port transport sea areas varies substantially based on factors influencing the sea areas, including how a sea area is used, its location, natural conditions, quantity of resources, environmental quality status, social and economic conditions in surrounding areas, and so on. China's Ministry of Finance has already passed regulations and rules to guide use of sea areas by different applications and grades. Thus, the main purpose of this paper is to address how to adjust the charge for use of the port transport sea areas of some coastal counties (cities, districts) of the same level but in different regions based on the current value limits within the upper and lower grades.

The determination of the value of the port transport sea area is actually an issue relating to the order of importance and calculation of multi-targeted values; in addition, the values of the sea areas introduced in this paper for determination of the indicators and data are monotonic. Hence, the use of the TOPSIS method in the determination of the value of port transport sea areas is not only applicable and feasible but also is the first in China for research of