

# Design and Development of Evaluation System for Marine Economy Based on Grey Prediction Model

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**Abstract**—According to the need of the provincial evaluation capacity of the marine economy in this paper, we design the evaluation system for the marine economic based on JAVA as the development language and Oracle 11g as the database. It introduces the division of the system architecture and function module firstly. And then the evaluation system for marine economy based on grey prediction model is constructed. The prediction is similar with the actual statistics. At last, the development methods and running results of evaluation system for marine economy based on grey prediction model is discussed. The system is constructed to realize the transition from monitoring data of marine economy to decision-making and to provide more scientific and accurate support for the development of regional marine economy.

**Keywords**- Ocean; Economical; Evaluation system; Grey prediction model.

## I. INTRODUCTION

The 18th Party Congress has put forward the great strategic goal of "developing marine economy as well as building a powerful marine country", which will definitely promote further development of marine economy. Meanwhile, factors which restrict healthy development of marine economy are showing, especially in lack of practical ability in acquisition and evaluation of marine monitoring information and in tracking and monitoring hot issues<sup>[1-2]</sup>. The government attaches great importance to the development of marine economy and put special emphasis on the evaluation of marine economy. The letter [2008] 9 "approval of development planning of national marine industry" put emphasis on establishing runtime evaluation and monitoring of marine economy<sup>[3]</sup>. In 2011 the central government extracted from marine space using fee a special fund to support coastal provinces (including listed cities) to establish a monitoring and evaluation system for marine economy, which proves the increasing importance

the government is attaching to the marine economy. However, evaluation system of provincial marine economy is still in its early stages with many core issues to be solved<sup>[4-5]</sup>. The paper focuses on analysis and research of the evaluation system construction of Liaoning provincial marine economy, providing reference to other coastal provinces.

## II. OVERALL DESIGN OF THE EVALUATION SYSTEM

The marine economy evaluation system utilizes monitoring data and other relevant data to carry out the analysis of the influence of regional marine economy, emerging industry, leading marine industry, influential factors and other major events. We are incorporating data into research result on the basis of data analysis to realize the transformation from data to decision-making knowledge.

### A. System architecture

The system adopts a multi-layer architecture based on middleware technology in order to fully accomplish maximum resource sharing and reduce repeated developing. A multi-layer architecture based on middleware technology has many virtues such as openness, expandability and maintainability. The architecture accords with the development trend of software technology and well satisfies the practical project needs. The function modules are realized via middleware where each function module can be distributed on arbitrary knot. Clients obtain access to services offered by the system by explorers. The data needed by the system is distributed in different databases, saved and extracted by visiting the middleware.

The marine economy evaluation system is logically composed by basic data layer, data access services layer, information service layer and business application layer. The information service layer contains four parts: platform resources manager, basic service middleware, Proprietary Middleware in marine economy, and economy evaluation

logic middleware. The four parts forms an organic integrity by standard protocol and interfaces as is shown in Fig .1.

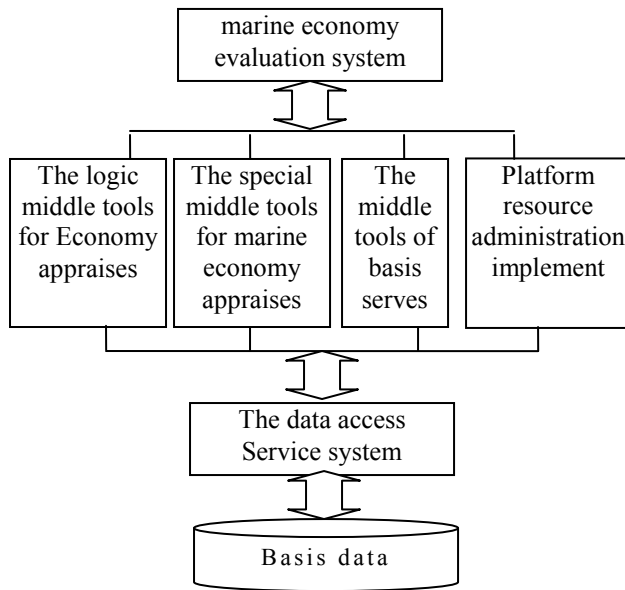


Figure 1 System architecture

### B. System function

The marine economy evaluation system is based on relevant data of regional marine economy, carrying out multiple functions such as statistic analysis, economic prediction, operational warning, multi-dimensional analysis and model presentation. The marine economy evaluation system transforms data to decision-making knowledge to help decision makers lay down scientific decisions. Its main function module is shown in Fig .2.

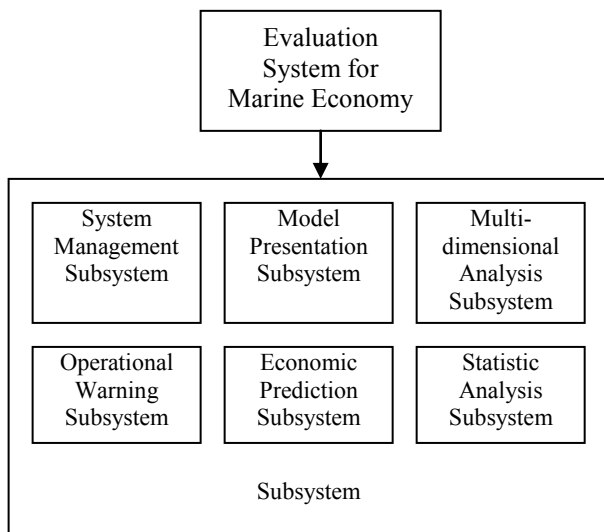


Figure 2 System function

① the statistic analysis subsystem carries out the following functions: enterprise gross output analysis, enterprise gross production value analysis, quantity

distribution statistics of monitoring enterprises, structural statistics analysis of monitoring enterprises, structural distribution analysis of the tertiary industry, proportion analysis of regional marine economy and marine economy development analysis. The subsystem monitors data via provincial monitoring system and displays the data in diagrams.

②the economic prediction subsystem is based on grey prediction module and carries out dynamic prediction of gross production value and gross output of 12 marine industries.

③The operational warning subsystem is based on linear regression model. The subsystem conducts scientific warning of the development of provincial marine economy.

④Multi-dimensional analysis subsystem presents multi-dimensional monitoring results (time-industry dimension, time-region dimension, industry-region dimension) according to the provincial monitoring data.

⑤Model presentation subsystem can deploy diagrams and charts on the page by simple dragging. It is used to present model analysis results and to realize linkage between data charts with a graphical dynamic effect.

⑥ System management subsystem carries out management of evaluation models, evaluation results, customer settings and evaluation products.

### C. The construct of marine economy appraising model based on gray forecast model

The grey prediction analytical method as one of the most important method of economic data prediction<sup>[6]</sup>, has many virtues such as high precision of prediction, minimum quantity need of data and longtime prediction. This paper uses the GM(1,1)model to establish a dynamic prediction model of marine economy development.

We adopt the marine economy data we acquired as original data, and then we get a cumulative value using the direct sum method. Then a marine economy grey prediction model is gradually obtained according to GM(1,1)modeling process. As follows, the national marine economy gross output value during the year 2001 to 2007 (TABLE I )is adopted as the original data to establish grey prediction model of marine economy development.

According to the differential equation of GM(1,1) model:

$$\frac{dX_1^{(1)}}{dt} + aX_1^{(1)} = b.$$

Get data vector YN and data matrix B:

$$Y_N = \begin{pmatrix} 90.5029 \\ 105.234 \\ M \\ 249.29 \end{pmatrix}, \quad \gamma = \begin{pmatrix} a \\ b \end{pmatrix}$$

$$B = \begin{pmatrix} -\frac{1}{2}(162.84 + 72.3380) & 1 \\ -\frac{1}{2}(268.07 + 72.3380) & 1 \\ M & M \\ -\frac{1}{2}(999.72 + 750.43) & 1 \end{pmatrix},$$

we can get the coefficients by OLS:

$$\hat{\gamma} = \begin{pmatrix} \hat{a} \\ \hat{b} \end{pmatrix} = (B^T B)^{-1} B^T Y_N = \begin{pmatrix} -0.2048 \\ 63.0593 \end{pmatrix}.$$

According to GM(1,1) model, the initial value is

$$x^{(1)}(t=1) = x^{(0)}(1) \text{ and the solution is:}$$

$$X^{(1)}(t) = 380.174e^{0.2048(t-1)} - 307.836$$

TABLE II show the fitting data according to this model.

TABLE I 2001-2007 CHINA'S GROSS OUTPUT VALUE OF MARINE ECONOMY (TEN BILLION)

Year	Raw data	Accumulative sequence
2001	72.338	72.338
2002	90.5029	162.84
2003	105.234	268.07
2004	128.41	396.48
2005	169.87	566.35
2006	184.08	750.43
2007	249.29	999.72

TABLE II CHINA'S GROSS OUTPUT VALUE OF MARINE ECONOMY (TEN BILLION)

Year	Raw data	Overfit data	relative error (%)
2001	72.338	72.34	0
2002	90.5029	86.43	4.5
2003	105.234	106.08	0.8
2004	128.41	130.19	1.38
2005	169.87	159.79	5.94
2006	184.08	196.11	6.54
2007	249.29	240.7	3.45

As to whether the model has a Usability some tests are required such as scale comparison and boundary region.

(1) test of scale comparison boundary region Relative error

$$\text{By caculating } \lambda(k) = \frac{x^{(0)}(k-1)}{x^{(0)}(k)}, \text{ we get}$$

$$(0.7993, 0.8600, 0.8195, 0.7559, 0.9228, 0.7384).$$

All level than fell on the capacity of coverage range

$X = (e^{\frac{-2}{n+1}}, e^{\frac{2}{n+1}}) = (0.7788, 1.2840)$ , that is to say, GM(1,1) model can be cnstructed and grey prediction can be conducted by  $X^{(0)}$ .

(2) test of the relative error

$e(k) = X^{(0)}(k) - \hat{X}^{(0)}(k)$ , Get the residual vector:

$$e = (e(1), e(2), L, e(N))^T = (-0.002, 4.0729, -0.846, -1.78, 10.08, -12.03, 8.59)$$

$$\Delta = \left\{ \left| \frac{\varepsilon(1)}{x^{(0)}(1)} \right|, \left| \frac{\varepsilon(2)}{x^{(0)}(2)} \right|, L, \left| \frac{\varepsilon(n)}{x^{(0)}(n)} \right| \right\}$$

$$= (0.00003, 0.04501, 0.00804, 0.01386, 0.05934, 0.06535, 0.03446)$$

$$\bar{\Delta} = \frac{1}{n} \sum_{k=1}^n \Delta_k$$

The fitting precision has reached second level which makes the model usable. through simulation of the above data, we predict the marine economy gross output by operating the grey prediction model and the predicting data results are shown in TABLE III. By comparing the prediction data with the actual statistic data releases by State Oceanic Administration, we can perceive small difference. Therefore, the evaluation system for marine economy based on grey prediction model constructed by the author has a very good application value.

TABLE III GROSS OUTPUT FORECAST VALUE OF CHINA'S MARINE ECONOMY (TEN BILLIONS)

Year	Forecast data	The actual statistical data
2008	295.23	296.62
2009	362.4	319.64
2010	444.7	384.39
2011	545.8	455.70
2012	669.9	500.87
2013	822.1	—
2014	1008.9	—

#### D. model construction of regression analysis

Regression analysis is a method to research economic development tendency and influential factors. The most classical kind of regression analysis is least square estimation, which must satisfy certain hypothetical conditions, among which multiple common line is one. In fact, it seldom happens when the explanatory variables are totally irrelevant from each other. Most variables share to a certain degree a multicollinearity which will cause the

model many uncertain results. So ridge regression is adopted to remove this multicollinearity.

Ridge regression was first put forward in 1962 by Hoerl. After the year 1970 he collaborated with Kennard to further improve this method. The main content is based on the multiple linear regression model matrix form  $Y = X\beta + \varepsilon$ . It modifies the ordinary least

squares estimators  $\beta = (X'X)^{-1} X'Y$  of parameter  $\beta$ .

If the independent variable has multicollinearity ( $|X'X| \approx 0$ ), add matrix  $kI$  to estimated matrix of

parameter  $\beta$ , which is  $\beta = (X'X + kI)^{-1} X'Y$ ,

$k \in [0, 1]$ . Ordinary least squares estimators is when  $k = 0$ . Detailed application is seen in reference [7].

### III. REALIZATION OF MARINE ECONOMY EVALUATION SYSTEM

The evaluation system for marine economy adopts B/S structure and JAVA as the development language. System realization adopts currently prevalent Struts2+Spring+MyBatis in the industry and incorporates advanced functional modules such as jQuery. The triple-layered application framework accords with the hierarchy in common use in the industry which is simple and concise. Presentation layer adopts partial Portal technique including single sign-on, centralized authority control and personalized interface design. Background database is relational database management system Oracle 11g, the server-side operation system is Linux enterprise edition whereas the client-side is Microsoft Windows XP or above which requires IE7.0 or above.

### IV. CONCLUSION

Building an evaluation system for marine economy is necessary to improve the quality and efficiency of economic operations. The evaluation of marine economy is supervision, observation, calculation and analysis carried out by the government during the practical operation process of marine economy. Its purpose is to master the essence as well as broaden the horizons of operational

monitoring and evaluation of marine economy. The Liaoning marine economy evaluation system constructed by the author demonstrates well-rounded function, friendly interface, and stable operation after trial. The system well satisfies customer needs by carrying out operational monitoring and evaluation in provincial marine economy. The evaluation system will gradually improve and refine by incorporating other models such as clustering analysis-based Aquaculture yield data model, PCA-based fishery industry model, DEA-based agriculture efficiency model and other mathematical models to extend its application role as well as provide support for decision-making in the development of regional marine economy.

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