Analysis and Forecast of Construction Waste Based on ARIMA Model

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Abstract: In the construction waste output forecast, it is difficult for forecasting and reducing the accuracy of forecasting. In this paper, a method for estimating the yield of urban construction waste is built on the basis of building area, by using the ARIMA model to predict demolition area and the area of the building was completed, from the empirical coefficient method and indirect method to predict for construction waste production. Haikou as an example to calculate and predict the 2015-2020 years of urban construction waste output.

Overview of related forecasting methods for construction waste

In recent years, with the accelerated pace of urban construction, construction waste will be generated with a large number of production. According to the source of construction waste and the way of producing, construction waste can be divided into three categories, in the construction site of construction waste, public buildings and residential decorative decoration construction waste and housing demolition [1].

The muck from construction sites can basically reach the balance of supply and demand. The processed resources mainly for decoration waste, demolition waste and garbage remaining under construction. At present, the prediction model of construction waste generated mainly includes Multiple Regression Model, Grey Model and Time Series Prediction. Multiple Regression Model is used to combine the urban population, urban residents' income, and then to predict the future construction waste output [2]. Grey system processing is using a certain mathematical method to eliminate the influence which based on the analysis of the observed data the establishment of the system can make a prediction of the Gray Model [3]. Through the process of forecasting target's own time series to study the forecast target itself on the change trends, so the prediction of the future of the data is a Time Series Model Prediction method [4].

These existing estimation method, however, there are factors to consider not to comprehensive, the data quantity demand is high or relatively poor commonality problem and so forth. Therefore, it is necessary to build a set of general method for the estimation of urban construction waste output based on the existing conditions. The ARIMA model based on time series analysis method in this paper, introducing the difference parameters d, in order to solve the data loss caused by the imbalance in non-stationary time series.

ARIMA model calculus ideas

Determination of prediction methods should be flexible to choose according to actual situation. Through the investigation of the current situation of construction waste in Haikou, we know that there is no statistical data about the construction and decoration waste in Haikou. Analyzing the

statistical data of the direct relationship of the amount of construction waste contain the construction of the demolition areas and the decoration areas [5]. The use of the general construction's industry of the demolition and renovation of the unit area of construction waste generated, combined with the quantitative forecast future demolition, decoration area of construction waste production amount. That is:

$$S = \sum_{i=1}^{n=3} S_i \qquad (1) \qquad\qquad S_i = X_i\eta_i \qquad (2)$$

Where S is the amount of construction waste generated, S_i is for the classification of construction waste, X_i for the corresponding garbage construction area, η_i is the corresponding coefficient of garbage classification (Set decoration area = then existing housing construction area $\times$ 10%) [6].

The prediction model used in this research is **ARIMA** model, which is a relatively mature model, suitable for short-term forecasting and only for stationary time series. The process can produce some kind of a stable new time series, further improvements **ARIMA**(p, q) model, using the model **ARIMA**(p, q, d) model [7]. d is the number of the original time difference series when the non-stationary time series converted into stationary time series. Using **ARMA**(p, q, d) model fits the data in the process, in essence, is the first observational data differencing d times, and then fitting **ARIMA**(p, q) model.

ARIMA (p, q, d) mathematical form as follows:

$$\Phi_1(B)\nabla^d X_t = \theta(B)\varepsilon_t \qquad (3)$$

Where: t represents Time, X_i represents Response Sequence; B is the Backward Shift operator; V = 1-B; p, d, q, respectively, Regression order, Difference order and Moving Average order; $\Phi_1(B)$ represents Auto Regressive operator; $\theta(B)$ represents Sliding Average operator. In this paper, data processing and analyzing to fit **ARIMA** (p, q, d) through the SPSS 22.0 software

Results Analysis

Haikou city construction completion and demolition of the status quo

According to the definition of demolition waste, demolition area is the direct cause of rise in demolition of garbage output, but the decoration waste production is completed based on building process, and the amount of decoration of waste is closely related to the area of existing building area. Haikou construction completed residential area of the time series from 2006 to 2014 is shown in Table 1.

Table 1   Completed Residential Area In HaiKou m^2

Time	2006	2007	2008	2009	2010	2011	2012	2013	2014
Completed residential areas	802208	1300193	1136665	1178098	1288480	331743	3074168	1950092	3936635

Due to the lack of historical data in the area of the demolition of Haikou city, this study Haikou

city demolition area data acquisition refer to big city for completion of construction waste generation characteristics of the ratio of completion area and demolition area [8]. So we can estimate the Haikou demolition area number of historical and forecast data under demolition area and completion area coefficients.

Prediction of construction completion and demolition area of Haikou city

Data preparation process

This research adopts the SPSS 22.0 to analyze the data of the construction completion area of Haikou in 2006-2014, from the data of Table 1, it can be seen that Haikou construction completion area has not significantly increased or decreased trend, does not require a smooth processing of the data. So, $d=0$

Determination of coefficients for model

In order to find the best order, using the ACF, PACF figure and Akaike Information Criterion minimum (AIC), Schwarz-Bayes criterion (BIC) a combination of methods to determine the optimal order of the model [9]. According autocorrelation and partial autocorrelation (see Figure 1) can be seen, are expressed as tailing phenomenon for **ARMA** model, **ARIMA**(3,0,3) model initially selected.
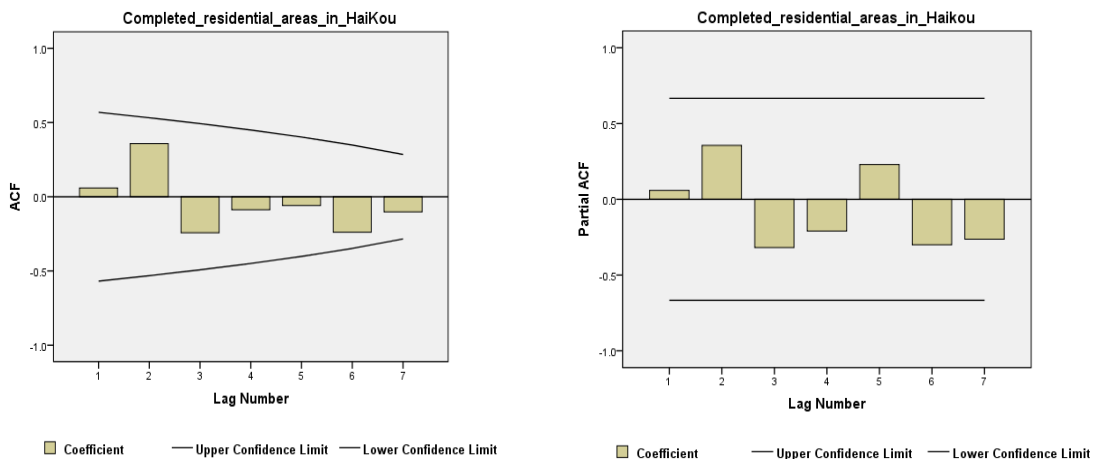

Figure 1 Completed residential areas sequence autocorrelation and partial autocorrelation

Suitability test sequence

Adaptability test of model is the sequence of the original data and the fitting error of the data sequence (residual sequence) corresponding test, see whether it is consistent with the actual situation, whether it can reflect the objective situation very well. We used the ACF and PACF diagrams of the residual series to test the white noise sequence. ACF diagrams and PACF diagrams of the residual sequence are shown in Figure 2. Figure 2 shows: the residual sequence is white noise

sequences, therefore, the model **ARIMA (3,0,3)** can be a good fit to the time series of Haikou city
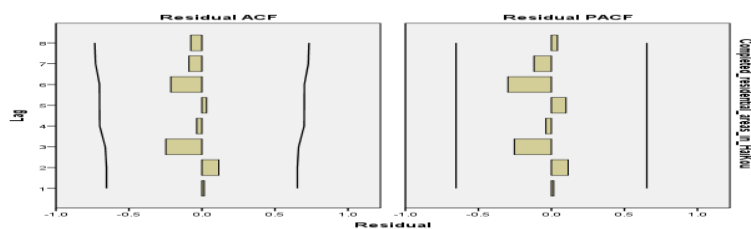
completed construction area.

Figure 2 residuals' autocorrelation and partial autocorrelation

Construction completion area forecast

With **ARMA** $(3,0,3)$ model to predict Haikou City construction completion area, thus the model predictions 2015--2020 Haikou City building completed in the area are shown in Table 2, 2006--2020 Haikou City construction completion area time series shown in Figure 3.

Referring to the characteristics of the large city construction waste generation with construction completed area and the demolition of the area of the coefficient (about 0.61) to estimate the demolition of the area of the time series of Haikou City shown in Table 3.
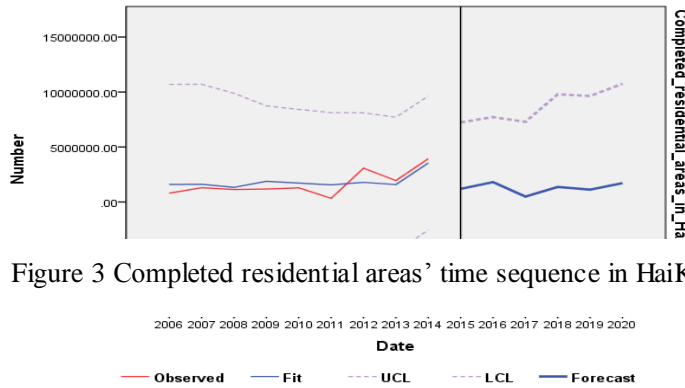
Figure 3 Completed residential areas' time sequence in HaiKou

Table 2 Forecast Completed Residential Areas In HaiKou						m^2
Model		**2015**	**2016**	**2017**	**2018**	**2019**	**2020**

	Model	2015	2016	2017	2018	2019	2020
Completed residential areas	Forecast	1195354.94	1807847.07	493399.48	1366776.07	1123854.83	1716941.82
	UCL	7242649.34	7723893.70	7290324.81	9797226.13	9638634.92	10749400.63
	LCL	-4851939.46	-4108199.55	-6303525.85	-7063673.99	-7390925.25	-7315516.98

Construction waste production forecast

According to the actual situation of the Haikou and statistics, the demolition areas forecast 2006-2014 demolition areas in Haikou as the basis. It is the existing housing construction areas in Haikou that the decoration areas can be project according to certain cycle as a basis. Combining with the construction budget law, with reference to the construction industry related information of this study is to take removal coefficient of $1.05t/m^2$ (demolition of construction waste production amount per unit area), under construction in the rest of the construction waste coefficient of 0.15 t/m^2.Decorate coefficient is $0.1t/m^2$ (decorate garbage output per unit area) [10]. The generated coefficient calculation of construction waste production is shown in table 3 according to the different types of construction waste.

Table 3 Construction waste production In HaiKou					kt	
Time	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
decoration waste	239.13	324.26	92.64	264.86	218.93	302.62
New residual waste	179.31	271.18	74.09	205.02	168.58	257.54
demolition waste	1212.62	1631.64	972.31	1037.22	689.84	874.33
total	1631.06	2227.08	1139.04	1507.1	1077.35	1434.49

The model prediction results

It can be seen from table 3 that the Haikou construction waste is mainly composed of demolition waste, accounting for more than 70% of the total construction waste produced, followed by decorate garbage, its production accounted for about 15% of the total construction waste, discharge the least is under construction in the rest of the trash, less than 10% of the total construction waste. Seeing from the characteristics of all kinds of construction waste, under construction in the rest of the construction waste, components is relatively single and pollution is small. Demolition waste is relatively fixed and the larger output category mainly contains concrete and broken block. Decorate buildings have mixed composition of construction waste, hazardous substances. So the management should be increased the demolition waste and the recycling of the waste harmless and decorate management efforts for construction waste.

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