FORECASTING MODEL OF INPATIENT IN INTERNA ROOM OF ALOEI SABOE GORONTALO HOSPITAL

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Abstract:

This study aims to predict the incoming and outgoing inpatients in Aloe Saboe Hospital Gorontalo, Indonesia by using ARIMA model transfer function. This research uses data in 2014 and found that the incoming and outcoming inpatients is affected by the incoming and outcoming inpatients the days before (t-1, t-2).

Keywords: Forecasting, Transfer function, ARIMA, Interna Room, Hospitalization.

1. Introduction

Urgent problems facing society and RS manager AloeiSaboe Gorontalo is the limited medical facilities and personnel, so much influence on the service aspect in the sense that you have to queue in the utilization of hospitalization room. In the face of the dynamics of health care in hospitals, dire need of planning by forecasting the number of hospitalized patients in and out in the internal room. One of the statistical analysis that allows to determine the development of one or several events and their relationship / influence on other phenomena are periodic data analysis [1]. Model that combines the approach to forecasting time series with a causal approach or correlation is a model which is very good equipment when there is a state or condition that meets [2]. This method is known as the Transfer Function Method combines some characteristics of univariate ARIMA models and some characteristics of the multiple regression analysis.

ARIMA has excellent accuracy for short-term forecasting and for non-stationary time series data at the time of the linear [3,4]. For data forecasting in a sufficiently long period accuracy is unsatisfactory because it will usually tend to be flat (constant). In addition ARIMA accuracy will decline if there is a component of nonlinear time series on observational data. ARIMA is not able to model the nonlinear time series [5]. Some literatures discussing about ARIMA can be seen at *Box et al*. (1994) [6].

Transfer function model is one model of a combined time series regression approach and time series (ARIMA) for the error. Dynamic regression model is one form of combination model and is often mentioned as a transfer function model in terms of Box and Jenkins (1994) [7],Fathurahman, M (2009)[8].Some research has been done using this transfer function such as by Mc Sweeny (1978) in Bowerman and O 'Connell. (1993) [9] to determine the effect of the enactment of a new policy in terms of local aid phone rates to the amount of incoming calls per month on average per day. Later Suhartono and Otok (2001) [10] conducted a study intervention model and transfer function model about business opportunities in Indonesia train services in facing the economic crisis.

ARIMA model is basically a special case in the issue, which is also a special linear testing technique [11]. Using the transfer function model for forecasting through testing a set of data, but the result is convincing when compared to the previous approach [12].

Moreover, the discussion of the implementation process of the transfer function analysis is still somewhat limited, especially in terms of the autocorrelation analysis as key to the transfer function, both found in the book (Assauri,1984), and in the book of Time series Analysis, Univariate and Multivariate Methods [13] so it is often difficult for the user or practitioner in performing the calculations or hypothesis examination.

2. Research Methods

This research is an analytic to obtain forecasting version of the transfer function equation by using secondary data at AloeiSaboe hospital in Gorontalo province.

The research variables which will be discussed in this article are the patients who entered as input (X), and patients who came out as the output (Y).To avoid stationary in the independent variable X and the dependent variable Y also in terms of identifying models that are used to plot the data, supported by the calculation of autocorrelation rk, which describes the relationship between the time series with the time series itself at slowness of time (Lag) k period and coefficients partial autocorrelation is used to assist in determining the right model. In terms of data processing program to be used is the S-Plus program package SPSS.

3. Results

3.1 Data About Inpatient

Data about inpatients in AloeiSaboe Gorontalo hospital taken based on data on the number of patients in $(X_t)$and out $(Y_t)$of the medical records.

The data were analyzed according to the unit of time (t) day that, Data on patients hospitalized in 2014 Interna room for 1-7 days can be seen in Table 1 below with n = 2640 observations.

Table 1: Data patients hospitalized in 2014.

Period of Inpatient	Total Inpatient
1 day	202
2 days	368
3 days	453
4 days	472
5 days	409
6 days	357
7 days	379

Data sources: AloeiSaboe Gorontalo Hospital

These results can be seen in Figures 1 and 2 below.
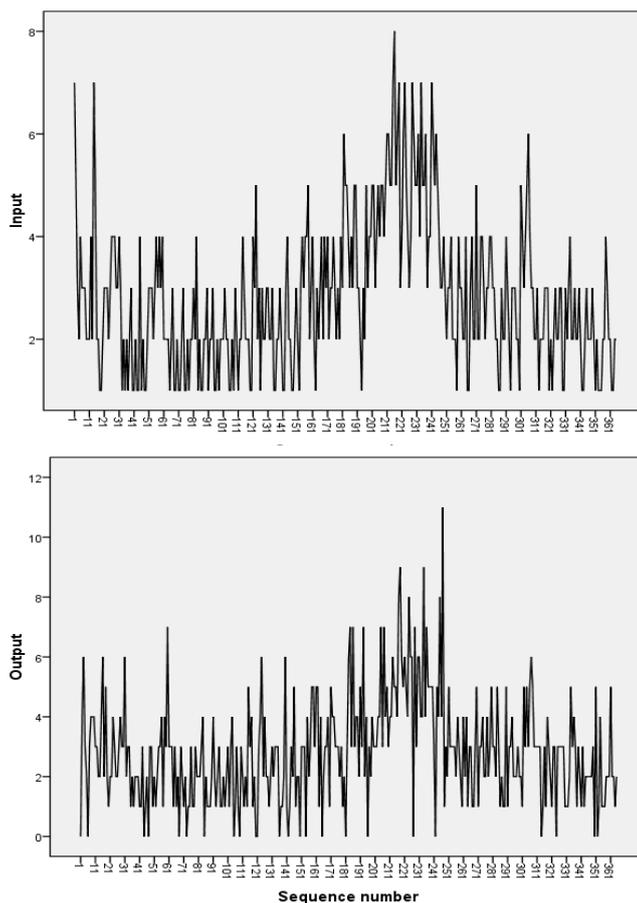
3.2. Analysis and the research r

Step 1: Identification X1 model and "prewhitening" at xt and yt

The input and output series is number of incoming and outcoming inpatients in aloeisaboe hospital. In this case using transfer function model to know the relation between xt and yt itself. In this level, it can be seen that the data is not stationary, and it should be changed to be stationary using the difference = 1 (first f differencing) to input and output series so the result will be stationary.

Step 2. Identify the initial model transfer function

1. The cross-correlation between the input and "output" series which has been "prewhitening"

After whitening on the input and output series, the next step is to calculate the cross correlation values between the input and output series. From the results of the cross-correlation plot shows that the input data series began influence the output series at the second lag so that it indicates that the data has been stationary. It also can be shown that the input series began affecting the output series until the lag 1. It shows there's a delay of patients who entered one day before affecting the patient out.

2. Parameters Estimation of Temporal and Final Models

Based on the temporal model derived from the identification phase, the model parameters estimated. The parameters estimation result can be seen on table 2 below.

Table 2: The parameters estimation resultof ARIMA (0,1,2) input model

Parameter	Estimasi	Std. Error	T. hitung
Θ_1	0,58022	0,05196	11,17
Θ_2	0,15899	0,05198	3,06
Constanta	-0,0099	0,01567	-0,63

After determining the temporal model from identification phase, then it can be obtain the transfer function model equation of ARIMA (0,1,2) : Yt = -0,0099 + at-0,58 a_{t-1} - 0,159 a_{t-2}, whereYt = Zt-Z_{t-1}.

Model (0,1,2) generated above, was already meet the stationarity. It can be seen on table above wherein the parameters Θ_1 and$\Theta_2$of 0,58021 and 0,15899already meet the restrictions-2 <Θ_1<2, and -1 <Θ_2<1.Therefore the analysis can be continue in step 3: Identifying the final model.

Step 3.Identifying the Final Model

Diagnostic Examination

1. Analysis of residual values at: Autocorrelation

Making plot residual (waste) on the graph ACF is supporting the statement that the series at essentially a random noise because there is no obvious pattern that strengthens the opinion that the residue - (waste) have decent behavior for modeling

2. Analysis of residual values: Cross Correlation

Therefore the value of the autocorrelation cross = 0, so that it can be concluded that the transfer functionmodel in the above equation meets the assumptions of independent between α_t da at.

Final model of transfer function residual obtained after residual at testing for randomness, and between at and input is also checked for randomness. Therefore autocorrelation and cross correlation value is equal to zero randomness means. The final model of the transfer function is:

$$x_t = (1\text{-}0{,}58022\ B - 0{,}15899\ B^2)\ \alpha_t$$

$$y_t = 0{,}00225849 + (0{,}45784 - 0{,}11522\ B^2)\ x_t + \frac{(1-0{,}9463)}{(1+0{,}28746)} \alpha_t$$

It turned out that the value of the parameter as a result of analysis of existing data in modeling is very significant or narrowed according to the triangle above.

4. Discussions

In accordance with the problems and research objectives so in this chapter will be discussed as follows: Establishment / model selection in transfer function model includes four stages: stage model identification Xt and "prewhitening" on xt and yt, identification of initial model of the transfer function and identify the final model

4.1. Step 1. Identify the model Xt and "prewhitening" on xt and yt

Based on the estimation model that has been chosen and discussed in this study is the most related model that is ARIMA (0,1,2)because the standard error is smaller than ARIMA (1,1,1). Therefore, the selected model is ARIMA (0,1,2) then this means that the input variables (patients who entered tend to undergo hospitalization time for 2 days in the AloeiSaboe hospital.

Based on the input series model has been prewhitening, ARIMA (0,1,2), it will obtain the input series$\alpha_t = x_t + 0{,}58x_{t-1} - 0{,}159\ x_{t-2}$ - 0,0099. After whitening an input series, whitening will be performed also on the output series. Before performing the whitening of output series will be seen whether the output series has been stationary. It turned out that the value of ACF and PACF it has to zero after the second lag indicating that the data is stationary, then the whitening as carried out in the input series is to observe the value x_t and y_t thus obtained $\beta_t = y_t + 0{,}58y_{t-1}$ - 0,519 y_{t-2}- 0.0099. To study the relationship between input and output, the key is to calculate the cross-correlation between the two series. In this case the input series is assumed to specify the output series. If note that almost all of the cross-correlation values for k = -1 to k = -15 per se = 0. Then when the time difference is 1 day, cross correlation = 0.15259 and for the second day of the cross-correlation = 0.28347.

4.2. Step 2. Identify The Initial Model of Transfer Function

From the results of the cross-correlation plot shows that all of the input series began effecting theoutput series in the second lag, and only up to the third lag, then the value b = 2. This shows there is a delay time of admission two days

before it affects the patient out. Due to the influence of the input series only 2 lag so it will obtain the value s = 2 and r = 0. After determining r, s, b, we will estimate the initial parameters ω_0, ω_1, ω_2, in order to obtain the transfer function model equation:

$$y_t = (-0,0099 + \text{at} - 0,58\, a_{t-1} - 0,159\, a_{t-2} + n_t)$$

From the above model should be seen the noise value whether random or not. It turned out that the computer output series shows that noise has been random. Final estimation of transfer function last parameters to be estimated as a whole is ω_0, ω_1, ω_2, ϕ, Θ. From the results of the residuals autocorrelation plot and residual correlation with input x. Then thecomplete transfer function final model obtained is as follows:

$$x_t = (1\text{-}0,58022B) -0,15899\ B^2)\ \alpha_t$$

This means that the number of entered patients now influenced by a constant value of 1 minus 0.58022 times the number of patients who entered 1 day ago minus 0.15899 times the number of patients entered two days ago, coupled with a current error value.

$$y_t = 0,00225849 + (0,3539 - 0,45784B - 0,11522B^2)\ x_{t-1} + \frac{(1-0,9463)}{1+0,28746}\alpha_t$$

This means that the number of entered patients now influenced by the constant 0.002584plus 0.45784 times the number of patients who entered 1 day ago minus 0.11522 times the number of patients who entered 1-7 days ago plus the fault current. Based on the data analysis result, the results of data collection and interviews that have been conducted with community and hospital personnel that:

1. The average inpatient only for 3-5 days (50.53). It can be assumed that this is caused by:
a. Their boredom inpatients to stay longer in RSUB Gorontalo
b. Their low economic pressures.
c. Their facilities were lacking.
2. Appropriate observations and interviews that inpatient hospital more chose private than Aloei Saboe Hospital. It is caused by several factors, among others are:
a. The existence of public discontent in service
b. Medical support facilities inadequate

5. Conclusions

Forecasting the incoming and outcoming inpatients can be one of the solutions to for the Aloeis Saboe hospital facilities and managing problems. By using the transfer function ARIMA, the result of this research found that the incoming and outcoming inpatients are affected by the incoming and outcoming patients days before (t-1, t-2)

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