Drug Usage Prediction in Teaching Hospitals using Neural Network and Adaptive Splines Threshold Autoregressive

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***Abstract*—**Hospital stock prediction is one of health management system that is required to improve hospital services. In this study, the drug usage prediction is conducted using Artificial Neural Network (ANN) and Adaptive Splines Threshold Autoregressive (ASTAR) methods where predicted medicine types are Aquadest 25 ml, Aspilet Chewable and EcosolNaCl. Input and output parameters in this paper is thenumber of daily usage of drug. Experiment results showed that the RMSE value of Aquadest 25 ml for ANN, ASTAR and Hospital prediction is 8.84, 8.97 and 13.921. As well for Aspilet Chewable, the consecutively RMSE values of ANN, ASTAR and Hospital prediction is 29.94, 151.87 and 110.74. As for EcosolNaCl, ANN has RMSE value of 2.39, ASTAR with 16.34, and Hospital prediction comes with 27.47 of RMSE value**.**

Index terms -prediction; artificial neural networks; adaptive splines threshold autoregressive; drugs usage; pharmacy installation; teaching hospital

I. INTRODUCTION

The management process of hospital logistics are involving supplier selection, purchase, transportation, storage (warehouse), waste treatment and disposal. These things affect not only financial and hospital economic efficiency, but also on medical services success [1]. Pharmacy installation is one of hospital unit with greater contribution than the other units since 90% of health care is using pharmaceutical logistic supplies. Moreover, 50% of overall income gained from the hospital pharmacy installation. Therefore, if the pharmacy supply management is not done properly, then the hospital income and services will be disrupted.

Nowadays, drug procurement is done collectively and conducted annually in according to the logistics procurement schedule in teaching hospitals. These issues definitely would be a problem because the demand of every drug type depends on the hospital needs within certain time. Medicine procurement planning that does not follow the hospital needs would open a gap of hospital losses. Drugs contain expired possibility due to rare usage or purchase long before these drugs are frequently used, called stockout. On the contrary, the lack of drug stocks possibility when the service demand increased yet procuring schedule is not anytime soon, also called drug stagnant. Therefore, the teaching hospital requires a prediction system to identify drug usage trends so as to minimize losses and decrease of hospital services [2].

Studies related to prediction system has been carried out by several researchers. In the previous study, the drug usage prediction is conducted by using Artificial Neural Networks. As a system improvement, predictions will be made by Adaptive Splines Threshold Autoregressive method. The selection method based on the result of research that ASTAR has the best performance with slightly gain form GA-NN in both RMSE and following trend of prediction to actual [4].In this paper, ASTAR and ANN are used for forecasting the drug usage. The comparison of accuracy will be measured from RMSE value.

II. RELATED WORK

MirnaAndriani, et.al. [2] have predict the drug use in teaching hospital using Backpropagation Neural Network. This research concluded that the results of predictionon Aspilet, BPNNshows the valueof the correlationcoefficientof0.96952andMSEvaluesof0.00012512.The prediction for Aspilet use BPNN is 12249, hospital's predictionis 9232andthe actual data is 11565.

Cao Qingkui, et.al [3] introduced the inventory control background of the DapingHospital of Third Military Medical University (CQDPHospital) and screened out the main influencing factors of theusage of 17GY scalp indwelling needles, and then applied datamining technologies including data cleaning, data integrationand data transformation to pre-process the original data,obtaining the training samples for BP neural network, andfinally built an inventory forecasting model based on BPneural networks, using the sample data for training to get theinventory forecasting network construction, and carried outthe stock prediction in a certain period of the future, whichprovided basis for decision-making.

Indrabayu, et.al [4] proposed a new idea in comparing two common predictors i.e. the statistic method andartificial intelligence (AI) for rainfall prediction using empirical data series. The statistic method uses Auto-Regressive Integrated Moving (ARIMA) and Adaptive Splines Threshold Autoregressive (ASTAR), most favorablestatistic tools, while in the AI, combination of Genetic Algorithm-Neural Network (GA-NN) is chosen. The resultsshow that ASTAR gives best prediction compare to others, in term of root mean square (RMSE) and following trendbetween prediction and actual.

III. Artificial Neural Networks, Multiple Adaptive Regression Splines

A. Data Classification

Before doing the training and prediction process, formerly perform data classification. In this study, there are 2059 kinds of hospital drug consumption data in 2014. For research purpose, used three drug types of fast move category which also means that this type of medication is used regularly. Another consideration is such three drugs covers complete history of usage since 2013, compared to other drugs that only used recently since the middle of 2014. All three drug is Aquadest 25 ml, Aspilet Tablet, and EcosolNaCl.

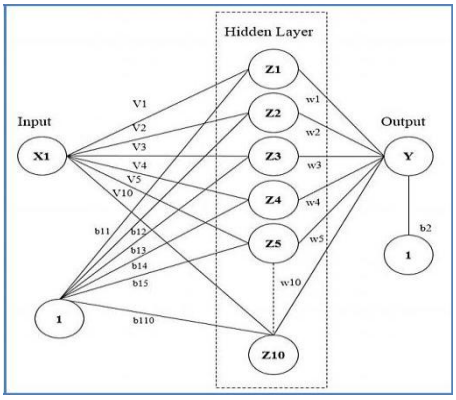
Training data used are daily usage data from January 2013 to December 2014. While the test data used is the daily usage data of January 2015 to March 2015.

B. Artificial Neural Network

Artificial Neural Network (ANN) is an approach that is different from other AI methods. JST is an intelligence model inspired by the human brains structure then implemented using computer program which able to resolve a number of calculation process during the learning process. ANN is commonly used for modeling non-linear statistical data, modeling complex input-output relationships development or data model exploration. One of ANN advantages that it is capable of describing relationship situation between the predictor variables (independents, inputs) and predicted variables (dependents, outputs), when the relationship is very complex and hardly describe in general terms.

C. Backpropagation Neural Network Architecture

BP Neural Network (BPNN) relies on gradient algorithm to acquire the weight of the model and reuse backpropagation algorithm to minimize the objective function. BPNN usually consists of three layers: input layer, hidden layer and output layer.[5] BPNN is the currently the most representative and most commonly used ANN. BPNN use the steepest descent method to adjust the network parameters to determine more accurate solutions by iterative computing [6].



This experiment use one input with daily drugs usage data that applied to both training and test data. Hidden layers used is ten and generatedone output value. Neural Network architecture used in this study are shown in Fig. 1 below.

Fig. 1. Used Neural Network Architecture

In the training process, the parameters used are error tolerance = 0.0001, Learning rate = 0:08 and training Functions = trainrp(resilent backpropagation). Whereas evaluating network training results, system testing process is done by changing epoch value in which the number of neurons in hidden layer, and the value of other parameters fixed. The best results are obtained when epoch value is 2000. The prediction flow of the drug usage with ANN method shown in Fig. 2.

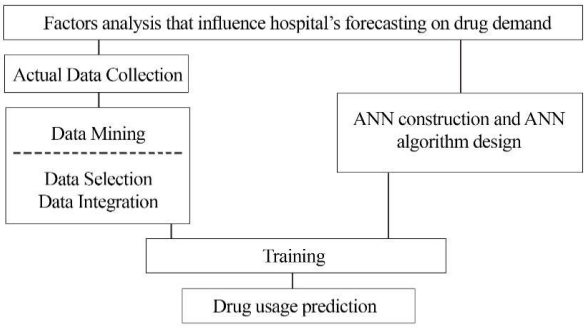


Fig.2. Drugs Prediction Flow with ANN

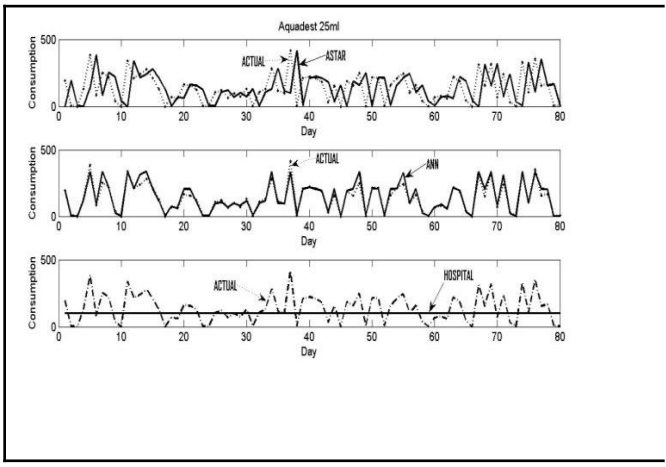
D. Adaptive threshold autoregressive (ASTAR)

ASTAR method is the advance techniques of *Multivariate Adaptive Regression Splines (MARS)* which can form a model with limit cycle when time series data model showed periodic behavior [7]. The ASTAR prediction flow in this study are shown in Figure 3.

On the initial stages, independent variable and coefficient values are inputted in the following regression equation.

(1)

At the ASTAR



forecasting stage, the Y value (dependent variable) is obtained by using existing X value (independent variable). To assess the system performance in this study used the RMSE value and correlation coefficient *(r)*. RMSE values to calculate use following equation [4].

$$= \frac{1}{} - \hat{y} \qquad (2)$$

Where y_t is the actual *data*, y_t is the prediction value, and N is the number of data.

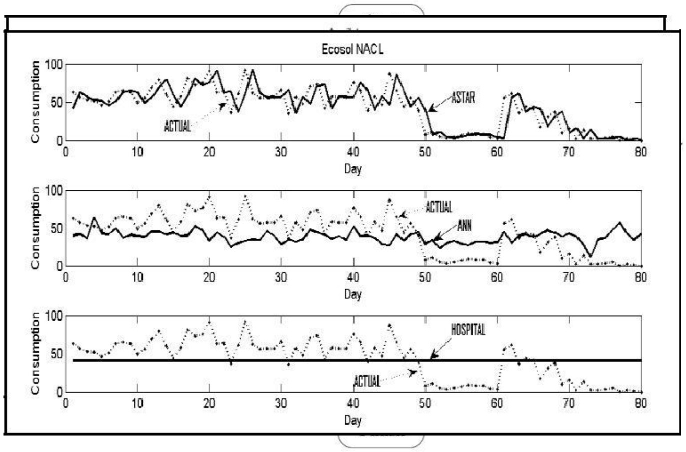


Fig. 3. Flow Design Prediction with ASTAR

IV. RESULT AND DISCUSSION

The result of consumption prediction from all three types of drug with ASTAR, ANN and Hospital prediction is shown in Table 1. For comparison chart of daily prediction using ASTAR, ANN, Hospital prediction, and actual data for Aquadest 25 ml, Aspilet Chewable and Ecosol NACL is shown in Fig. 4, 5, and 6.

Table1. Prediction result comparison of ANN method and ASTAR method

	Pred	Jan – Mar	RMSE
Aquadest 25 ml	Actual	3053	
	ASTAR	3045	8.97
	NN	3041	8.84
Aspilet Chewable	Actual	10952	
	ASTAR	10946	151.87
	NN	11592	29.94
EcosolNaCl	Actual	3397	
	ASTAR	3439	16.34
	NN	3378	2.39

Based on the results in Table 1, ANN method gives more accurate prediction with RMSE value 8.84 for Aquadest 25 ml, 29.94 for Aspilet Chewable, and 2.39 for Ecosol NACL, compare with ASTAR method with value 8.97 for Aquadest 25 ml, 151.87 for Aspilet Chewable, and 16.34 for Ecosol NACL.

Fig. 4. Comparison chart of daily prediction using ASTAR, ANN and Hospital predictions with actual data forAquadest 25 ml consumption

Fig.5 . Comparison chart of daily prediction using ASTAR, ANN andHospital predictions with actual data for Aspilet Chewable consumption

Fig. 6 . Comparison chart of daily prediction using ASTAR, ANN and Hospital predictions with actual data for

Fig. 4, Fig. 5 and Fig. 6 above shows daily prediction from January 2015 until March 2015. Based on figures above, it can be seen that ANN method gives better accuracy than ASTAR method. ANN method can follows the pattern of drug use actual data. The blue line shows the prediction of ASTAR, red line is predicted ANN method and the green line is actual data.

The result shows that ANN method capable for better prediction compare with ASTAR and Hospital prediction. In the previous related studies, ASTAR method in some cases gives better result than ANN method. However, for drugs consumption case, ANN method in fact give better prediction compare with ASTAR. This case shows that ASTAR is more suitable for large data while ANN properly with both large data and small data.

However, specifically for both Artificial Intelligence method used in this study, either ANN or ASTAR, both gives more accurate prediction value. Based on this result, hospital can used Artificial Intelligence method for supply and demand planning so that stock out case possibly can be avoided.

VI. CONCLUSION

Basedon the results of a prediction using a drug consumption data, it is shown that the methods of artificial intelligence can be used to predict the hospital needs. Prediction using ANN and ASTAR gives more accurate results than the conventional prediction of teaching hospital.

REFERENCES

[1]. Wen Yan, Liu Zixian, and Liu Junlan. *Logistics Mode Reengineering of Hospital Materials Based on JIT Theory*. IEEE Logistics Systems and Intelligent Management, 2010 International Conference. 2010; 2:1039 - 1042

[2]. MirnaAndriani, IndrabayuAmirullah, Intan Sari Areni. *Drugs Usage Prediction in Pharmaceutical Installations of Teaching Hospital using Neural Network*. Dielektika, SSN 2086-9487. Vol.2, No. 1:77-80, February 2015

[3]. Cao Qingkui, RuanJunhu. *Study on the Demand Forecasting of Hospital Stocks Based on Data Mining and BP Neural Networks*. IEEE International Conference on Electronic Commerce and Business Intelligence 2009; 978-0-7695-3661-3/09

[4]. Indrabayu, N. Harun, M.S. Pallu, and A. Achmad. *Statistic Approach versus Artificial Intelligence for Rainfall Prediction Based on Data Series*. International Journal of Engineering and Technology. Vol 5 No 2 Apr-May 2013

[5]. Li Cheng, Jin Liu. *An Optimized Neural Network Classifier for Automatic Modulation Recognition*. TELKOMNIKA Indonesian Journal of Electrical Engineering. Vol.12, No.2, February 2014, pp. 1343 ~ 1352

[6]. Han-Chen Huang. *A Hybrid Neural Network Prediction Model of Air Ticket Sales*. TELKOMNIKA, Vol.11, No.11, November 2013, pp. 6413~6419

[7]. Sutikno, dkk. *Weather Forecast using Autoregressive Integrated Moving Average, Neural Network and Adaptive Threshold Autoregression Splines at Juanda Station Surabaya*. Dirgantara Science Journal Vol. 8 No. 1 December 2010: 43-61