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IMPLEMENTATION OF ARTIFICIAL NEURAL NETWORK FOR STATE – OWNED ASSETS FORECASTING OF ROOM RENTAL PRICES IN INDONESIA

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Abstract

Leasing is a state-owned assets utilization scheme that needs to be optimize because of its easy to find objects and large potential for non-tax revenue. In the city of Yogyakarta, the economy grows above the national average, this is supported by the mobility of tourists, overseas students, and businessman. The characteristics of the regional economy are suitable for the optimization of state-owned assets through leasing scheme in the form of lodging room. The author tries to develop a state-owned assets leasing price forecasting model for lodging room using an Artificial Neural Network to capture the potential state revenue. By using market data for lodging room rental from the OYO website, author create a model architecture with the backpropagation algorithm. Analysis results of this study indicate that the obtained network model achieves an accuracy of 97.5%. There are 25 state-owned assets buildings that can be projected as objects of lodging space rental utilization with a predicted rental value of IDR 108,570.00 to IDR 122,669.00 per day.

***Keywords**:* Artificial Neural Network, State-Owned Asset, Non-Tax Revenue, Yogyakarta

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INTRODUCTION

Lease is one of the most common utilization schemes for State Property. The rental mechanism also contributes more non-tax revenue (PNBP) than other BMN utilization schemes. As an illustration, in the 2019 central government financial report, revenue from rental utilization was recorded at 251,296,665,000 rupiah or around 45.42% of the total revenue sourced from the use of State-owned assets (BMN) (Indonesia, 2020). Meanwhile, 99.73% of the revenue was obtained from BMN leases in the form of land and buildings.

The implementation of the lease should be encouraged to be more active in order to obtain optimal utilization of BMN (Management, 2019). To achieve this, potential exploration needs to be done. The potential exploration carried out includes the identification of business opportunities and potential BMN. The implementation must consider the provisions related to the assessment in the context of the utilization of BMN. In practice, the efforts to explore potential encounter constraints of time and personnel constraints.

Based on the considerations above, to support the activity of extracting the BMN leases potential, a fast analysis method that is able to accurately represent the rental potential is needed. The Artificial Neural Network (ANN) is a branch of Artificial Intelligence. The ANN is an information processing system resembling a biological neural network (Fausett, 1994). Several applications that can be generated by ANN include pattern recognition, signal processing, and forecasting.

ANN has given the best results among several mass valuation models that are used to predict property values effectively (Yacim & Boshoff, 2016). In addition, the advantage of ANN as a property valuation model is that its construction allowing the use of a small data sample (Abidoye & Chan, 2017). Based on this description, the ANN approach is considered suitable to be applied as a predictive tool in the assessment in order to explore the potential utilization of State Property rental because it can provide fast and accurate analysis.

The online travel agency (OTA), Pegipegi, conducted a survey in collaboration with the international survey agency, YouGov. The survey, which was held in 2019, was conducted on more than 2,000 respondents spread throughout Indonesia to find out the traveling preferences of the Indonesian people. In this survey, Pegipegi found three types of preferences for Indonesian people's favourite tourist destinations. The survey results show, 78% of respondents choose to travel to destinations that offer beautiful views, 62% choose to travel to destinations with affordable costs, and 51% choose to travel to destinations that have cultural and historical heritage (Agmasari, 2019).

Referring to the survey results above, the city of Yogyakarta seems to be one of the alternatives that meet the preferences of potential tourists. It is found to be correlated with the low living cost in Yogyakarta, the number of natural

tourist destinations around the city, as well as the cultural and historical sites that have been attached to the image of this city (Yogyakarta City Tourism Office, 2019). In addition, the city of Yogyakarta has long been one of the favourite tourist destinations for both domestic and foreign tourists.

Yogyakarta, one of major city in Indonesia, is a city that has high mobility bustling with tourists, students and overseas students, as well as business people. This high mobility is one of the driving factors for economic activity in the city of Yogyakarta. Data from the Central Bureau of Statistics of the City of Yogyakarta shows that the economy of the city of Yogyakarta in 2019 grew 6.6%, higher than the national economic growth rate of 5.02% (Yogyakarta City Statistical Center, 2020).

The good economic growth and a high level of mobility due to tourism activities and several other activities are opportunities for the lodging business sector. In this case, the city of Yogyakarta is also often the activity centre for the central government work units because of its strategic location. There are at least 5 training centres with dormitories belonging to Ministries/Institutions around the city of Yogyakarta. Some of these conditions are opportunities in boosting the utilization of State Property rental through renting lodging rooms in the city of Yogyakarta.

LITERATURE REVIEW

State-owned assets, land and buildings, rental valuation using a market data approach

The factors compared in the rental valuation with the market approach are highly dependent on the type of use/utilization of the building/space and are adjusted to the characteristics of the object of the assessment. Adjustment factors with lodging objects can be and are not limited to the following items: transaction time, type of transaction, rental period, lodging location, lodging accessibility, type of lodging, material and interior design, lodging facilities, room size, surrounding view, type of accommodation. room, room facilities (The Director General of State Assets Management Regulation Number 4/KN/2018 Concerning Technical Instruction for Valuation of State Assets Lease, 2018).

Artificial Neural Network

ANN is a tool designed to resemble the human brain that aims to carry out a certain task (Haykin, 2008). The term 'artificial' or ‘imitation' is used because neural networks are implemented using computer programs to solve problems and carry out learning in the process (Fausett, 1994).

ANN that has been exposed to the data will be able to make predictions by detecting the similarity of the input data pattern. ANN is not an exact duplication of the biological system of the human brain, but this artificial neural network can perform abilities such as generalization, learning, abstraction, and even intuition. The ability of ANN is quite good, as evidenced by several ANN

applications, it is very suitable to be applied to classification, association, self-organizing, and optimization (Hermawan, 2006).

ANN mimics the computational principles of biological neural networks found in the human brain. Human brains have a neural network of about 1011 nerve cells (neurons). In ANN, a neuron is assumed to a node functioning as a data processing element. The relationship between nodes in the ANN is obtained from the connection weight (weight) which models the synapses in the human brain neural network (Sudarto, 2002).

The concept of ANN can be observed from its working model in the form of the number of layers and the number of neurons. The layers making up the multilayer ANN are divided into three, the input layer, one or more hidden layers, and the output layer. The neurons located in the same layer will have the same state. The most important factor in determining the behaviour of a neuron is its activation function and weight pattern (Fausett, 1994). In each of the same layers, the neurons will have the same activation function. The neurons in one layer are connected to neurons in another layer, so that every neuron in that layer must also be connected to each neuron in another layer.

Activation function

The activation function is a function used to process input information. As an illustration, the activation function can be seen in Figure 2 below.

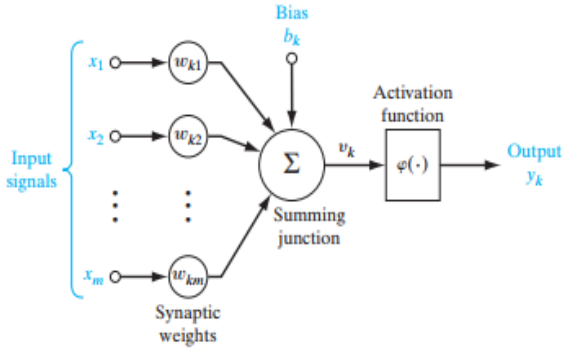

Figure 1: ANN Structure
Source: Haykin (2008)

Based on the ANN structure above, the transfer function functions to change a number of inputs (x_1, x_2,… x_m) which have weights (w_k1, w_k2, . . . w_km) and are biased into input values (v_k) for the activation function. Furthermore, the activation function processes the input value to be compared with the specified threshold and activates the value into output (y_k) (Haykin, 2008).

Backpropagation learning algorithm

Rumelhart, Hinton and William in 1986 first introduced an artificial neural network with a backpropagation algorithm which was later developed by Rumelhart and McClelland in 1988. Generally, an artificial neural network with a backpropagation algorithm is designed to operate on supervised learning methods. learning) with many layers (multi-layer network) which at least consists of input layer, hidden layer, and output layer (Haykin, 2008).

There are three stages in backpropagation training, including feedforward, backpropagation of error and weight and bias modification (Fausett, 1994). The way backpropagation works is first to look for the output error in a forward direction to correct the weights which is then carried out in a backward direction. At the time of forwarding there will be an activation function that will activate the neurons to produce output. The activation function used in backpropagation is generally continuous, differential, and does not descend like the sigmoid activation function.

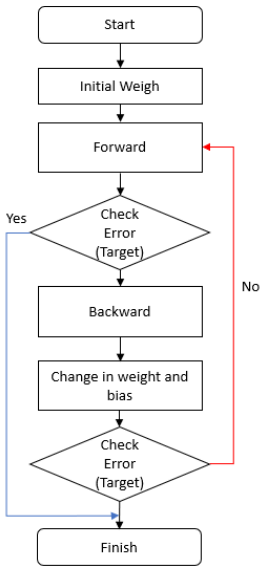

Figure 2: Stages of Backpropagation Learning Algorithm

Data normalization

In this backpropagation ANN algorithm, a binary sigmoid activation function is used where this function has a value between 0 to 1. Therefore, the data needs to be normalized first using the equation below:

$$E_i' = \frac{e_i - E_{min}}{E_{max} - E_{min}}$$

Meanwhile, to get results that match the original data form, the model output is denormalized using the equation:

$$e_i = E_i' \, (E_{max} - E_{min}) + \, E_{min}$$

RESEARCH METHODS

Research population

The object of research used is all data on lodging rental offers in the city of Yogyakarta and surrounding areas on the OYO website. In addition, several State-Owned Assets that meet the criteria for optimizing their use through lodging room rentals are then simulated for rent price predictions based on the ANN model formed from training on lodging rental price forecasting data. There are 51 data of lodging rental offers trained to simulate the rent price of 25 state-owned.

The types of BMN that are projected as objects of rental use include permanent dormitories, permanent resting places, and permanent flats. The location of the building is in Yogyakarta City and Sleman Regency which is located on the border of Yogyakarta City. In addition, the selection of locations also avoids objects that are in places where the work unit has duties and functions in the defense and presidential fields. The condition of the goods used in this study also only involved goods that were in good condition.

Research variable

In building the ANN model for forecasting the rental price of lodging rooms, it is necessary to determine the variables in the input layer and output layer. Based on the available information, with the scrapping method, the researcher draws information that is considered to affect the variable (Y), namely the rental price or the bid price. The extracted information is then used as the required supporting variable (X). For each of the lodging rental price forecasts, the supporting variables used include: accessibility (road width), location (area and distance to tourist centers), building structure, interior design, room area, room furniture, toilets, and other facilities (refrigerator, water heater, room service, swimming pool, fire extinguisher/ CCTV, generator, parking area, 24-hour reception).

Determination of operational variables for forecasting rental prices for lodging in the city of Yogyakarta and its surroundings is carried out by considering the factors compared in the valuation of the rental of part of the land and buildings in accordance with The Director General of State Assets

Management Regulation Number 4/KN/2018 Concerning Technical Instruction for Valuation of State Assets Lease, 2018, characteristics of the city of Yogyakarta, and information available on the website for lodging rental offers.

Research Framework

This study aims to develop the most accurate ANN model in forecasting accommodation rental prices. The model that is formed is then simulated against BMN data which is projected as the object of the use of lodging rentals to then know the prediction of the rental price.

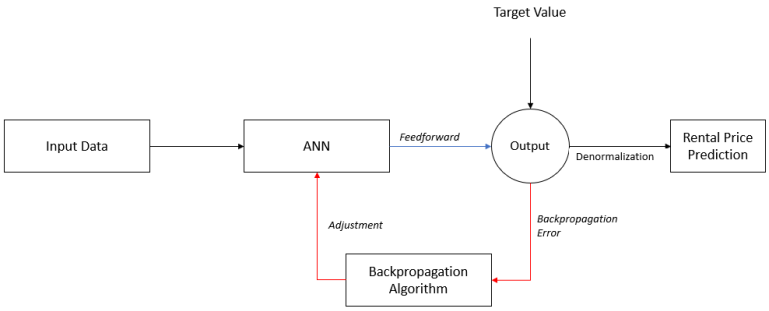

Figure 3: Research model

The preparation of the ANN model is done using the backpropagation algorithm (Fausett, 1994). When the training process on the backpropagation algorithm has been fulfilled, the weight pattern in the network has formed the best model. Under these conditions, the activation function integrates the input values and transfers them to the hidden layer. Operations in the hidden layer in the form of weighted addition and transformation function produce the value *Zj*. The *Zj* value can be formulated as follows

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$$Zj = f(V_{0j} + \sum_{i=1}^{m}\sum_{j=1}^{n} X_i V_{ij})$$

for (i = 1, …, m dan j = 1, …, n)
Information
Zj = output value in hidden unit -j
f = nonlinier function
V_{0j} = bias weight on hidden unit -j
X_i = sum of the output values of the input units -i
V_{ij} = the weight of the input unit against the hidden unit-i

To get the output value, the value of Z_j is transferred to the output layer so that the output value can be calculated through the following equation:

$$Yk = f(W_{0k} + \sum_{j=1}^{n}\sum_{k=1}^{p} Z_j W_{jk})$$

for (k = 1, …., p dan j = 1, …, n)
Information:
Yk = output value in hidden unit -k
f = nonlinier function
W_{0k} = bias weight on hidden unit -k
Z_j = sum of the output values of the input units -j
W_{jk} = hidden unit weight to output unit

The weight value composing the two equations is the result of weight modification to produce the best model, namely the model with the lowest error value. The weight is the result of a modification of the backpropagation algorithm processing. Meanwhile, to obtain a rental price prediction, a denormalization process of the output data is carried out to the original form.

FINDING AND DISCUSSION

Based on the trial of the formation of a lodging rental price forecasting model using an Artificial Neural Network backpropagation algorithm, the best model was achieved with a MAPE value of 1.47%. Meanwhile, the determination of neurons in the hidden layer as the basis for testing the formation of the model is set at 2/3 part of the number of input and output neurons (Heaton, 2017).

Table 1: MAPE Value Resume on ANN Model Formation Test

Scenario	Number of Neurons in Hidden Layer	MAPE Value
1	11	3,51%
	12	1,47%
2	6	3,93%
	7	4,59%
3	6	5,12%
	7	4,63%

The architecture for the ANN model that is formed based on the lowest MAPE value is presented in Figure 4. The daily lodging room rental price forecasting model consists of three layers consisting of 16 neurons in the input layer, 12 neurons in the hidden layer, one neuron in the output layer, and each there is one bias neuron that leads to the hidden layer and output layer.

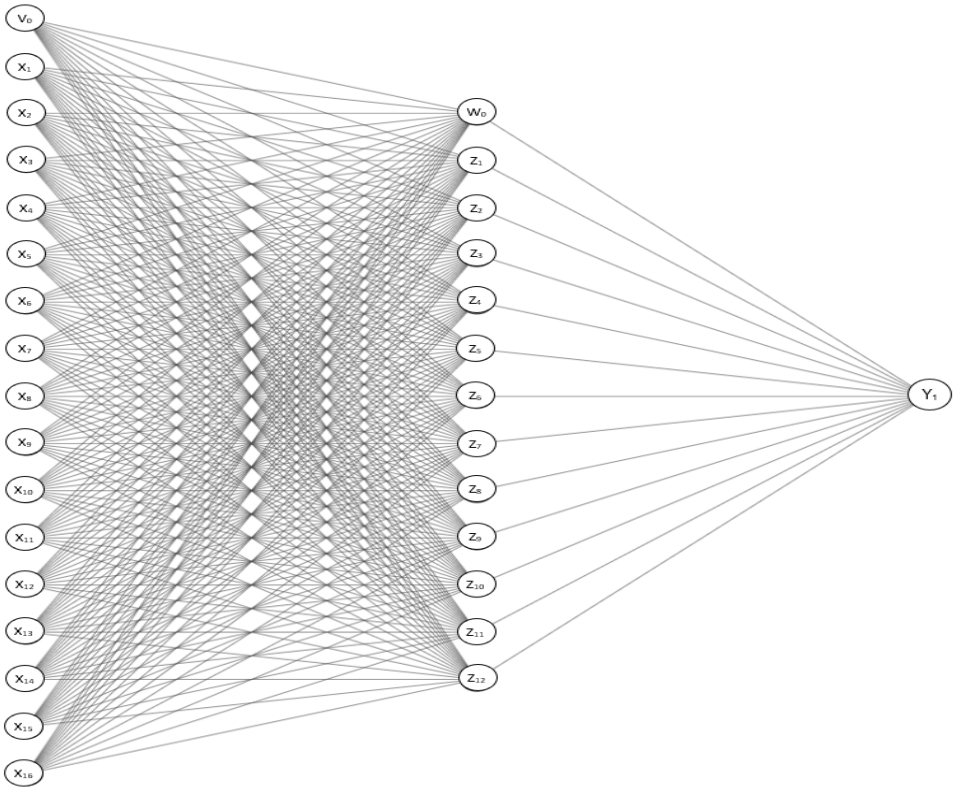

Figure 4: ANN Architecture Forecasting Daily Lodging Rental Prices

The equation for the lodging rental price forecasting model is $Zj = f(V_{0j} + \sum_{i=1}^{m}\sum_{j=1}^{n} X_i V_{ij})$ for the hidden layer, and the equation for the output layer $Yk = f(W_{0k} + \sum_{j=1}^{n}\sum_{k=1}^{p} Z_j W_{jk}$. The values that make up the equation Zj describe the weights on each network of the input variable neurons and the bias in the input layer to the neurons in the hidden layer. Besides that, the value that composes the Yk equation shows the weight of each network of neurons in the hidden layer and one neuron in the hidden layer to the output. The weights formed are represented by each line that makes up the ANN architecture as shown in Figure 4.

Processing for BMN input data also uses network architecture and weights that have been formed in the lodging rental price forecasting model. The resulting output is then denormalized to the initial form of numbers to get a prediction of room rental prices.

Table 2: Prediction Results of BMN Rental Prices for Lodging Rooms

Building name	Type	Number of buildings	Output	Daily Rental Price Prediction (Rp)
Hostel – Agency A	-	4	0.23459138	117.125,17
Hostel – Agency B	A	14	0.14880795	110.862,98
Hostel – Agency B	B	2	0.31053732	122.669,22
Hostel – Agency C	A	3	0.1173982	108.570,07
Hostel – Agency C	B	1	0.19057721	113.912,14
Mess/Guesthouse/Bungalow/ Resting Place – Agency D	-	1	0.31053732	122.669,22

CONCLUSION

The application of the Artificial Neural Network method in forecasting the price of lodging room rentals in the city of Yogyakarta and surrounding areas has resulted in accurate predictions. This method has provided an accurate output with a MAPE value of 1.47%. Prediction of room rental prices in buildings with BMN status in the city of Yogyakarta and its surroundings based on the Artificial Neural Network model that has been formed ranges from Rp. 108,570.07 to Rp. 122,669.22 per day.

Artificial Neural Network modelling for forecasting rental prices for lodging rooms in the city of Yogyakarta and its surroundings has provided accurate results so that it can be developed as an alternative appraisal practice in order to explore the potential for lodging rentals. In its application, the use of the ANN model requires the development of a separate system or application.

In its development, the use of input variables in the application of the Artificial Neural Network model for forecasting rental prices needs to pay attention to the characteristics of the location either geographically, economically, socially, or other characteristics that may have an effect. The prediction results on the BMN rental price for lodging rooms when used to describe the total potential non-tax revenue per certain period of time need to pay attention to the occupancy rate factor.

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