Forecasting of Store Maintenance in Retail Chain Operation with Neural Network Method: The Case of True Corporation Public Company Limited

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Abstract

This research aimed to study the repair data within the maintenance department of True Corporation Public Company Limited by using the repair period as a variable and measurement. The 236 branches and 3,103 total repair alerts in 2017 and 2018 were collected as the research data to perform the mathematical process in the form of artificial intelligence (AI: Neural network) in order to predict the repair in the future.

The process used in this research was based on the Neural Network, a basic model of machine learning that is popular in many industries. Most of them are used in forecasting and classified, including integrating with Image processing technology. By creating a single-layer Perception feed-forward neural network model using two large amounts of data from data collected from repair notifications of 3,103 repair notifications; namely, the date and time of the repair notification, the number of repair notifications comes through a mathematical process based on function x plus the randomized weight and through the training of the AI process to get results that are close to the actual values.

The results of this research may be used as a guideline for significant improvements and efficiency in stores in the maintenance process so that management can be made in terms of budget preparation, maintenance management costs each year. When adjust properly, it can adjust maintenance strategies from a passive strategy to an active strategy and can prevent preventive maintenance more efficiently.

Keyword : Artificial Intelligence, Neural Network, Forecasting Model, Retail Chain Operation.

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1. Introduction

With this undeniable current trend, the issue of artificial intelligence has a greater impact on business operations. The artificial intelligence has been expanded from the subject of data science and has been applied in many areas of various industry. Business only view this as the tools used in science alone, the perspective of artificial intelligence that is only the tools of data sciences. It is undoubtedly from the lack of application skills to apply these effective tools into business sector. In this research, theories of artificial intelligence are used to measure and predict data for business.

The sample of the shop maintenance is used as the case study in this research, the store is considered the forefront of the business operation in terms of physical contact with its customer. It is the first thing that customers experience and it is the image of the organization. In terms of maintenance management, it is considered to be the cost center of an organization. It is the sector that come with expenditure on the organization rather than making profit. The researcher is well aware of the business operations, business owners want to increase revenue and reduce expenses. Therefore, reducing the burden of maintenance costs means gaining more profit.

This research is conducted to prove that the artificial intelligence theory can be applied in many areas of business. In order to use this as a tool to help in making various decisions. By doing this research, the data of the repair notification throughout the 2 years were used for the artificial intelligence model. To analyze and learn from the information and brought to the forecast of the next 5 months repair in the future. Business will be able to check the data by comparing the errors that occurred if it is accurate or not. This is to conclude that the use of artificial intelligence in forecasting is useful and can help budgeting and implementing the preventive maintenance.

1.1. Objectives

1.1.1. To discover demand of repair requests through the forecasting model and to increase efficiency of the repair process.

1.1.2. To prove the principles and precision of artificial intelligence in applying to forecast repair work in-store transactions.

1.2. Research Process

1.2.1. Collect all repair records from 2017 to 2018 log file from maintenance records tracking system (N=3,097 records.)

1.2.2. Study information and format data to be able to enter into the mathematic model.

1.2.3. Check the result of the root mean square error and mean absolute percent error to measure the accuracy of the model.
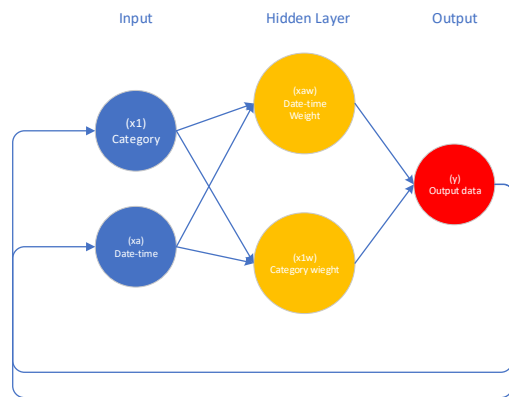
Figure 1. Conceptual framework show apply data with neural network methodology to forecasting maintenance demand

This artificial intelligence method is part of fuzzy logic, developed from the set theory of fuzzy implications, which is the approximate reasoning. This is different from the logical reasoning of right/wrong, yes/no, of classical logic. Ambiguous logic can be considered an application of fuzzy implications to simulate expert decisions to complex problems.

In this case, the data are taken and randomized to calculate the possibility of future calculations. To use in predicting the upcoming information and use it to prepare the prevention of maintenance work by using the repair workgroup and the date that the data flows in (Date of notification of repair).

2. Literature Review

2.1 Neural Network

Artificial neural networks (artificial neural networks) are mathematical models or computer models for processing information with connection-based calculations. (Connectionist)

The initial idea of this technique was obtained from the study of the bioelectric network in the brain, which consists of neurons and synapses. According to this model, the neural network is formed by the connection between nerve cells until it is a network that works together.

Neural Network is a branch of Artificial Intelligence technology that has been around since 1943. It is the development of the Algorithm network to work in the same way as the human nervous system. Or more specific, it copies the work of the human brain. Neural Network will use multiple Algorithms to work together as a network to work more diverse. There are 4 characteristics of the human brain that inspired the Neural Network.

Recalling the things that were seen in milliseconds, humans can see some images and understand what it is by connecting various information in the brain. For example, if you see a black silhouette of a bird, you will understand that this is a bird. This feature allows humans to perform tasks more quickly

and more accurately with objectives by referring to the article from Artificial Neural Networks. (*Thanawut Prakobphon)*

Human can understand various skills that are not related. Human can improve skills in many ways. For example, they can play many types of music while having coding skills or cooking skills, craft skills, understanding Calculus, or be good at sports at the same time. Having a variety of skills helps them to be creative in solving various problems.

Logic and rules are abstract subjects that humans can understand, even if never seen or touched. In which these issues are essential to co-existence and collaboration between human and a complex nervous system that helps us understand other people's logic and accept various rules.

Sometimes the problems are so complicated that we have to "throttle" the brain to understand and find a solution. This "throttle" is an attempt to connect many brain cells. Units to work together to support learning and synthesize new solutions. It is associated with the processor to solve complex problems.

Most researchers today agree that artificial neural networks have different structures than the brain networks. But still like the brain in the sense that the artificial neural network is a parallel grouping of sub-processors and this connection is an important part of the intelligence of the network. Considering the size the brain is much larger than the artificial neural network, including neurons are more complex than the subordinate units of the network. However, the important function of the brain like learning can still be easily modeled with neural networks.

2.1.1 Model

Neural networks consist of a set of nodes that may be defined as input nodes, output nodes, or intermediate buffers, which are called hidden nodes. Buff (or neurons) by specifying weight on every welding line when the network starts working the value will be assigned to the input buffer. By these values may have been determined by humans from sensors that measure various values or results from other programs. Then buffering input will send the received value. Follow the connecting line in which the output will be multiplied by the weight of the connecting line Buffs in the next layer will get which is the sum from various buffs and then calculate the results easily. In general, it uses the sigmoid function and sends the value to the next layer. This calculation will occur step by step until the output buffers. In the first period (around 1970) the number of layers would be fixed but at present, there is a genetic algorithm to help design the structure of the work. (Neuroevolutionary).

2.1.2. Multi-layer perceptron

The MLP neural network is a type of artificial neural network that has a multi-layered structure used for complex tasks that work well. The training process is supervised and uses the process of returning

The principle of MLP is that in each layer of the hidden layer (Hidden Layer) there is a function for calculating when receiving signals (Output) from nodes in the previous layer, called the Activation Function. Each layer does not have to be the same function.
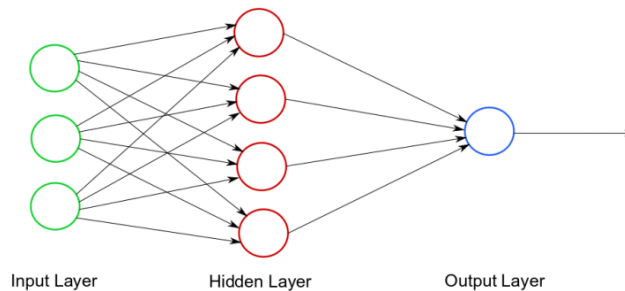
Figure 2. Show simple neural network diagram

values. (Backpropagation) for practicing the process of returning values consists of 2 sub-sections: Forward Pass, Backward Pass. For forwarding Data which will pass through the artificial neural network at the data layer and will pass from one layer to another until reaching the data layer. As for the reverse transmission, the connection weight value will be adjusted following the error correction rules. (Error-Correction) is the difference between the actual response (Actual Response) and the target response (Target Response) is an error signal (Error Signal), which will be sent back to the artificial neural network. In the opposite direction to the connection And the weight of the connection will be adjusted until the actual result approaches the target result

The hiding floor has an important function which is Will try to convert the information into that layer to be able to distinguish it using a single straight line (Linearly Separable) and before the data will be sent to the Output Layer sometimes more than 1 stealth layer is needed to transform data into linearity separable form.

To calculate the Output in the classification problem can be done by inserting the Input data into the artificial neural network that we have already searched. Then compare the output values in the Output Layer and select the higher Output values (the higher Neuron) and get the prediction values that match the selected Neuron and take the values of to compare with the acceptable values. If the value is in the acceptable range (Error is less than the error that we specify),
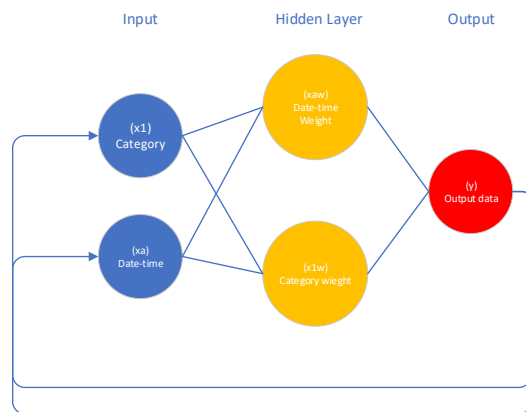
Figure 5. Process flow of neural network method

then we will receive the next set of data. But if the value of more than the acceptable value we adjust the weight and biased according to the steps mentioned above. When adjusting the weight to receive the next set of data and repeat the process until the last set of data. And when the final data set is completed, it is counted as 1 calculation cycle (1 Epoch). After that, the average total error will be determined. From the average of which has been kept to check that the value on average, in that classification, is it less than the acceptable error value? If so, then the artificial neural network can produce the correct results for every information. But if not, go back to take the first steps by starting to receive new data set 1.

3. Research result and discussion

Neural Network (NN) is a mathematical model or computer model for processing information with connection-based calculations. (Connectionist) The initial idea of this technique was obtained from the study of the bioelectric network in the brain, which consists of neurons

and synapses. According to this model, the neural network is formed by the connection between Nerve cells until it is a network that works together. It can be seen that the Neural network that we are starting to imitate from the bio itself.

3.1 Neurons (round balls)

Inside Neuron will differ according to the layer it is in. If it is an Input, inside it will have the data received, but if it is a Hidden Layer, there will be an equation that helps in calculating what class it is. Or regression can be calculated, but if it is an Output, it will indicate what class it is.

3.2 Input Layer (Green)

It is responsible for receiving data into the neural network, with only one input layer and a page to send data to the next layer (Hidden Layer).

3.3 Hidden Layer (Orange)

It is responsible for receiving data from the previous layer. Notice that the hidden layer

can be greater than 1 and basically If we need more precision, we will increase the number of hidden layers and the number of neurons. (Not always)

The researcher can prove from the trial of Tensor flow, which is the most descriptive and clear web site for the Hidden Layer.

$$f(x) = \sum_{i}^{n}(x_i x_{iw}) + \sum_{i}^{n}(x_a x_{aw})$$

x_i = Repair groups

x_{wi} = Weight Repair groups
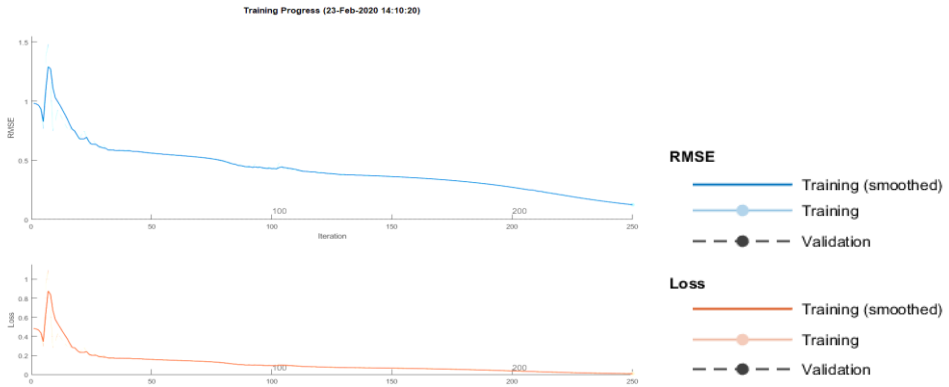
x_a = Date-time

x_{aw} = Weight Date-time

Figure 6. Graph show training process of neural network

4   Output Layer

It is the final output layer waiting to be received from the last hidden layer. In the output layer, each neuron weights the class. For example, we have all 2 types of output. Cats and dogs. So

our output layer will have 2 neurons. The first may be a dog and the second neurons will be cats. When the data are passed through the hidden layer to the output, both neurons have unequal values inside, where Which neuron has more weight? Denote that class and in the
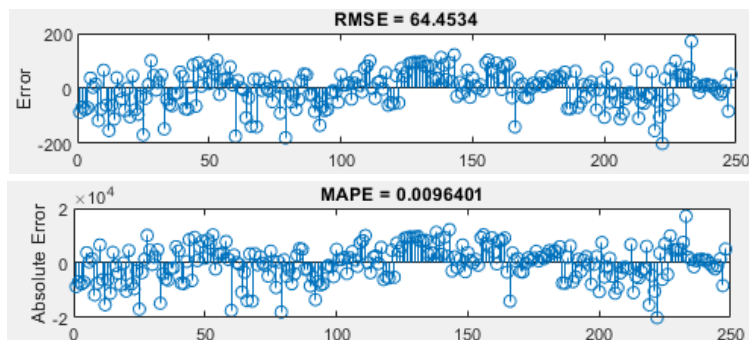

Figure 7. Root mean square error and Mean absolute percentage error of training result

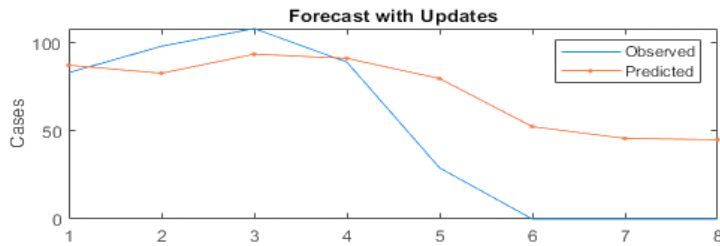hidden layer, there are two other hidden things: bias and weight.

Figure 9. forecast data before adjust root mean square error

B$_1$, B$_2$, and W$_x$ every hidden layer has bias connected so that all calculations for forwarding are equal. The simple interpretation is that every neuron in the hidden layer must have a bias in their calculations so that the decision boundary does not need to pass the origin. With reference to article of Manassakarn Sanayha., remaining useful life prediction machine used to enhance deep convolution neural network.

According to the figures above and the function equation using data of this process with random weight variables replaced by a matrix size 1 by 3169. Based on the number of n or population groups multiplied by the actual data variable. To follow the fuzzy logic guidelines and to adjust the weight variable to have an appropriate value. By doing 250 cycles

under the figure training loop that is shown. In doing so, the root mean square error (RMS) was adjusted to get the smallest value as well, so that the result is as close to the probability as possible.

And the result as shown in the forecasting maintenance graph figure, with a downward repair trend in the next half of the year.

Results are adjusted according to the Root mean square error and created the Lower bound, and Upper bound of the forecast. It is found that when comparing the MAPE (Mean Absolute percentage error), it has an error of 9%, with the upper bound and the lower bound of 5%. Therefore, we can be confident that the model used in this forecast is reliable, and able to be applied to actual work in the actual maintenance work.

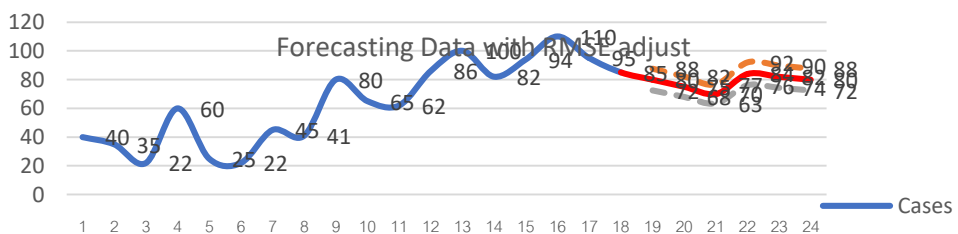This method has another advantage: if there is more data in the part of artificial

Figure 8. Graph show the result of forecasting by neural network process

intelligence, it will be able to predict the result with more accuracy. The greater the amount of initial data, the more the predictive capability will increase. It is a significant variation. This is because the initial data is only 1 and a half years, which may result in insufficient data to be obtained in other forms of forecasting. It should be enough for making seasonal predictions, but it may not be enough in this respect.

From figure 8, it shows that the forecast

Table 1. Table show forecasting data

Month (2017)	Case	Month (2018)	Case
Jan-17	40	Jan-18	100
Feb-17	35	Feb-18	82
Mar-17	22	Mar-18	94
Apr-17	60	Apr-18	110
May-17	25	May-18	95
Jun-17	22	Jun-18	85
Jul-17	45	Jul-18	80
Aug-17	41	Aug-18	75
Sep-17	80	Sep-18	70
Oct-17	65	Oct-18	84
Nov-17	62	Nov-18	82
Dec-17	86	Dec-18	80

Forecasting Data (applies to Jul-18 through Dec-18)

3.5 BI implementation

Sharing is critical to the success of a BI project because everyone involved in the process must have the ability to access all the information to be able to change the way they work. BI projects should begin with top management. But the next group of users should be salespeople because their job is to increase sales and because they tend to be rewarded for achievable sales. They will be more likely to accept tools that will help them make more sales. Of course, this tool is easy to use and they trust information. With the help of the BI system, employees will change the way individuals and teams work, leading to improvements in sales performance. When sales executives see performance differences from one team to another, they work to lead the team that follows to the leader level.

4. Conclusion

The experiment in this research showed the forecasting results and the neural network model. It found that the approximate root means square error = 64.5 and Mean Absolute Percentage error = 0.0094. Of the total data, 3,097 records have a +/- 64.5 forecast and a 0.94% forecast. This model can be used for actual maintenance. And this movement is acceptable if used as a tool for decision-making. By looking at the financial perspective, based on the actual budget spent for maintenance for the year 2017-2018, which is 26,792,126 baht and uses a MAPE of 0.94% to calculate the movement expectation is likely to occur. Of budget setting which costs only 25,318.56 baht

Therefore, it can be concluded that the use of artificial intelligence can be applied to many parts of various industries or businesses.

And is an effective machine if the application is and can also increase the effectiveness of this model in a variety of ways and also indicates that today the use of advanced business intelligence technology is a necessary delivery in a lot of competition.

is possible that the cost can be reduced. It is very useful for the company to understand and develop appropriate strategies to reduce unnecessary costs. There are rooms of
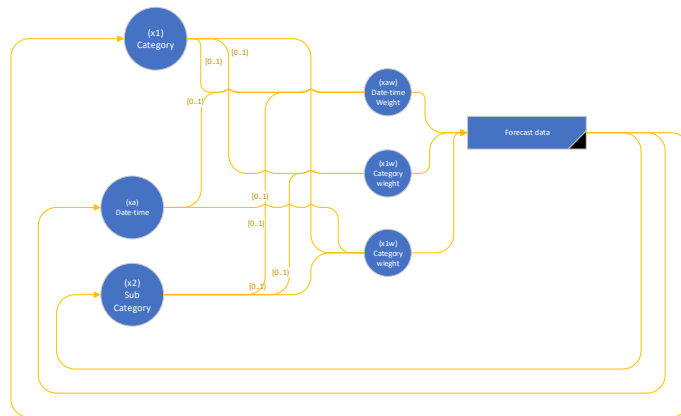

Figure 10. Classified neural network function

In summary, the integration of data between historical data and new data is now a fundamental component of advanced business intelligence (BI) systems as more and more businesses are added. The results from the said system will enable the development of administrative tools using factor analysis or predict trends to be used to make business and market decision-making decisions. Businesses that start using this concept today will be the most profitable organization before anyone else before it became commonplace soon.

4.1 Contribution

This study contributes to the cost reduction of the business. It is clear, based on the findings of this research, that the variable factors are controllable by the company and it

improvement for maintenance which is one of the main costs of the company.

4.2 Further research

It is an artificial intelligence process called *Machine learning*, which is the decision-making process for *data classification*. This method is often used in the field of surveillance cameras to separate the suspects that we want to know.

But in this process to separate the damaged data which can identify waste that is likely to occur in the future, is a prediction of the type deep down in each Item so that we can carry out preventive repairs beforehand. More clearly, to prevent unplanned damage that will occur. This is to **reduce the waiting time** for repairs, and to **reduce the cost of repairs** as well.

5. References.

Zhang, J., Wanga, P., Yanb, R. and Gao, R. X. (2018). Long short-term memory for machine remaining life prediction .Case Western Reserve University., Journal of Manufacturing Systems · 48, 78-86. Retrieved from, https://www.researchgate.net/publication/325564535_Long_short-term_memory_for_machine_remaining_life_prediction

Intuanchayong, S. (2013, January-March). Business Intelligence. Journal of Business Administration Thammasat University. 36(137), 3-7. Retrieved from http://www.jba.tbs.tu.ac.th/files/Jba137/Column/JBA137SrisomrukC.pdf

Prakobphon, T. (2009, January-June). Artificial Neural Networks. Journal of Huachiew University. 12(24), 73-87. Retrieved from http://journal.hcu.ac.th/pdffile/5.%20โครงข่าย%2073-87.pdf

Sanayha, M., (2016). Remaining useful life prediction machine using enhance deep convolution neural network., Master' thesis of Science, Chulalongkorn University.