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ANALYSIS OF ELEARNING QUALITY MEASUREMENT WITH WEBQUAL METHOD USING ARTIFICIAL NEURAL NETWORKS

Erwin Daniel Sitanggang[1], Misdem Sembiring[2], Anjar Pinem[3], Maranata Pasaribu[4]
[1,2,3,4] Universitas Mandiri Bina Prestasi

rwins.sitanggang@gmail.com[1], misdem@umbp.ac.id[2], anjar.pinem@gmail.com[3], kiainggo@gmail.com[4]

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Abstract

Currently, artificial intelligence is a concern for the world because of its increasingly rapid and sophisticated application in helping humans to complete their work in everyday life. One of the widely used methods is artificial neural networks that are part of deep learning and a subsection of machine learning. In its network training, the data used as input is the gap score of each webqual dimension and the data used as the output is the gap score of the average webqual attributes of each respondent. The training process is expected to produce an actual output close to the predetermined target output, resulting in the best model of artificial neural networks with feedforward backpropagation algorithms. From the results of the training experiment, the best model of artificial neural network architecture was obtained with a feedforward backpropagation algorithm at the time of training from 174 data to be able to replace the Webqual method in this study using the 3-20-1 model and the algorithm used was Levenberg-Marquardt (trainln). Where there is 1 Input layer with 3 neuron units, 1 hidden layer with 20 neuron units and 1 Output layer with 1 neuron unit with a mean square error (mse) of 0.00000000000721 and regression of 1 or 100%. And after testing using 58 data using the network configuration obtained during training, the results of the comparison between the network output and the target were 100% accurate.

Keywords: artificial intelligence, deep learning, artificial neural networks, feedforward backpropagation, webqual

1. Introduction

Currently, artificial intelligence is a concern for the world because of its increasingly rapid and sophisticated application in helping humans to complete their work in everyday life. Some scientific fields that often use artificial intelligence include the fields of medicine, business, and information technology. With the application of artificial intelligence such as pattern recognition, forecasting, classification, and signal processing [1]. One of the widely used methods is artificial neural networks that are part of deep learning and subsections of machine learning [2]. This artificial neural network is inspired by the structure of the human brain, which consists of three layers of neural networks but can learn and adapt to large data in solving various difficult problems to solve.

In the process of learning to recognize patterns, there are several algorithms used, one of which is feedforward backpropagation. Feedforward Backpropagation is a supervised learning algorithm in which the inputs and outputs are predetermined [3]. In its network training, the data used as input is the gap score of each webqual dimension and the data used as the output is the gap score of the average webqual attributes of each respondent [4]. These data are used in training input weights to obtain the actual output which is then compared with the target output. This difference between the actual output and the target output is called an error. This error is used to make changes to the weights so that it is expected to reduce the magnitude of the error to the desired value. The training process is expected to produce an actual output close to the predetermined target output, resulting in the best model of artificial neural networks with feedforward backpropagation algorithms.

Webqual is one of several methods used to measure the quality of a website. This method is a development of the Service Quality (Servqual) method which has been widely used to measure the

quality of service services [3]. Webqual is structured based on three dimensions of quality, namely Usability Quality (ease of use), Information Quality (quality of information), and Interaction Quality (quality of information). In its development since 1998, webqual has undergone several interactions in the preparation of its dimensions and question items [5].

However, the analysis process using the webqual method to get results is quite complicated and requires high accuracy and a long enough time. To make up for these shortcomings, designing a computerized intelligent system can be the right choice. The intelligent system in question uses artificial neural networks that have a way of working to resemble human biological neural networks. By simulating like a human neural network, it will produce a new class of software in the form of an artificial neural networks model that can recognize patterns by learning from past experiences [6].

2. Method

This research is quantitative with the phenomenon studied to measure the quality of elearning and design a new intelligent system model of artificial neural networks with feedforward backpropagation algorithms that can replace the methods used in measuring the quality of elearning. In processing the data collected using a number processing application (spreadsheet) until the analysis produces target data which then the data is used in the design of an intelligent system of a new model of artificial neural networks with a feedforward backpropagation algorithms using the Matlab R2017b application.

2.1 Research Design

To achieve the objectives of the topic under study here is outlined the research design to describe the steps that will be applied in conducting research. This is applied so that this research can be carried out in a gradual and structured manner as shown in figure 1.

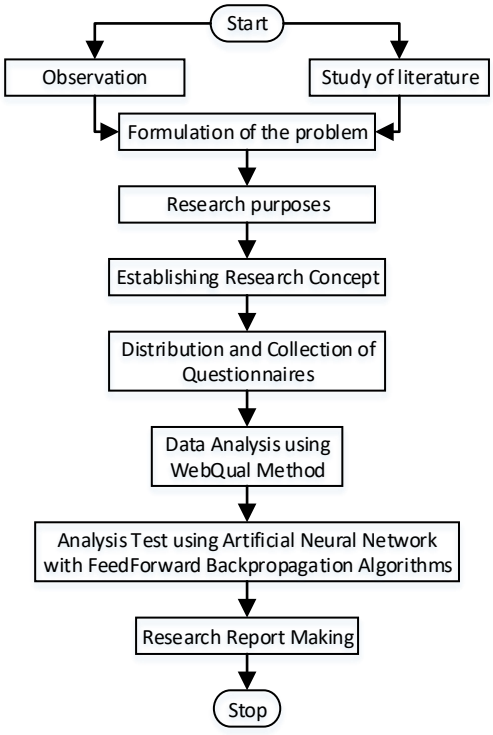

Figure 1. Research Design

2.2 Population and Research Samples

The population of this study is active students in the even semester of the 20th Academic Year 20/2021 which amounts to (population) 551 people. This population is students from universities who

will be analyzed for their level of satisfaction in using elearning by comparing the performance of college elearning against expectations from students. Meanwhile, the sample studied was 232 people, calculated based on the Slovin formula [7].

2.3 Sampling Techniques

The sample data collection technique is a non-probability sampling type of purposive random sampling, which is to determine the research sample where the researcher determines the respondent based on the assumption that the informant can provide definite, complete, and accurate data. Purposive Random Sampling is used by assigning a sample whose members are all equally likely and not bound by anything to be included in the research sample. The study of this study will be described quantitatively in the form of mathematical and statistical numbers.

2.4 Data Collection Methods

The data used when viewed from the nature of the research consists of quantitative data, quantitative calculations can be carried out to obtain a generally accepted conclusion in a parameter and the value of the data can change. And qualitative data is in the form of information containing sentences that are not in the form of number symbols or numbers. The process of obtaining qualitative data is carried out with in-depth analytical techniques and cannot be obtained directly.

Based on the functions and characteristics of the data, it is divided into 2 categories, namely: Primary Data, data obtained directly from data providers, and sources who are considered knowing and trustworthy. In this study, the source of the data in question came from the website of the Higher Education Database which is located at the https://forlap.kemendikbud.go.id, and academic departments, the information center section as elearning managers, lecturers, and students. And Secondary Data, data collected from documents, scientific books, research reports, scientific essays, lecture notes, and other written sources that are still closely related to elearning, methods used by researchers in analyzing the performance of elearning and designing intelligent systems of new models of artificial neural networks with feedforward backpropagation algorithms.

2.5 Data Collection Techniques

In collecting data on this study, it was carried out through interviews that were conducted in a semi-structured manner including in-depth interviews. With the interview technique, researchers intend to find out the opinions of managers and users of elearning in online learning during the Covid-19 pandemic. In questionnaires, researchers get a general description of students, regarding the expectations and realities of elearning performance felt by students. Documentation, data collection is carried out by taking materials or references from books, and other literature related to this research of a documentation nature.

2.6 Data Collection Tools

The data collection tool in this study was in the form of a questionnaire consisting of 22 multi-attributes based on the webqual method and distributed to students as respondents. Determination of the level of student satisfaction with each attribute (question) using a five-level scale (Likert).

2.7 Data Analysis

To get good results from research on the data collected, the research stage is divided into 2 main discussions. In the first discussion, data analysis is carried out using the webqual method. The second discussion is an analysis test using artificial neural networks with backpropagation algorithms.

Data Analysis using Webqual Method

In this discussion, the stages of analysis data to measure service quality and student satisfaction using the webqual method.

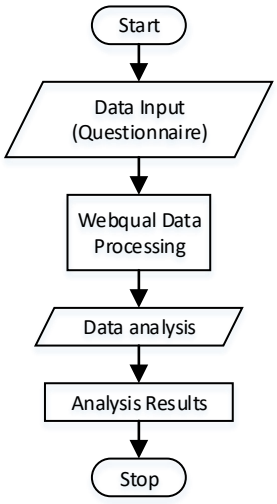

Figure 2. Data Analysis using the Webqual Method

The questionnaires that have been distributed to the responders are then collected. The answers are then input into the spreadsheet application. The data that has been inputted is then processed using formulas owned by webqual. The variables processed in the webqual method are Usability (X1), Information (X2), Interaction (X3), and User Satisfaction (Y). The scores obtained will then be determined based on a pattern to determine the level of satisfaction: If Score Gap is smaller than 0 (< 0) then it is called "Dissatisfied" and If Score Gap is greater or equal to 0 (>= 0) then it is called "Satisfied". The results of data analysis are hereinafter referred to as Data Target [9].

Analysis Test using Artificial Neural Networks with Feedforward Backpropagation Algorithms

In this stage, the analysis test uses artificial neural networks with feedforward backpropagation algorithms with Matlab R2017b.

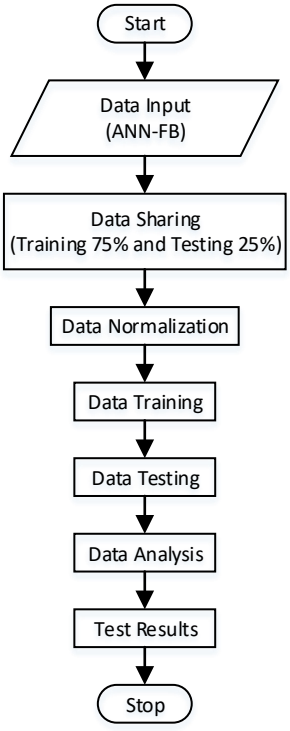

Figure 3. Analysis test using Artificial Neural Networks with Backpropagation Algorithms

Data processing that was previously done with the webqual method will be the input for the architecture of the artificial neural networks with feedforward backpropagation algorithms. The data is then divided into two large parts, namely: Data for training as much as 75% and data for testing as much as 25%. Data recovery on artificial neural networks with backpropagation algorithms with the following parameters [8]: Maximum epoch, Goal performance, Learning rate, Ratio to increase learning rate, Ratio to lower learning rate, Maximum failure, Maximum work increase, Minimum gradient, Momentum, Number of epoch to be shown progress, and Maximum time for training [9]. Once the values of the parameters are known and the results are adjusted to the Target Data, it will be tested with Test Data. The results of data training and data testing are retested with target data so that the level of accuracy will be obtained after testing with artificial neural networks. The test results will be concluded from the corresponding values of each parameter.

3. Results and Discussion

The training process is carried out to obtain the best configuration by changing the parameters and number of neuron units from the hidden layer in a trial and error manner. Once the best configuration is obtained with the network parameters and the number of neuron units in the hidden layer that produces the smallest MSE, then the configuration is used to test the network model. The test results will then be compared with analysis from the webqual method to obtain a comparison of the accuracy level of its network model.

3.1 Training Process

The network architecture trained in this process consists of 1 Input layer with 3 neuron units, namely: X1 which is the gap score from the Usability Quality dimension, X2 which is the gap score from the Information Quality dimension and X3 which is the gap score from the Service Interaction Quality dimension. 1 Output layer with 1 neuron unit as target data which is the average gap score of the webqual (Y) attributes of each respondent. The hidden layer consists of 1 layer with the experimentation of several units of neurons to get the best architecture. And the algorithm for training used is Levenberg-Marquardt (trainln). By using the 3-X-1 architecture where X is an experimental unit of neurons with several 1 to 25 in the hidden layer and Epochs of as many as 5000, the following training results were obtained:

Table 2.
Model 3-X-1 Network Architecture Training

Unit	Iteration	MSE
1	565	0.00000000924
2	145	0.000000190
3	3309	0.0000000000353
4	918	0.0000000000551
5	153	0.0000000707
6	1412	0.0000000287
7	2847	0.0000000000248
8	658	0.000000000314
9	160	0.0000000613
10	280	0.00000000150
11	1793	0.0000000000205
12	12	0.000000540
13	2103	0.0000000000110
14	13	0.000000508
15	24	0.000000517
16	41	0.000000187
17	364	0.000000000143

18	12	0.0000000783
19	8	0.00000173
20	596	0.00000000000721
21	992	0.0000000000100
22	487	0.000000000129
23	1478	0.00000000000955
24	59	0.0000000459
25	9	0.000000121

Based on the results of training experiments from artificial neural network models as stated in table 2 above, it was found that the best network architecture was in the 20th experiment. The network architecture uses the 3-20-1 model, where there is 1 Input layer with 3 neuron units, 1 hidden layer with 20 neuron units, and 1 output layer with 1 neuron unit. The selection of architecture with the 3-20-1 model is considered the best of all experiments because, from the results of the training experiment, the smallest mean square error (mse) value was 0.00000000000721 whose value was almost close to 0 [10].

3.2 Test Results

After obtaining the parameters for the best configuration of the artificial neural network architecture model using the feedforward backpropagation algorithms, 56 (25%) were tested using test data. The test results are shown in Table 3. And the result of the plot between The Network and Target output is shown in figure 4.

Table 3.
Network Test Results

Data to-	X1	X2	X3	Target	Output	Error
1	0,00	0,00	0,00	0,00	0,0000027393790114657936	0,0000027393790114657936
2	-0,50	0,00	-0,43	-0,32	-0,318184821878598	-0,000030036967793023 45
3	-0,13	0,00	-0,14	-0,09	-0,090916393510196	-0,000073026011047083 73
4	0,00	0,00	0,00	0,00	0,0000027393790114657936	0,0000027393790114657936
5	0,00	0,00	0,00	0,00	0,0000027393790114657936	0,0000027393790114657936
6	0,00	-0,29	0,00	-0,09	-0,090896650184394	0,00012440724697082 57
7	0,00	0,00	0,00	0,00	0,0000027393790114657936	0,0000027393790114657936
8	0,00	0,00	0,00	0,00	0,0000027393790114657936	0,0000027393790114657936
9	0,00	0,00	-0,86	-0,27	-0,272729080579748	-0,000018078524752772 72
10	0,00	0,00	0,00	0,00	0,0000027393790114657936	0,0000027393790114657936
11	0,00	0,00	0,00	0,00	0,0000027393790114657936	0,0000027393790114657936
12	1,00	1,00	1,00	1,00	0,999999987182052	-0,000000012817948480403 63
13	1,00	1,00	1,00	1,00	0,999999987182052	-0,000000012817948480403 63
14	0,00	0,00	0,00	0,00	0,0000027393790114657936	0,0000027393790114657936
15	-0,50	-0,14	-0,43	-0,36	-0,363637926713805	-0,000015630774403696 54
16	-0,13	0,00	-0,29	-0,14	-0,136381621654528	-0,000179852908912536 7
17	0,00	0,00	0,00	0,00	0,0000027393790114657936	0,0000027393790114657936
18	0,13	0,43	0,00	0,18	0,182077580923127	0,0002593991049453237

19	0,00	0,00	0,00	0,00	0,0000027393791146579 36	0,0000027393791146579 36
20	0,00	0,00	0,00	0,00	0,0000027393791146579 36	0,0000027393791146579 36
21	-0,88	-0,14	-0,14	-0,41	-0,409092672131696	-0,000017630407871394 03
22	-0,50	0,00	-0,14	-0,23	-0,227280919325632	-0,000081920529040324 65
23	-0,63	-1,14	-1,86	-1,18	-1,181818152964832	0,0000000288533505976 5737
24	0,00	0,00	0,00	0,00	0,0000027393791146579 36	0,0000027393791146579 36
25	-0,13	0,00	0,00	-0,05	-0045454429949070	0,0000001155054749624 185
26	-1,88	0,14	-0,57	-0,82	-0,818181785060133	0,0000000331216851723 3260
27	-0,88	-0,86	-0,71	-0,82	-0,818679796114685	-0,0004979779328670997
28	-0,13	-0,86	-0,14	-0,36	-0,363636276738262	0,0000000868981016033 3877
29	0,00	0,00	-0,14	-0,05	-0,045454650026508	-0,000001045719622005947
30	-0,38	-0,29	0,00	-0,23	-0,227274740758571	-0,000020134858442766 30
31	-0,13	0,00	-0,14	-0,09	-0,090916393510196	-0,000073026011051524 62
32	1,00	1,00	1,00	1,00	0,999999987182052	-0,000000012817948480 40363
33	0,00	-0,14	0,00	-0,05	-0,045462235958185	-0,000076905036392460 60
34	0,00	-0,71	-0,14	-0,27	-0,272573539927903	0,0001537327993696991
35	0,00	-0,14	0,00	-0,05	-0,045462235958185	-0,000076905036392460 60
36	0,00	0,00	0,00	0,00	0,0000027393791146579 36	0,0000027393791146579 36
37	-0,38	0,00	-0,86	-0,41	-0,409090495128965	0,0000041396194472298 48
38	-0,25	-0,29	0,00	-0,18	-0,181816455614633	0,000017262035494347 57
39	0,00	0,00	0,00	0,00	0,0000027393791146579 36	0,0000027393791146579 36
40	-0,63	-1,14	-1,86	-1,18	-1,181818152964832	0,0000000288533505976 5737
41	0,00	0,00	0,00	0,00	0,0000027393791146579 36	0,0000027393791146579 36
42	0,00	0,00	0,00	0,00	0,0000027393791146579 36	0,0000027393791146579 36
43	-1,00	-0,86	-0,86	-0,91	-0,909090746414154	0,0000001626767551776 709
44	-0,75	-1,29	-1,14	-1,05	-1,037982423865913	0,007472121588632
45	-1,63	-2,00	-2,00	-1,86	-1,863636352304305	0,0000000113320586248 0224
46	1,13	0,43	1,29	0,95	0,954545446807943	-0,0000000077375115203 89262
47	-0,13	-0,14	-0,57	-0,27	-0,272720663616410	0,000006609110862587642
48	0,00	-0,14	0,00	-0,05	-0,045462235958185	-0,000076905036392460 60

49	-0,25	0,00	0,14	-0,05	-0,045435418434782	0,00001912701976358733
50	0,00	0,00	-0,14	-0,05	-0,045454650026508	-0,0000010457196264468 39
51	-0,13	0,00	0,00	-0,05	-0,045454429949070	0,0000011550547496241 85
52	-0,13	0,71	0,00	0,18	0,181818047997978	-0,0000013382020425112 27
53	0,00	0,14	0,29	0,14	0,136355940798279	-0,0000076955653574017 90
54	0,00	0,00	0,00	0,00	0,00000027393791146579 36	0,00000027393791146579 36
55	1,00	1,00	1,00	1,00	0,999999987182052	-0,0000000128179480363 1442
56	-0,25	0,00	0,00	-0,09	-0,090904360358380	0,000004730550710707604
57	-0,88	-0,57	-0,86	-0,77	-0,772727632073759	-0,0000035934648634495 00
58	-0,63	-0,29	-0,14	-0,36	-0,363632199086196	0,000004164550168272996

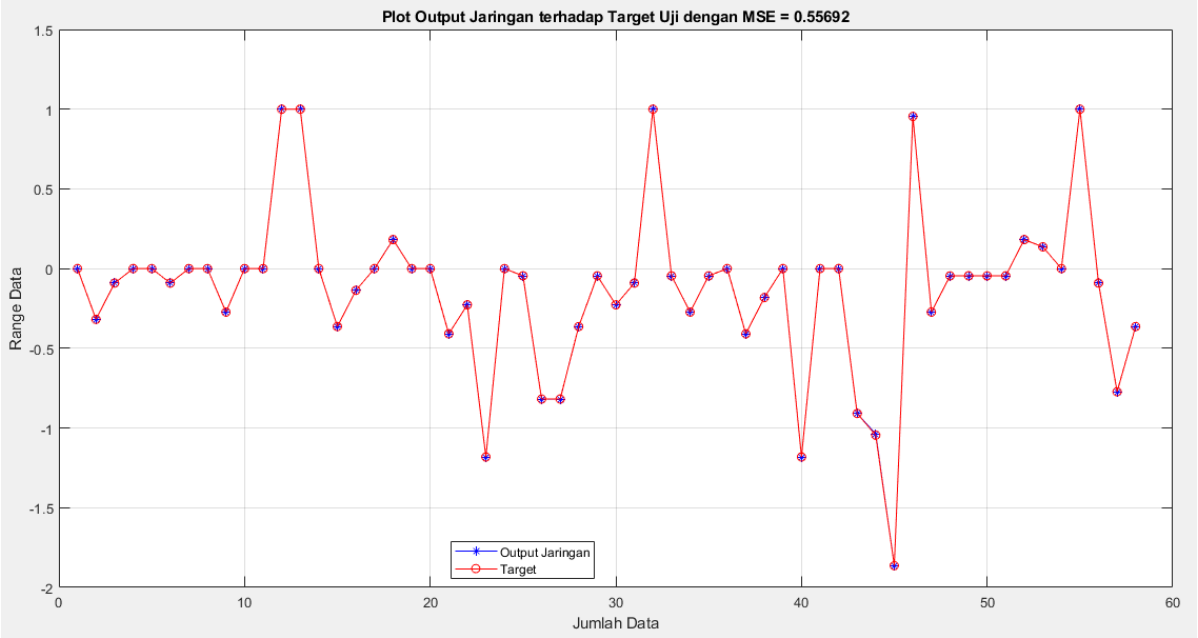

Figure 4. Plot The Network Output against the Test Target

3.3 Discussion

The results of the network testing with the new architecture model using parameters obtained from network training for network model configuration using data as much as 58, will be grouped with the provision of the desired output pattern in the form of "Dissatisfied" < 0 and "Satisfied" >= 0.

Table 4.
Desired Target Conformity with Network Test results

Data to-	Target	Output	Target Pattern	Output Pattern	Pattern Accuracy
1	0,00	0,00000027393791146579 36	Satisfied	Satisfied	True

2	-0,32	-0,318184821878598	Dissatisfied	Dissatisfied	True
3	-0,09	-0,090916393510196	Dissatisfied	Dissatisfied	True
4	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
5	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
6	-0,09	-0,090896650184394	Dissatisfied	Dissatisfied	True
7	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
8	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
9	-0,27	-0,272729080579748	Dissatisfied	Dissatisfied	True
10	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
11	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
12	1,00	0,999999987182052	Satisfied	Satisfied	True
13	1,00	0,999999987182052	Satisfied	Satisfied	True
14	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
15	-0,36	-0,363637926713805	Dissatisfied	Dissatisfied	True
16	-0,14	-0,136381621654528	Dissatisfied	Dissatisfied	True
17	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
18	0,18	0,182077580923127	Satisfied	Satisfied	True
19	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
20	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
21	-0,41	-0,409092672131696	Dissatisfied	Dissatisfied	True
22	-0,23	-0,227280919325632	Dissatisfied	Dissatisfied	True
23	-1,18	-1,181818152964832	Dissatisfied	Dissatisfied	True
24	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
25	-0,05	-0,045454429949070	Dissatisfied	Dissatisfied	True
26	-0,82	-0,818181785060133	Dissatisfied	Dissatisfied	True
27	-0,82	-0,818679796114685	Dissatisfied	Dissatisfied	True
28	-0,36	-0,363636276738262	Dissatisfied	Dissatisfied	True
29	-0,05	-0,045454650026508	Dissatisfied	Dissatisfied	True
30	-0,23	-0,227274740758571	Dissatisfied	Dissatisfied	True
31	-0,09	-0,090916393510196	Dissatisfied	Dissatisfied	True
32	1,00	0,999999987182052	Satisfied	Satisfied	True
33	-0,05	-0,045462235958185	Dissatisfied	Dissatisfied	True
34	-0,27	-0,272573539927903	Dissatisfied	Dissatisfied	True
35	-0,05	-0,045462235958185	Dissatisfied	Dissatisfied	True
36	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
37	-0,41	-0,409090495128965	Dissatisfied	Dissatisfied	True
38	-0,18	-0,181816455614633	Dissatisfied	Dissatisfied	True
39	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
40	-1,18	-1,181818152964832	Dissatisfied	Dissatisfied	True
41	0,00	0,0000027393379114657936	Satisfied	Satisfied	True
42	0,00	0,0000027393379114657936	Satisfied	Satisfied	True

43	-0,91	-0,909090746414154	Dissatisfied	Dissatisfied	True
44	-1,05	-1,037982423865913	Dissatisfied	Dissatisfied	True
45	-1,86	-1,863636352304305	Dissatisfied	Dissatisfied	True
46	0,95	0,954545446807943	Satisfied	Satisfied	True
47	-0,27	-0,272720663616410	Dissatisfied	Dissatisfied	True
48	-0,05	-0,045462235958185	Dissatisfied	Dissatisfied	True
49	-0,05	-0,045435418434782	Dissatisfied	Dissatisfied	True
50	-0,05	-0,045454650026508	Dissatisfied	Dissatisfied	True
51	-0,05	-0,045454429949070	Dissatisfied	Dissatisfied	True
52	0,18	0,181818047997978	Satisfied	Satisfied	True
53	0,14	0,136355940798279	Satisfied	Satisfied	True
54	0,00	0,0000027393791146579 36	Satisfied	Satisfied	True
55	1,00	0,999999987182052	Satisfied	Satisfied	True
56	-0,09	-0,090904360358380	Dissatisfied	Dissatisfied	True
57	-0,77	-0,772727632073759	Dissatisfied	Dissatisfied	True
58	-0,36	-0,363632199086196	Dissatisfied	Dissatisfied	True

In table 4 it can be known that 58 data (100%) of the expected targets and the test output of the data are appropriate. So in this case, the accuracy level of the 3-20-1 model for artificial neural network architectures using the feedforward backpropagation algorithm is 100% accurate.

4. Conclusions

The best model of artificial neural network architecture with feedforward backpropagation algorithm at the time of training of 174 data to be able to replace the webqual method in this study used the 3-20-1 model and the algorithm used was Levenberg-Marquardt (trainln). Where there is 1 Input layer with 3 neuron units, 1 hidden layer with 20 neuron units, and 1 output layer with 1 neuron unit with a mean square error (mse) of 0.00000000000721 and regression of 1 or 100%. And after testing using 58 data using the network configuration obtained during training, the results of the comparison between the network output and the target were 100% accurate. For suggestions on research that can provide improvements by conducting data training with more data so that the level of network accuracy is maintained.

Reference

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