MAPPING AND PREDICTION OF COMMUNITY HEALTH LEVEL IN THE EAST JAVA REGION USING ANN BACKPROPAGATION METHOD

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ABSTRACT

Predicting the level of public health in an area is very important to know the development of public health in order to give consideration to local governments in making policies that can increase the level of health and health services for the community. So we need a system that is able to make predictions and describe the development of public health in the years to come. The data used in the study were the percentage of the population who had health complaints and outpatient treatment for a month, the percentage of households that had access to proper sanitation, the percentage of households that had access to decent drinking water sources, the percentage of poor people, the average length of schooling, infant mortality rate, number of health centers and life expectancy. Backpropagation neural network method is a method that is often used in forecasting or prediction. Where this method can identify activities based on past data. Past data will be studied by neural networks so that they have the ability to make decisions on data that has never been studied. This method is expected to provide a prediction of the level of health by studying data from previous years. The results of this study produced a predictive map of the level of public health in the East Java region in 2019, 2020 and 2021 based on the model obtained from the training results with an epoch of 100 and an MSE value of 0.0173254.

Keywords : *Prediction, Health Level, East Java, Artificial Neural Networks, Backpropagation*.

1. INTRODUCTION

Health is a very basic need for everyone. However, health problems are often the impact of various problems experienced by individuals and the surrounding environment. In fact, health is one of the factors that play an important role in improving quality human resources. Henrik L. Bloom (1981) states that there are 4 factors that affect health status in a row, namely: lifestyle (life style), environment (social, economic, political, cultural), health services, and genetic factors (heredity). The four determinants interact and affect a person's health status (Henrik L. Bloom, 1981). The government as a public servant is the party responsible for providing public services to the community in accordance with established public service standards. This is a function of the existence of the government that has been regulated in law, one of which is the Decree of the Minister of Empowerment of State Apparatus Number 63 of 2003 concerning General Guidelines for the Implementation of Public Services. Health services are one form of implementing public services from the government to the community. So that the government needs to make predictions on the development of public health in the coming years so that the government can make policies that can improve the level of public health. Therefore we need a system that is able to predict the level of public health by mapping and also describing fluctuations or developments in the level of public health in an area seen from the factors that affect the level of public health. One method that can be used for mapping and prediction is to use the backpropagation artificial neural network method.

Berdasarkan uraian di atas maka penulis tertarik untuk melakukan penelitian mengenai “Pemetaan dan prediksi tingkat kesehatan masyarakat di wilayah Jawa Timur menggunakan metode JST- backpropagation”.

2. THEORETICAL BASIS

2.1. Artifiial Neural Network (ANN)

An artificial neural network is a knowledge engineering concept in the field of artificial intelligence which is designed by adopting a system human nerves, whose main processing is in the brain and the smallest part of the brain is nerve cells called information processors or neurons (Samarasinghe, S, 2006). ANN was developed as a mathematical model which is a simplification for the human biological nervous system based on the assumption that information processing occurs in the various elements called neurons, signals are passed between neurons via connection links having a weight that will divert the signal passing through, and each neuron has an activation function that will determine the value of the output signal (Fausett, 1994).

2.2. Backpropagation

Backpropagation is an algorithm supervised learning and is usually used by multilayer perceptrons to change the weights associated with neurons in layers hidden. Backpropagation algorithm use error output to change the value of the weights in the backward direction. The forward propagation stage (feed forward propagation) must be done first to get the error value (Finki and Vincent, 2013). Backpropagation training includes three phases. The first phase is the forward phase. The input pattern is calculated forward from the input layer to the output layer using the specified activation function. The second phase is the backward phase. The difference between the network output and the desired target is an error that occurs. The error is propagated backwards, starting from the line that is directly related to the units in the output layer. The third phase is weight modification to reduce errors that occur (Dwi and Dwiza, 2013).

2.3. Algorithm Feedforward

Feedforward is used as an algorithm to calculate the activation values that exist in all neurons, both those in the hidden layer or the output layer or output layer. The following are algorithms used in advanced computing:

1. Initialization of initial weight (assigned a small value at random),
2. Each input unit (Xi, i = 1 .... n) receives the input signal Xi and the signal is transmitted to the next unit units.
3. Each hidden layered unit is multiplied by its weight and is added up and added to its bias weight:

$$H\_in_j = b_{0j} + \sum_{i=1}^{n} x_i w_{ij} \qquad (2.1)$$

4. Then it is calculated according to the activating function used:

$$Z_j = f(H\_in_j) \qquad (2.2)$$

If the sigmoid function is used, then the form of the function is

$$H_j = \frac{1}{1 + exp^{(-H_{inj})}} \qquad (2.3)$$

5. Each output unit (Yj, j = 1,….., n) is multiplied by a weight and added to and added to its bias weight:

$$Y\_in_j = b_{0j} + \sum_{i=1}^{n} H_i W_{ij} \qquad (2.4)$$

6. Then recalculate according to the function activator

$$Y_j = f(Y\_in_j) \qquad (2.5)$$

If the sigmoid function is used, the form of the function is:

$$Y_j = \frac{1}{1 + exp^{(-Y_{inj})}} \qquad (2.6)$$

2.4. Normalization

Normalization is a transformation process in which a numeric attribute is scaled in a smaller range such as -1.0 to 1.0, or 0.0 to 1.0. normalization is done to equalize the scale with the following formula.

$$Xnormal = \frac{X\text{origin} - \text{min value}}{\text{Max value} - \text{min value}}$$

2.5. Mapping

The definition of mapping formulated in the Indonesian dictionary emphasizes the expression of feelings in the form of pictures, writings, maps, and graphics. This definition emphasizes the product or output of the map. Meanwhile (Spasser, 1997) emphasizes the process of mapping activities. These two opinions are not different but complementary, because a product or mapping output is produced through a process. So it can be stated that the mapping is a process that allows a person to recognize elements of knowledge and configurations, dynamics, interdependencies and interactions. Knowledge mapping is used for technology management purposes, including the definition of research programs, decisions regarding activities related to technology, design, knowledge-based structures and education and training programming. The output of the mapping activity is pictures, writings, maps, and graphs that show the relationship between elements of knowledge.

2.6. Prediction

Prediction is a process of systematically estimating something that is most likely to happen in the future based on past and present information that is owned, so that the error (difference between something that happens and the predicted result) can be minimized. Prediction does not have to provide a definite answer to events that will occur, but rather tries to find answers as close as possible to what will happen (Herdianto, 2013: 8).

2.7. Health

Health is a very basic need for everyone. However, health problems are often the impact of various problems experienced by individuals and the surrounding environment. In fact, health is one of the factors that play an important role in improving quality human resources. Henrik L. Bloom (1981) states that there are 4 factors that influence health status in a row, namely: lifestyle (life style), environment (social, economic, political, cultural), health services, and genetic factors (heredity). Fourth these determinants interact with each other and affect a person's health status (Blum, Henrik L, 1981).

2.8. Health index

The health index is a reflection of the level of health in an area. The health index is based on life expectancy at birth (AHH). AHH is the average estimate of many years that can be traveled by a person cell(a2m.7a) life. Calculation of AHH through indirect approach (indirect estimation). The types of data used are Children Born Alive (ALH) and Children Still Living (AMH). AHH is calculated based on ALH and AMH using the Trussel method with the West model, which is in accordance with the population history and conditions of Indonesia and Southeast Asian countries in general (BPS, 2015). The method of calculating the health index is as follows:

$$I_{\text{Health}} \frac{AHH - AHH_{min}}{AHH_{max} - AHH_{min}}$$

with a maximum value and a minimum value of life expectancy according to UNDP (United Nations Development Program) standards, namely the highest number as the upper limit for calculating the index is 85 years and the lowest is 20 years. The health index is categorized according to the categories in the composite index that it composes, namely the Human Development Index. The index is categorized as low if the index value is between 0.00 - 59.99, categorized as moderate if the index value is between 0.60 – 0.69, categorized as high if the index value is between 0.70 – 0.79, and categorized as very high if the index value is between 0.80 – 1.00.

2.9. Percentage of Population Who Have Health Complaints

Health complaints are disturbances to physical and mental conditions, including due to accidents, or other things that interfere with daily activities. In general, the main health complaints experienced by many residents are fever, headache, cough, runny nose, diarrhea, asthma/shortness of breath, toothache. People who suffer from chronic diseases are considered to have health complaints even though at the time of the survey (last one month) the disease does not recur.

This indicator can be used to measure the level of public health in general, which can be seen from the presence of complaints that indicate a certain disease. Knowledge of the health status of a community can be considered in the development of the health sector, which aims to make all levels of society obtain health services easily, cheaply and evenly. Through With these efforts, it is hoped that a better level of public health will be achieved.

2.10. Access to Adequate Sanitation and Adequate Drinking Water Sources

Environmental health problems often occur due to the lack of clean water sources and proper sanitation. Akper (2012) states that good sanitation and clean water sources will reduce disease prevalence, increase productivity, and reduce pollution from water sources. Another factor that also causes problems with clean water and proper sanitation in the community is access to clean water and proper sanitation services. The availability of clean water is a very important issue because it has implications for the quality of life of the community.

2.11. Average length of school

Various studies show that education is a protection for health. In rich countries, an additional one year of education can reduce mortality by about 8 percent (Fred C. Pampel, 2010). One year of education can also increase the average income by 8 percent and can reduce mortality twice as much, both directly and indirectly (Pellet Kathleen, 2007). Freudenberg argues that policies to prevent dropouts and improve educational achievement have a major impact on the health of the population (Freudenberg N, 2007).

2.12. Poverty

Poverty and unemployment are phenomena that are often heard and become a problem in every country. Almost every country has problems in poverty and unemployment, especially in countries that are still in the developing stage Todaro, (2011). Poverty and unemployment will directly or indirectly have an impact on the level of public health. According to Atmarita, (2015) the amount of income which is a determinant of a person's condition is poor or will not affect his level of health. This is reflected in household spending to consume foods that contain protein, vitamins, and others. In the long term, of course, the level of consumption will affect individual health.

2.13. Infant Mortality rate

The infant mortality rate is an important indicator to reflect the state of health status in a society, because new babies Birth is very sensitive to the environmental conditions in which the baby's parents live and is very closely related to the social status of the baby's parents. The progress made in the field of prevention and eradication of various diseases that cause death will be clearly reflected in the decline in IMR levels. Thus the infant mortality rate is a sensitive benchmark of all intervention efforts made by the government, especially in the health sector (BPS, 2012).

2.14. Number of Health centers

Henrik L. Bloom (1981) stated that one of the factors that influence health status is health services. Community Health Center, abbreviated as Puskesmas, is a health service facility that organizes public health efforts and first-level individual health efforts, by prioritizing promotive and preventive efforts, to achieve the highest degree of public health (Regulation of the Minister of Health of the Republic of Indonesia No. 75 of 2014).

3. RESEARCH METHODOLOGY

3.1. Research Methods

The data collection method used in this study is a quantitative method, namely taking data on life expectancy in East Java through the Website of the Central Bureau of Statistics of East Java. The research method used is an artificial neural network with backpropagation method.

3.2. Data Source

The data used in this study is secondary data about the variables forming Public Health Indicators in 38 districts/cities obtained from the results of Riskesdas and the Central Statistics Agency of East Java Province in 2014 - 2018.

3.3. Research Variable

The research variables used are variables that form the Public Health Indicators, which include lifestyle (life style), environment (social, economic, political, cultural), health services, and genetic factors (heredity). the details are as follows:

Tabel 3.1 Research Variable

Variable	Variable Name
X_1	Percentage of Health Complaints Population
X_2	Percentage of RT . Eligible Sanitation
X_3	Access to Adequate Drinking Water
X_4	Percentage of Poor Population
X_5	Average Length of School
X_6	Infant Mortality Rate
X_7	Number of Health Centers

4. RESULTS AND DISCUSSION

4.1. Research Result

The result of this research is a health level mapping information system that produces a report in the form of a classification of health levels based on the district-city area and the presentation of the information in the form of a map. The results of the report can also be used as a reference for the government in determining development priorities in the field of education.

4.2. Discussion

The data used in this study are the data on the percentage of population health complaints, the percentage of proper RT sanitation, access to adequate drinking water sources, the percentage of poor people, the average length of schooling, infant mortality rate, the number of health centers in 2014 - 2017 as training data and year data. 2018 as test data obtained from the website of the Central Java Statistics Agency, in this case there are 32 districts and cities.

4.3. Data Normalization

At this stage, normalization of training data and test data is carried out. The results of the normalization of test data can be seen in table 4.1 below:

Table 4.1 Normalization Results of Test Data

Region	X_1	X_2	X_3	X_4	X_5	X_6	X_7	T
Pacitan	0.27	0.44	0.55	0.47	0.49	0.1	0.35	0.71
Ponorogo	0.58	0.61	0.72	0.295	0.48	0.14	0.47	0.82
Trenggalek	0.43	0.66	0.3	0.371	0.5	0.06	0.32	0.93
Tulungagung	0.43	0.77	0.56	0.154	0.6	0.07	0.48	0.97
Blitar	0.26	0.58	0.53	0.266	0.5	0.12	0.35	0.9
Kediri	0.25	0.75	0.48	0.339	0.55	0.16	0.57	0.81
Malang	0.52	0.49	0.67	0.296	0.48	0.24	0.6	0.8
Lumajang	0.5	0.55	0.56	0.278	0.36	0.4	0.37	0.5
Jember	0.36	0.44	0.37	0.278	0.34	0.83	0.78	0.39
Banyuwangi	0.29	0.64	0.62	0.178	0.48	0.24	0.7	0.57
Bondowoso	0.27	0.16	0.47	0.479	0.28	0.72	0.37	0.1
Situbondo	0.42	0.36	0.44	0.362	0.34	0.79	0.23	0.39
Probolinggo	0.35	0.29	0.44	0.676	0.29	0.97	0.5	0.15
Pasuruan	0.55	0.59	0.5	0.254	0.44	0.67	0.5	0.54
Sidoarjo	0.77	0.91	0.87	0.082	0.89	0.11	0.38	0.98
Mojokerto	0.39	0.83	0.62	0.283	0.62	0.09	0.4	0.8
Jombang	0.33	0.84	0.58	0.259	0.62	0.22	0.52	0.77
Nganjuk	0.3	0.81	0.58	0.375	0.54	0.28	0.28	0.68
Madiun	0.65	0.8	0.74	0.344	0.54	0.29	0.38	0.65
Magetan	0.56	0.81	0.79	0.293	0.59	0.1	0.32	0.8
Ngawi	0.23	0.5	0.7	0.499	0.44	0.14	0.35	0.76
Bojonegoro	0.53	0.77	0.69	0.423	0.43	0.47	0.55	0.66
Tuban	0.44	0.72	0.74	0.521	0.4	0.28	0.5	0.65

Lamongan	0.65	0.95	0.64	0.452	0.57	0.35	0.5	0.77
Gresik	0.7	0.96	0.83	0.365	0.72	0.1	0.48	0.82
Bangkalan	0.46	0.29	0.42	0.717	0.24	0.8	0.32	0.53
Sampang	0.65	0.63	0.72	0.791	0.11	0.64	0.3	0.28
Pamekasan	0.2	0	0.57	0.483	0.38	0.63	0.28	0.21
Sumenep	0.24	0.02	0.7	0.743	0.23	0.65	0.45	0.64
Kediri city	0.22	0.95	0.54	0.173	0.84	0.07	0.1	0.98
Blitar city	0.57	0.96	0.59	0.162	0.84	0	0	0.93
Malang city	0.17	0.84	0.78	0.01	0.88	0.03	0.22	0.88
Probolinggo city	0.69	0.82	0.75	0.151	0.66	0.04	0.05	0.53
Pasuruan city	0.58	0.82	0.84	0.131	0.74	0.41	0.08	0.67
Mojokerto city	0.78	0.95	0.71	0.073	0.85	0.08	0.03	0.89
Madiun city	0.27	0.96	0.91	0.027	1	0.1	0.05	0.84
Surabaya city	0.5	0.87	0.95	0.045	0.91	0.09	1	1
Batu city	0.41	0.92	0.83	0	0.69	0.2	0.03	0.81

4.4. Testing

Testing the results of artificial neural network modeling is carried out by comparing data that has never been seen by the model during training, namely the actual data in 2018 with the predicted results or output from the model, namely the life expectancy value, then the mean square error value is calculated from the difference in actual life expectancy. with the life expectancy of the predicted model This testing process aims to see the accuracy of the model predictions using the weights and biases of the training results with data that are not used in the training process. The test data is propagated (feed-forward) so that the output data is obtained which is then calculated the difference with the actual value of the test data. The test results using 2018 test data obtained an MSE value of 0.0173254. The MSE value obtained in the testing process shows that the error value is below 0.1. it means that the model has succeeded in making predictions based on data that was not known by the previous model with the difference between the actual value and the ANN result value is quite small. Complete test results can be seen in table 4.2.

Tabel 4.2 Table of Test Results Using 2018 Data

No	Years	Region	Actual	ANN 7-12-1		
				Otput	Difference	Square Error
1	2018	Pacitan	0.71	0.765	-0.0522	0.0027
2	2018	Ponorogo	0.82	0.751	0.0679	0.0046
3	2018	Trenggalek	0.93	0.852	0.074	0.0055
4	2018	Tulungagung	0.97	0.887	0.0846	0.0072
5	2018	Blitar	0.9	0.81	0.0938	0.0088
6	2018	Kediri	0.81	0.854	-0.0422	0.0018
7	2018	Malang	0.8	0.718	0.0807	0.0065
8	2018	Lumajang	0.5	0.586	-0.0868	0.0075
9	2018	Jember	0.39	0.408	-0.0212	0.0004
10	2018	Banyuwangi	0.57	0.803	-0.2289	0.0524
11	2018	Bondowoso	0.1	0.309	-0.2104	0.0443
12	2018	Situbondo	0.39	0.31	0.0762	0.0058
13	2018	Probolinggo	0.15	0.311	-0.1614	0.026
14	2018	Pasuruan	0.54	0.511	0.0248	0.0006
15	2018	Sidoarjo	0.98	0.873	0.1084	0.0117
16	2018	Mojokerto	0.8	0.861	-0.0646	0.0042
17	2018	Jombang	0.77	0.839	-0.0663	0.0044
18	2018	Nganjuk	0.68	0.748	-0.0675	0.0046
19	2018	Madiun	0.65	0.703	-0.0546	0.003
20	2018	Magetan	0.8	0.794	0.0091	0.0001
21	2018	Ngawi	0.76	0.719	0.0404	0.0016
22	2018	Bojonegoro	0.66	0.642	0.0175	0.0003

23	2018	Tuban	0.65	0.684	-0.0317	0.001
24	2018	Lamongan	0.77	0.732	0.0414	0.0017
25	2018	Gresik	0.82	0.838	-0.0154	0.0002
26	2018	Bangkalan	0.53	0.341	0.1869	0.0349
27	2018	Sampang	0.28	0.443	-0.1665	0.0277
28	2018	Pamekasan	0.21	0.284	-0.0745	0.0056
29	2018	Sumenep	0.64	0.308	0.3366	0.1133
30	2018	Kediri city	0.98	0.91	0.0688	0.0047
31	2018	Blitar city	0.93	0.894	0.0334	0.0011
32	2018	Malang city	0.88	0.919	-0.0422	0.0018
33	2018	Probolinggo city	0.53	0.797	-0.262	0.0686
34	2018	Pasuruan city	0.67	0.635	0.0374	0.0014
35	2018	Mojokerto city	0.89	0.848	0.0382	0.0015
36	2018	Madiun city	0.84	0.889	-0.0518	0.0027
37	2018	Surabaya city	1	0.939	0.0607	0.0037
38	2018	Batu city	0.81	0.78	0.0321	0.001
Total					-0.187509	0.4750992
Average error | *MSE* Testing					-0.004935	0.0125026

4.5. Ratio

To find out the accuracy of the application program created, a comparison of the results from the feedforward using the application with the feedforward results using manual calculations is carried out. From the results of manual calculations obtained feedforward output of 0.767518156 which then denormalized to 71.99228024. while the results of the application also obtained a value of 71.99228024. further comparisons are also made to 9 other data which can be seen in table 4.3.

Tabel 4.3 Comparison Results

District / city	Years	Manual result	Application results	Difference
Pacitan	2019	71.99228024	71.99219264	8.76013E-05
Ponorogo	2019	71.70597426	71.7060641	8.98433E-05
Trenggalek	2019	72.66075269	72.66101551	0.000262823
Tulungagung	2019	72.94767506	72.9477933	0.000118244
Bondowoso	2020	68.24546158	68.24581021	0.000348629
Situbondo	2020	68.40256154	68.40275983	0.000198294
Probolinggo	2020	68.21219382	68.21215976	3.40521E-05
Probolinggo city	2021	72.19989773	72.19969551	0.000202212
Pasuruan city	2021	71.3626896	71.36269508	5.4781E-06
Mojokerto city	2021	72.74501436	72.74502275	8.3903E-06
Pacitan	2021	71.99228024	71.99219264	8.76013E-05
Accuracy				99.9998092

From the comparison results of manual feedforward calculations and feedforward calculations with applications, it can be concluded that the ANN program that has been made has an accuracy rate of 99.9998092 %,

4.6. Prediction

Prediction is done by calculating feedforward. With predictive data entered manually into the system. Where the user can estimate the value of each variable. This data will be used to provide an overview or mapping of health level predictions. The input data in 2019 can be seen in table 4.4

Tabel 4.4 Input Variable Value and Prediction Results per Region in 2019

No	Region	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	Pacitan	41	52	68	14	7.3	19	25
2	Ponorogo	55	65	82	10	7.2	21	31
3	Trenggalek	49	72	51	12	7.3	18	22
4	Tulungagung	49	78	68	7.1	8.1	19	32
5	Blitar	42	63	70	9.5	7.3	20	25
6	Kediri	42	76	64	11	7.8	22	37
7	Malang	53	56	79	10	7.3	25	39
8	Lumajang	51	62	72	9.8	6.3	32	25
9	Jember	46	51	56	9.8	6.1	50	50
10	Banyuwangi	42	67	72	7.7	7.2	25	45
11	Bondowoso	41	30	65	14	5.7	45	26
12	Situbondo	47	47	61	12	6.2	48	17
13	Probolinggo	44	39	60	19	5.8	56	34
14	Pasuruan	54	65	65	9.3	6.9	43	33
15	Sidoarjo	62	89	93	5.6	10	20	27
16	Mojokerto	46	86	72	9.9	8.3	19	27
17	Jombang	45	86	70	9.4	8.3	25	34
18	Nganjuk	42	83	70	12	7.7	27	21
19	Madiun	56	80	68	11	7.7	27	27
20	Magetan	54	84	81	10	8	19	22
21	Ngawi	42	56	87	15	7	21	25
22	Bojonegoro	53	80	78	13	6.8	35	36
23	Tuban	50	76	78	15	6.6	27	34
24	Lamongan	57	95	80	14	7.9	30	33
25	Gresik	60	97	75	12	9.1	20	33
26	Bangkalan	50	41	90	19	5.4	49	22
27	Sampang	58	69	59	21	4.4	42	21
28	Pamekasan	40	16	80	14	6.4	42	20
29	Sumenep	42	18	70	20	5.3	42	31
30	Kediri city	40	95	82	7.5	10	18	10
31	Blitar city	52	96	67	7.3	10	15	4
32	Malang city	37	87	71	4	10	17	17
33	Probolinggo city	59	82	84	7.1	8.6	17	7
34	Pasuruan city	54	84	82	6.7	9.2	32	9

35	Mojokerto city	63	95	87	5.4	10	19	5
36	Madiun city	41	96	79	4.4	11	20	7
37	Surabaya city	52	86	91	4.8	11	19	63
38	Batu city	47	93	98	3.8	8.9	24	5

Figure 4.1 2019 Health Level Prediction Results

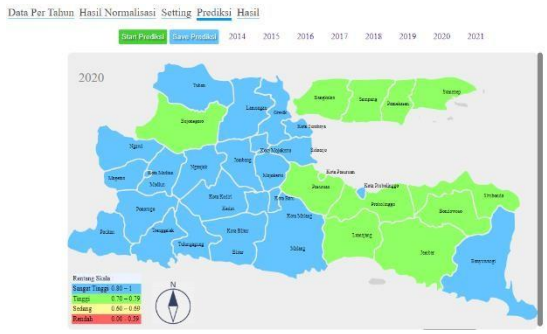

Figure 4.1 maps the prediction results with ANN-Backpropagation based on 2019 input data from the admin where there is a change in the level of health increasing from high to very high:

1. Madiun Regency

a. Percentage of population health complaints changed from 56.49 to 55.63 or decreased -1.55%
b. Percentage of proper household sanitation changed from 81.55 to 79.94 or decreased -2.01%
c. Access to proper drinking water sources changed from 81.97 to 80.64 or decreased -1.65%
d. Percentage of poor people changed from 11.42 to 11.27 or decreased -1.33%
e. Average length of school changed from 7.57 to 7.65 or increased 1.05%
f. Infant mortality rate changed from 27.61 to 27.33 or decreased -1.02%
g. Number of Puskesmas changed from 26 to 27
h. Health Index changed from 0.78 to 0.79

2. Nganjuk Regency

a. Percentage of population health complaints changed from 42.97 to 42.26 or decreased -1.68%
b. Percentage of proper household sanitation changed from 82.16 to 83.07 or increased by 1.10%
c. Access to proper drinking water sources changed from 71.26 to 70.01 or decreased -1.79%
d. Percentage of poor people changed from 12.11 to 12.33 or increased by 1.78%
e. Average length of school changed from 7.61 to 7.69 or increased 1.04%
f. Infant mortality rate changed from 27.07 to 26.79 or decreased -1.05%
g. Number of Puskesmas changed from 20 to 21
h. Health Index changed from 0.79 to 0.80

3. Probolinggo city

a. Percentage of population health complaints changed from 58.1 to 59.16 or increased by 1.79%
b. Percentage of proper household sanitation changed from 83.49 to 81.97 or decreased -1.85%
c. Access to proper drinking water sources changed from 83.18 to 81.99 or decreased -1.45%
d. Percentage of poor people changed from 7.2 to 7.09 or decreased -1.55%
e. Average length of school changed from 8.49 to 8.58 or increased 1.05%
f. Infant mortality rate changed from 17.16 to 16.99 or decreased -1.00%
g. Number of Puskesmas changed from 6 to 7
h. Health Index changed from 0.77 to 0.80

4. Banyuwangi Regency

a. Percentage of population health complaints changed from 42.88 to 42.11 or decreased -1.83%
b. Percentage of proper household sanitation changed from 68.06 to 66.62 or decreased -2.16%
c. Access to proper drinking water sources changed from 74 to 72.31 or decreased -2.34%
d. Percentage of poor people changed from 7.8 to 7.7 or decreased -1.30%
e. Average length of school changed from 7.12 to 7.19 or increased by 0.97%
f. Infant mortality rate changed from 25.62 to 25.36 or decreased -1.03%
g. Number of Puskesmas fixed from 45 to 45
h. Health Index changed from 0.77 to 0.80

The input data in 2020 can be seen in table 4.5.

Table 4.5 Input Variable Values and Results

No	Region	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1	Pacitan	41	54	67	13	7.3	19	26
2	Ponorogo	56	64	84	9.9	7.3	21	32
3	Trenggalek	50	75	50	11	7.4	18	22
4	Tulungagung	50	75	66	7	8.2	18	33
5	Blitar	43	61	72	9.2	7.4	20	25
6	Kediri	43	74	63	11	7.9	22	38
7	Malang	54	53	82	9.8	7.3	25	40
8	Lumajang	53	63	74	9.6	6.3	32	26
9	Jember	47	51	54	9.4	6.2	49	50
10	Banyuwangi	41	66	72	7.4	7.3	25	45
11	Bondowoso	40	31	67	14	5.7	44	26
12	Situbondo	46	48	59	11	6.2	48	18
13	Probolinggo	43	39	60	18	5.8	55	34
14	Pasuruan	55	66	63	9.1	7	43	33
15	Sidoarjo	63	87	96	5.4	11	20	28
16	Mojokerto	44	89	71	9.7	8.3	19	27
17	Jombang	47	88	69	9.3	8.4	25	35
18	Nganjuk	41	85	69	13	7.8	27	21
19	Madiun	54	77	79	11	7.7	27	28
20	Magetan	55	86	89	9.8	8.1	19	22
21	Ngawi	43	54	75	14	7	21	25
22	Bojonegoro	54	82	77	13	6.9	36	37
23	Tuban	51	78	78	15	6.7	27	35
24	Lamongan	60	96	73	13	8	31	33
25	Gresik	61	99	91	11	9.1	19	34
26	Bangkalan	51	42	57	19	5.5	50	23
27	Sampang	59	70	78	20	4.5	41	21

28	Pamekasan	41	16	69	14	6.5	41	21
29	Sumenep	42	18	85	21	5.4	42	31
30	Kediri city	39	96	65	7.3	10	18	11
31	Blitar city	51	97	69	7	10	15	5
32	Malang city	37	89	81	4	10	17	17
33	Probolinggo city	60	79	81	6.9	8.7	17	8
34	Pasuruan city	52	86	86	6.6	9.3	32	9
35	Mojokerto city	65	97	77	5.3	10	19	5
36	Madiun city	40	97	89	4.3	11	19	8
37	Surabaya city	54	83	101	4.6	11	19	64
38	Batu city	45	96	93	3.7	9	24	6

Prediction Per Region in 2020

Figure 4.2 Health Level Prediction Results in 2020

Figure 4.2 maps the prediction results with ANN-Backpropagation based on input data in 2020 from the admin where there is an increase in the level of health from high to very high in the following districts :

5. Tuban district

a. Percentage of population health complaints changed from 49.75 to 51.06 or increased by 2.57%
b. Percentage of proper household sanitation changed from 76.37 to 77.93 or an increase of 2.00%
c. Access to proper drinking water sources changed from 80.43 to 77.83 or decreased -3.34%
d. Percentage of poor people changed from 15 to 14.76 or decreased -1.63%
e. Average length of school changed from 6.59 to 6.67 or increased by 1.20%
f. Infant mortality rate changed from 27.03 to 26.71 or decreased -1.20%
g. Number of Puskesmas changed from 34 to 35
h. i. Health Index changed from 0.79 to 0.80

CONCLUSION

From the results of this study it can be concluded that:

1. The ANN-Backpropagation method can be used to map and predict the results of the training model using data from 2014 to 2018 with an MSE value of 0.008955896.
2. The system using the ANN-Backpropagation method can predict the level of health based on user input and provide an overview of the level of health in 2019, 2020, and 2020 in the form of a map

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