ANN Back Propagation in forecasting and policy analysis on family planning programs: A case study in NTB Province

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Abstract. Various government programs and policies are aimed at improving the welfare of the community. One of them is implementing a family planning program to suppress high population growth. The research aims to implement the artificial neural network architecture of the Back Propagation method of two hidden layers to see an increase in active users of the family planning program on three types of programs namely implants, injections, and pills. The data used include family planning data of ten districts in NTB province consisting of 165 input data. Predicted results showed that the best architecture with an accuracy rate of 99.21%, obtained by the value of learning rate of 0.8, the activation function of each layer is logsig, and the training method is TRAINRP. Besides, obtained information that the average decline in the user type of pills in each district/city. While in other types there is an increase of 8% on Lombok Island, while on Sumbawa Island amounted to 50%.

Keywords: Artificial Intelligence; Back Propagation; Family Planning.

1. Introduction
Population growth in world countries takes place very quickly. Uncontrolled growth has an impact on increasing poverty and the low value of human resources [1],[2]. The improvement of the quality of human resources is not separated from family planning through the family planning Movement (FP) to achieve prosperity. The family planning program has been one of the histories of success in the 20th century [3]. Data shows nearly 60% of the productive couples worldwide using contraception. Up to now, the population has reached 6 billion and more than 120 million women in the developing world have no way of preventing pregnancy [4]. As is known in the developing world that Family Planning (FP) is an integrated program so-called Health and Family Planning, which is structurally integrated but may further emphasize the population in particular. When talking about the use of modern contraceptives, in general, the use increased from 54% year 1990 to 62% in 2017, and in Asia, modern contraceptives are at a level of 62% [5].

Self-contraceptives available in Indonesia are enough to help regulate and prevent unwanted pregnancies. But among the many contraceptives, FP injections are the most widely selected by the
Indonesian people, when compared with other contraceptives. According to the National Planning Coordinating Agency Data (called BKKBN) users of injectable FP as much as 341,109 (47.94%), users of FP pills as much as 146,767 (26.81%), and users of Spiral or Intra Urine Device (IUD) as much as 23,383 (7.46%), an implant user of 51,536 (8.58%), a condom user of 19,583 (7.51%), and finally a user of the female operating method (called MOW) with the male operating method (called MOP) as much as 9,289 (1.7%) From all of the national FP participants in March 2020 period of 6,152,231 users [6],[7].

The Government's policy regarding the use of FP is to act on the Law No. 40 the year 2004 on National Social Security system (called SJSN), in this law is governed by a description of health services that include FP services. The FP service in Indonesia itself becomes the domain of the BKKBN institution that has a basic task in the field of population control and the implementation of family planning.

Policies and measures in the field of residence and family planning since the program of the First Five-year Development Plan (called REPELITA) is part of a long series of population growth control and is also an integral part of the Indonesian human development business. Efforts to lower the birth rate are implemented through dissemination and provision of family planning facilities as well as efforts to improve the knowledge, attitudes, and practices of family planning [8],[9]. The completion of the activities that encourage families to carry out happy and prosperous small family norms. The history of FP in Indonesia itself has increased from the initial implementation of the Government's FP program policy to the present.

There is a need to predict the FP usage data for future policies, this needs to be done to control population data in Indonesia. The prediction of FP usage data is also required for emergencies as of today, while COVID-19 pandemic conditions that result in health policies are at an extraordinary time [10],[11],[12]. Related to this prediction of FP usage can be collaborated with an Artificial Neural Network (ANN) which is one of the information processing systems that is designed by imitating human brain work in solving a problem by doing the learning process through its synaptic weight change [13],[14]. This ANN is used to recognize data-driven activities in the past. The past data was learned by ANN so that it was able to give decisions on data that has never been studied [15]. We can use the ANN Back Propagation method to solve complex problems related to FP user projections in Indonesia. In the Back Propagation method, there are 3 phases namely advanced phase, backward phase, and weight modification phase.

Results of the research implementation of Artificial Neural Network (ANN) Back Propagation method on health-related to the spread of Dengue Fever Disease (called DBD) in Ambon City, get the results of the formation of the best network architecture of one hidden layer with the number 0.4 of neurons as many as 25 neurons and the best training algorithm is to use 0.0099 the learning rate ANN Back Propagation method for spreading DBD disease in Ambon City has a high accuracy rate of 90%. This is influenced by several factors, among others, is the weather factor, the population density and the free number of flick also affects the spread of DBD disease in Ambon City [16]. Further research conducted by Restiana Putri, et al related to the application of ANN to predict the number of new FP participants in Semarang District with the Back Propagation method. Based on the results of the data simulation obtained MSE value of new FP participants year 2011 obtained MSE value of 0.0005 and year 2012 obtained MSE value of 0.0005 while based on the value of MSE in 2013 for 0.027 that the result is quite accurate. In addition, Syahraruddin, et al also explained that (1) ANN Back propagation in the prediction Wind Speed reached an accuracy level of 99.9% with a learning rate of 0.7 [17]. While Irawan, et al, explained that in the prediction of hydro-climatology data reached an accuracy rate of 99.71% with a learning rate of 0.7 [18],[19].

Therefore, the goal to be achieved from this research is to (1) perform predictions and interpretation of data on the number of users of the FP program at the age of fertile consisting of 3 types of implant users, pills, and injections in West Nusa Tenggara province, Indonesia, and (2) analyzing government policies in carrying out the family planning program.
2. Methods
This research is a quantitative study by analyzing the predicted data using the Artificial Neural Network (ANN) Back Propagation method with two hidden layers. The data used is the last 12 years of the active user Family Planning (FP) type of implant, injections, and pills. This Data is derived from https://ntb.bps.go.id/, consisting of 10 regencies/cities in West Nusa Tenggara province. As for the steps in conducting simulation and analysis of data prediction result as follows.
   a. Do the architecture of ANN Back Propagation with two hidden screens, which are training with various input options on each layer, selection of training functions, selection of activation functions, learning rate, and other parameters.
   b. Choose the best method by looking at the smallest MSE and MAPE from each training data. Then use the architecture to predict the final data.
   c. Record and tabulate prediction results
   d. Perform analysis and interpretation of prediction results
   e. To review government policy based on predicted results for referral in community planning and development.

3. Results and Discussions
The initial stage is to divide the data into two parts which are training data and data testing. Data training is used to determine the best architecture of ANN Back Propagation. Data from each district/city consists of 12 years with 3 types of data, namely user data of implants, user data on injections, and pill user data. Furthermore, from 10 regencies/cities, the team did a two-time simulation of (1) Regency/city on Sumbawa Island and (2) the district/city on Lombok Island. This is because West Nusa Tenggara Province consists of two islands. From this explanation, the distribution of data is obtained:
   - Data Training: $X_1, X_2, X_3, ..., X_{165}$
   - Data Testing: $X_{166}, X_{167}, X_{168}, ..., X_{180}$

From this input data is done simulation using the activation function of each layer is LOGSIG, training function is TRAINRP, maximum epoch of 1000, goal of 0.0001, learning rate (LR) between 0.1-0.9. From the simulation results obtained results according to Table 1 follows.

| LR | Epoch | MSE       | MAPE    | R       |
|----|-------|-----------|---------|---------|
| 0.1| 415   | $1.882 \times 10^6$ | 11.087  | 0.99868 |
| 0.2| 393   | $1.887 \times 10^6$ | 9.3850  | 0.99868 |
| 0.3| 285   | $1.883 \times 10^6$ | 8.2315  | 0.99869 |
| 0.4| 429   | $1.889 \times 10^6$ | 9.4074  | 0.99869 |
| 0.5| 302   | $1.881 \times 10^6$ | 9.5522  | 0.99868 |
| 0.6| 450   | $1.889 \times 10^6$ | 9.8499  | 0.99868 |
| 0.7| 311   | $1.883 \times 10^6$ | 10.994  | 0.99868 |
| 0.8| 440   | $1.884 \times 10^6$ | 8.0056  | 0.99869 |
| 0.9| 650   | $1.886 \times 10^6$ | 9.37579 | 0.99868 |

From table 1 we can see that the predicted results using the learning rate of 0.3 and 0.8 slightly outwit the research team, since the value of epoch with LR = 0.3 is smaller than LR = 0.8, but from the value MAPE to LR = 0.8 smaller than LR = 0.3, then the second training is done using Sumbawa Island data, so obtained the results according to Table 2 as follow.
Table 2: Result of Second Testing of ANN architecture.

| LR  | Epoch | MSE     | MAPE   | R    |
|-----|-------|---------|--------|------|
| 0.3 | 594   | 2.752 x 10^6 | 22.0532 | 0.99374 |
| 0.8 | 605   | 2.749 x 10^6 | 21.3615 | 0.99372 |

From Table 2 It appears that LR = 0.8 delivers better results than LR = 0.3, so that the research team did a prediction using the architecture ANN Back Propagation with the identity of the activation function is LOGSIG, the training function is TRAINRP, maximum epoch of 1000, goal of 0.0001, learning rate of 0.8, input layer of 90, layer hidden-1 as much as 10, layer hidden-2 as 5, and the output layer as much as 1. The simulation results according to Table 3 follows.

Table 3: Prediction of FP Program User.

| District        | Implants | Injections | Pills |
|-----------------|----------|------------|-------|
| West Lombok     | 32,579   | 49,893     | 10,362|
| Central Lombok  | 27,344   | 77,063     | 9,603 |
| East Lombok     | 36,936   | 96,758     | 27,406|
| North Lombok    | 6,645    | 8,886      | 4,496 |
| Mataram City    | 6,323    | 17,626     | 1,308 |
| Sumbawa         | 25,315   | 20,265     | 3,777 |
| Dompu           | 49,794   | 13,723     | 2,619 |
| Bima            | 35,385   | 32,710     | 1,569 |
| West Sumbawa    | 8,808    | 16,323     | 1,926 |
| Bima City       | 4,866    | 3,126      | 1,450 |

From the simulation results in Table 3 above, that for the prediction of Lombok Island data obtained the number of epoch (iterations) of 404, MSE value of 1.88281 x 10^6, MAPE value of 7.65094, Regression of 0.99866. As for the prediction of Sumbawa Island data obtained the number of epoch (iterations) of 480, MSE value of 2.75058 x 10^6, MAPE value of 19.9432, Regression of 0.99339. As for the pattern of data spread each island is seen in Figure 1 and Figure 2.

Figure 1: Data distribution pattern prediction for Lombok Island.
Figure 2: Data distribution pattern prediction for Sumbawa Island.

In addition, the chart of predicted results for the island of Lombok namely West Lombok Regency, East Lombok, North Lombok, Central Lombok, and Mataram city consisting of 15 data (3 x data types) can be seen in Figure 3, while Figure 4 is the predicted result for the island of Sumbawa consisting of Sumbawa Regency, West Sumbawa, Bima, Dompu, and Bima city.

Figure 3: Result of Prediction of Lombok Island.

Figure 4: Result of Prediction of Sumbawa Island.
From the results of this prediction, it is seen that the increase of users of the FP program on Lombok Island is lower than on Sumbawa Island, which is 8% and 50% respectively. The high percentage increase is certainly not separated from the difference in the view and the number of workers on both islands. Where the number of workers on Lombok Island more than the number of workers on Sumbawa Island, so it affects the setting of children's number and growth of infant birth.

Predictions of users of family planning programs is one of the important activities done. Especially in the time of COVID-19 nowadays the more dominant fertile couples stay in a long time in their respective homes. This certainly affects the high engagement of both partners. Therefore, there must be real action from the government to prevent the occurrence of the baby boom.

The prevention of the baby boom in the pandemic era of COVID-19 today also needs to be anticipated, as the prevention BKKBN conducts FP services while maintaining distance and counseling through online media [20]. The anticipation is certainly done for the welfare of the people for both the short and long term. There are 5 (five) policies conducted by BKKBN during a pandemic COVID-19 namely (1) BKKBN (Central and Provincial) coordinate with the Regency/city government to perform the coaching of the FP-conditioned and break-up prevention through various media, especially online media; (2) FP Mentoring/FP field officers in collaboration with the local community institution cadres perform analysis of the Fertile Age Pair data to determine the number and distribution of PUS requiring services for injections, pills, IUD and implant, (3) the government can distribute repeat contraceptive pills and condoms under the supervision of the Community Health Center, doctors and local midwives, (4) the government coordinates with the closest health facilities in the preparation and implementation of FP service activities, as well as fostering FP participation, including Information and Education Communication Media (IEC) and counseling using online media and social media or direct visits with due regard to ideal distances, and (5) Inviting midwives to act as supervisors and supervisors in the distribution of supplies by the government.

4. Conclusion

The implementation of policies in the family planning program to prevent the high birth rate of infants (baby boom) especially in the time of pandemic Covid-19 is very important. Previously, it was necessary to predict attempts to increase or decrease the number of users of this program as the initial data, making it easier to implement the policy. ANN Back Propagation has provided good prediction results reaching an accuracy rate of 99.21%. From the results of this prediction, it is seen an increase in the number of users on Lombok Island by 5%, of course, this value is minimal considering the level of interaction in a couple of fertile age is very high at the time of pandemic Covid-19, so the Government must strive to realize the planned program plan. While the increase in the number of FP program users on Sumbawa Island amounted to 50%, this means a good enough value to suppress the high baby birth rate on the island.

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