Data Visualization of Environmental Factors in Poultry Farm

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Abstract. The purpose of this study was to show the data visualization of environmental factor in poultry farm. In poultry farm sector, the environmental factors around the cages is important to support the success of poultry farm business. Breeders must have good knowledges about environmental factors, such as temperatures, humidity, and ammonia level. Ignorance of one of these can affect growth of broilers. Management of poultry farms and breeders need tools to facilitate the monitoring processes for environmental factors in their poultry farms. This research will focus in discovering proper data visualization for breeders using data visualization method. Moreover, hidden knowledges in this domain can be extracted too in the process of visualization using DBSCAN method. Software which visualizes all of analyzed information will be developed as main result of this research. By using software that can visualize proper visualization about environmental factors in poultry farm, breeders can make proper strategic decision and decrease less favorable events in their poultry farm.

1. Introduction
All aspects in life need knowledges. Knowledges can be gotten from many sources. Before getting the knowledges, information must be read in proper way. Data owner can present their data in many forms. Sometimes, it can be difficult to extract information if data were presented in wrong ways. This thing can result wrong knowledges and lead the business to the wrong path. Absolutely, business owners don’t want this thing happens. One of critical sector that needs easy and optimal way to extract information and knowledges is poultry farm sector.

For Business like poultry farm, information may lead to the increment or decrement of profit. If the cage condition is not well maintained then failure may occur. Failure of a poultry farm can start from the breeder’s error in cage maintenance and temperature regulation [1]. Failure in cage maintenance can cause disadvantages and reduced the revenues.

The environmental factors such as air temperature, humidity, and ammonia level must be known by breeders. Ignorance of one of these can affect the growth of broilers. Management of poultry farms and breeders need tools to facilitate the monitoring processes for environmental factors in their poultry farms. The need for monitoring is also due to anomalies in the enclosure. The anomaly occurs because there are differences in the condition of one or several broilers with other broilers [2]. A large number of broiler chickens in each cycle period also makes breeders have difficulty in knowing causes of chicken death. Collection of data history can help the production and management of broiler breeding. Data which are shown at tools must be visualized in appropriate way so that breeders can immediately know about proper strategies that must be taken.
One of the best ways to understand great data is with data visualization. Data visualization is a way to bring data more alive in the form of visual form to make them more efficient to understand and to be read [3-5]. With data visualization, the pattern in data can be extracted rather than just using the usual statistical methods. Visual forms, such as diagrams, symbols, and combination between them with texts, can represent environmental factors data to breeders and translate all of them in easiest way to be read. In this research, website will be developed to present data visualization in this domain case and usability testing will be conducted to measure how far the users can extract and understand about those visualizations.

The purpose of this study was to show the data visualization of environmental factor in poultry farm.

2. Research methodology
Research methodology, which was used to conduct this research, was referred to data visualization processes [6,7]. Based on that methodology, this research was conducted by using the methodology that can be seen at Figure 1.

![Figure 1. Research methodology in this research.](image)

Based on Figure 1, this research will be started by collect data from data source. After that, information needs would be identified for each user to filter data. Knowledge discovery was conducted as an enrichment process so that valuable information could be shown together with other visualization. To make this research more measurable, all of analyzed visualization were implemented in the form of software and usability will be held to ensure user’s understanding level about the visualizations.

3. Results and discussions
In this section, all stages in methodology will be discussed further. Explanations in this section is more about inputs, processes, and outputs of each stages. Some diagrams, figures, and tables will be presented to give more explanations. This section will be divides into five subsections same as methodology.

3.1. Acquire data from IoT sensors
Broiler data which will be used comes from two sources. First source is IoT sensors and second source is Excel documents that were filled by breeders manually. Data from IoT sensors was sent into Firebase so transforming data were happened here. The data structured were transformed into hierarchical structure with the intention of making data easier to be accessed. Data that were received by Firebase from the sensors are about how much chicken feed that were given per day and quality data of broilers.

Data from Excel documents were used as a comparator for IoT data. Sometimes, sensors can result some errors and to fix this, breeders need comparator. Data which will be used can be seen on Table 1.
Table 1. Data in this research.

| Data     | Name               | Attribute                          | Description                                                                 |
|----------|--------------------|------------------------------------|----------------------------------------------------------------------------|
| Data 1   | Mobile Sensor      | • Ammonia                          | These data contain environmental factors from each grid (equal to 1 cage for 20-50 broilers). |
|          |                    | • Weight                           |                                                                            |
|          |                    | • Humidity                         |                                                                            |
|          |                    | • Temperature                      |                                                                            |
| Data 2   | Fixed Sensor       | • Humidity                         | These data contain environmental factors in one cage (there are several grids in one cage). |
|          |                    | • Temperature                      |                                                                            |
|          |                    | • Wind speed                       |                                                                            |
| Data 3   | Outdoor Sensor     | • Humidity                         | These data contain environmental factors from outside area of cage.         |
|          |                    | • Temperature                      |                                                                            |
| Data 4   | Feed and Mortality | • Amount of Feed                   | These data is about amount of chicken feeds that were given per day and number of chicken death per grid. |
|          |                    | • Mortality                        |                                                                            |
| Data 5   | Quality of broiler | • FCR (Feed Conversion Ratio)      | All parameters in these data give big picture about how success breeders in growing up broilers. |
|          |                    | • IP (Index Performance)           |                                                                            |

3.2. Data filter based on user needs

Data filter in this research includes two stages, are parse and filter data. Parse is the process of classifying data that has been collected based on information needs to solve existing problems. While the filter is the process of mapping data based on information needs to be used in the next stage.

In this research, there are two groups of users. They are breeders and poultry farm owner. Breeders need information that specific about environmental factors in poultry while poultry farm owner need information that more specific about how success poultry farm that they owned. Based on that fact, information was mapped based on information needs per users as can be seen at Table 2.

Table 2. Result of information mapping based on information needs.

| Information Needs                                      | Data | For            |
|--------------------------------------------------------|------|----------------|
| Broiler conditions and the environmental factors per day| 1,2,3 | Breeders       |
| Is there a broiler grid that is different from other broiler grids | 1    | Breeders       |
| How good the development trend of broiler per day      | 1,4,5 | Poultry farm owner and Breeders |
| Success level of broiler maintenance                   | 5    | Poultry farm owner |

3.3. Mining knowledge’s using DBSCAN

Based on Table 2, there are two information that need to be extracted into knowledge. To know about the existences of grid that have different condition with others, it can’t be done if not doing knowledge discovery [8,9]. Analysis of methods and algorithms (mine) is a process in which problem solving is done using statistical calculations or certain algorithms [8-11]. Mapping methods and algorithms based on information needs can be seen on Table 3.

Table 3. Result of method and algorithm mapping

| Information Needs                                      | Method |
|--------------------------------------------------------|--------|
| How broiler conditions and the environmental factors per day | Statistics |
| Is there a broiler grid that is different from other broiler grids | DBSCAN  |
To find information about how broiler conditions and the environmental factors per day, descriptive statistics method was applied to data 1 and data 2 to find the average of each attribute. Contrary to that, DBSCAN was applied to data 2 to find outlier between grids in one cage. DBSCAN is a clustering method which be able to identifying noise in a group of data based on density between data points [12,13]. Some data from mobile sensor were chosen as sample data. Sample data come from January 1, 2018.

To determine the optimal eps value is to measure the distance between the center of the cluster with each data point used Euclidean Distance, then get the distance matrix [12,14]. In this example, the number of nearest neighbors (k) is 3 (3-Distance). Based on the k-distance results, they can be determined the optimal estimation of eps value for each data. Results of plots that have been sorted ascending are described by k-distance Graph at Figure 2. It can be seen that the optimal value of eps is in the range of number 71 with minPts worth 3 [13]. After the data is done for the implementation, cluster results were obtained. Results plot of clusters can be seen on Figure 2 and Figure 3.

![Optimal eps value=71.00](image)

**Figure 2.** K-distance graph with optimal eps value.

![Cluster plot](image)

**Figure 3.** The result of clusters plotting.

### 3.4. Mapping visualization

Visualization aims to make data easy to read and understand [15]. In general, the presentation of data can be grouped into three parts: presentation in the form of text, presentation in the form of tables and presentation in the form of graphs or diagrams [16,17]. The diagram is used because it is easier to get the picture data as a visual tool for the layman [18]. The result of data visualization mapping can be seen on Table 4.

| Information Needs                              | Chart       |
|------------------------------------------------|-------------|
| How broiler conditions and the environment every day | Symbol      |
| Is there a broiler grid that is different from other broiler grids | Heat map   |
| How is the development trend of broiler every day | Line Chart  |
| How big the success of broiler maintenance     | Symbol      |

These are the explanations of several forms of visualization that is used in this research:

#### 3.4.1. Symbol

The needs for this visualization is to show the condition of broilers and their environments from each grid. The conditions of broilers and the environment are described by symbols that represent the condition. Explanation of symbols used can be seen at Table 5. Results Form of visualization that is used these symbols can be seen at Figure 4.
### Table 5. Explanation for each symbol.

| Symbol | Information  |
|--------|--------------|
|        | Weight       |
|        | Ammonia      |
|        | Humidity     |
|        | Temperature  |

### Figure 4. Visualization about weight, ammonia level, humidity, and temperature.

#### 3.4.2. Heat map.

The needs for this visualization is to find out whether there is a broiler grid that is different from other broiler grids. This information is obtained from the calculation of DBSCAN clustering algorithm that has been done before. The results of cluster visualization can be seen at Figure 5.

#### 3.5. Implementation and usability testing

In this last stage, a website to visualize information in this research was built. This is meant for users to try and be measured how understanding level of them. Usability testing was conducted to ensure that visualization in website meets the research objectives [19].

Scenario testing usability testing by defining the tasks that will be ordered to system testers, namely the cage officer. A defined task consists of two types: poor task and better task. The example of test scenarios can be seen at Table 6.

### Table 6. Poor and good task for usability testing.

| User Goals                                      | Poor Tasks                                                                 | Better Task                                                                 |
|------------------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| Knowing about environmental factors around cages | Search information about average number of temperature of cage at first floor | Search information about environmental factors at cage 1.                   |
| Knowing about the growth of broilers            | Search information about weight of broilers at cage 1 in Mei 20, 2017      | Search information about growth level of broilers.                          |
| Knowing about cages that have different conditions with others | Search information about abnormal grid at second floor                    | Search information about the condition of broiler that had been showed on grid |
From the results of usability testing, the results of the effectiveness level are 100%. From these results can be concluded that the testing of broiler data visualization system has met the expected goals. The cage officer can do the job well provided and understand the knowledge of each displayed data.

4. Conclusions
Based on the results of implementation and testing, it can be concluded that the visualization in the developed software can help the cage officer in monitoring the environmental conditions of the cage and the development of broiler and beside that, symbols are more effective to be understood by users in this domain than other visualization forms. However, there are still constraints faced in visualizing data in real-time. A constraint if the data captured by the sensor can not be stored into the database or the constraint due to error reading the data from the sensor. Therefore, for the development of a data visualization system in the future, optimizing communication between sensors and database and optimizing of data which is served by services will be needed to be research further.

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