Maximizing the water resource potential in Girikerto Village, Sine Subdistrict, Ngawi Regency by establishing bottled water home production

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Abstract. The importance of water in human being’s life is an undeniable fact. On that part, water can have countless function and holds an important key to the development of a civilization. On this paper, a procurement of commercializing the water potential of Girikerto village, on the north slope of Mount Lawu in Ngawi Residence, East Java, Indonesia was held. The enormous water source in Girikerto has potential for Produksi Air Minum Dalam Kemasan or bottled water production as a local commodity water product. The non-filtered water taken from samples is tested for the bacteria, and compared to the water after filtration system is installed. By installing less-sophisticated homemade water filter, the coliform bacteria could be eliminated by 99.14%. The economic advantages of producing bottled water is also profitable, since it could generate sales up until 10 million rupiahs, profit margin 0.54, and return on asset reached 3.15.

1. Introduction
Water is an essential need for any human being in every single part of the world; as it is a mutual resource; industry, agriculture, along with living and environmental purposes. For Indonesia, the amount of water differs among regions and is fluctuating by the season. Yet, even though the annual rainfall reaches of 2700 mm, the number of it infiltrates and percolates as groundwater is only 278 mm (10 percent) [1]. Due to the fact that Indonesia is one of the richest countries in the world in terms of water, average domestic water consumption between 1996-2005 was only 28.5 liters/person/day [2]. Based on the data provided by [3] showed that among 2007-2011, 30.8 per cent of households in urban areas had access to a piped water supply, 9 percent in rural areas and an average of 18.4 percent across the country.

Nestled in the northern part of Mount Lawu in Indonesia, Girikerto village, East Java, is one of the areas that do not have access to a piped water supply. This distinctive-looking village is specifically located on the north slope of Mount Lawu which has been dormant for quite a long time, within Sine District, Ngawi Regency, East Java. The land has a mountainous structure of ± 800 m asl and receives relatively high rainfall. Most of the area is in the form of forest conservation area, tea garden, and village farms. Girikerto is populated by 2,200 people; 40% of them are farmers. Girikerto has 4
different regions within the area of 1,097,117 ha; Girikerto, Nglegok, Jamus, and Banjaran. The regions on the upper side is occupied with tea gardens with a view of Ngawi Region [4].

With the location of Girikerto village within the slope of Mount Lawu, it has tremendous water resources. Water resources such as springs, waterfall, and underground water all can be found in the mountain area; Mount Lawu in this case. According to [5], underground water is stored in aquifers with depths from several meters to hundreds of meters below the surface, and had a residence time of several days to millions of years. This underground water then will form kinds of water resources stated above as a continuation of the natural process. The water from spring will be back to its cycle to becoming groundwater. During its drainage, underground water undergoes various processes that makes it contain various kinds of minerals and eventually have different qualities in each place.

![Figure 1. Sumber Koso Spring, one of the two main springs of Girikerto village, Ngawi Regency, Indonesia](image1)

![Figure 2. Sumber Lanang Spring, one of the two main springs of Girikerto village, Ngawi Regency, Indonesia](image2)

Girikerto village has two main springs; Sumber Koso spring (Fig.1) and Sumber Lanang spring (Fig.2). These springs are several hundred meters apart in terms of height and a few kilometers away in terms of distance. Sumber Lanang spring is higher located in Jamus, whereas Sumber Koso spring is located in Banjaran. Even when the dry season dried a lot of springs back in 2015, these springs
never runs out of water and it still is flowing with water until the very now. This particular spring is used for tourist attraction as well, that could be seen by a lot of children play facilities and swimming pool; the public interest around Ngawi is high. The distinctiveness of this spring and the comforting surroundings result in the survivability of this place.

Sumber Koso Spring, although not placed geographically higher, still holds a great amount of water to provide sources for Girikerto, Banjaran, and Nglegok; mostly Banjaran. Sumber Koso, unlike Sumber Lanang, shaped more like a small lake rather than heavy tide-ish like Sumber Lanang spring. The beautiful look of Sumber Koso also is used for tourist attraction, although not as well-known as Sumber Lanang is, that adds one more great potential. This water potential can also bring advantages to development of small to medium homestay businesses [6].

The particular village is out of reach from the government piped water supply; yet Girikerto village initiated its own piped water system due to their rich water resource. Having not only one but two source of water, these resources could have been maximized. The enormous amount of water generated from two springs are only used for agricultural, daily needs, and consumption from households in Girikerto village. Most amount of water are used for irrigation, watering people’s garden and farms. Not many use the water for growing fish in a pond by their house, but not for a commercial use. From the water, the development of small homestay businesses in Girikerto village are also helped by the water resources, as the visitors will see into the Girikerto people’s daily life and the water potential experience. Conducted interview of Girikerto village resident stated that the water is overwhelmingly wasted. People have to keep their tap open so that the pipe will not be broken because of the water that keeps on flowing. Yet, the idea of commercializing the resource is still seen as a taboo; it is considered unfair. Even, people that is going to sell Girikerto water have to do the transaction in secret.

Water treatment engineering began to evolve around the beginning of the twentieth century as to ensure that the water supplies consumed were removed or inactivated from infectious organisms. Practices of chlorination and filtration were playing a big role in the success of visibly eliminating major death-causing waterborne by 1930s [7].

The initiation of Air Minum Dalam Kemasan or Bottled Drinking Water (will be abbreviated by BDW) is economically, environmentally, and strategically advantageous. Producing bottled water in Girikerto village needs to undergo several standards, needs small human resource management, and uphold the economic standards of the particular village. By having their own very brand of Girikerto’s Bottled Drinking Water, it will be the first local brand bottled water of Ngawi Regency, adding the regency’s pride and water production independency. The production of BDW in Ngawi could be one of the biggest local commodity.

Drinking water is processed or unprocessed water which meets health requirements and is able to be consumed directly [8]. According to [9] the quality of drinking water is a determinant of health for the environment, for water holds a crucial role in life and is capable of transmitting plague to a country even to all continents. Bottled Drinking Water (BDW) are products that are regulated extensively. WHO, country, local government and associations such as IBWA plays a major role in regulating standards of BDW. Generally, the regulations are standards that are based on health considerations.

Former research of water quality in Girikerto showed that in general, the water source used by people can still be safely used on their daily activities since it still meets the quality standard and not polluted [10]. The research compared the samples among two main springs in Girikerto and the river which are flown from them. This will be a form of continuation from the research, which analyze whether the water flows from the two main sources of water in Girikerto can be safely used for consumption and even of a commercial use.

Several objectives of this brief research paper are 1) to examine the quality of the water in the locals’ houses and the two main springs in Girikerto, 2) to contrast the water quality with the standards, based on bacteria level, 3) to figure out whether a bottled water home production can be operated to maximize the water potential, and, to 4) to analyze the economic benefit in establishing a BDW home production.
2. Methodology
This research started with collecting water sources data and information. Samples are taken from field survey and is from different sources of springs that is used by Girikerto residents, even the sources from springs in another village but is used by the particular resident. 1) Water sample taken directly from Sumber Koso spring, 2) Water sample taken directly from Sumber Lanang spring, 3) Water sample taken from Lastri, Girikerto resident, sourced from Gunung Gandhel spring, 4) Water sample taken from Diranto, Girikerto resident, sourced from Sumber Kupang spring, 5) Water sample taken from Rudi, Girikerto resident, sourced from Sumber Koso spring.

Unfiltered sampled water then would be tested for coliform bacteria amount. Coliform bacteria is defined as categories of microorganisms generally found in surface water, soil, on plants, and some of them are inside animals and humans’ digestive system [11]. Observations and analysis of the water sample will be conducted in the laboratory of Dinas Kesehatan Ngawi, East Java, on January-February 2019. The test is based on [12] as stated in the [13] by using the Most Probable Number (MPN) method. This method is to enumerate the most probable number of coliforms per 100 ml of water; the bottom line is to dilute the sample in such a way that inocula in the tubes contains viable organisms at times, but not all of them will in every case [14]. By this bottom line, the estimation of original, undiluted concentration amount of bacteria in the sample can be implied by the number of tubes and the number of tubes with growth at each dilution. Double incubation tubes is used to obtain estimates over a broad range of possible concentration [15].

Indonesian National Standard or SNI for mineral water and demineralized water requires Coliform contamination where coliform colonies cannot be detected per 250 ml of bottled water, as Permenkes 492/2010, and WHO stated. From this sample, we will compare the result and filter the water using hand-made filter. The simple, less-sophisticated water filter (Fig. 3) is a filter made from these materials:

1. Nanotec Housing x2
2. Nanotec Bracket x2
3. Wrench Housing x2
4. Screwdriver x2
5. DN 3/4” x1
6. SDL 3/4” x2
7. PVC Glue x1
8. Sediment Filter x1
9. CTO Carbon x1
10. TBA Tape x1
11. UV filter x1

![Figure 3](image-url) Hand-made water filter to refine the remaining bacteria for establishing BDW in Girikerto village, Ngawi Regency, Indonesia
The particular materials are then assembled and attached to the water pipe. Then, it would automatically filter the water. The installation of simple water filter takes 3 hours at most, from assembling the material to attaching it to the pipe. After several hours, water flowing to the pipe then taken as a sample and sent once again to the lab. Thus, the filtered water will sustain the second test of coliform water amount, where the effectiveness of homemade water filter will be put at stake. This second test will also determine whether or not the maximization of water potential in Girikerto by establishing bottled water production can be conducted.

3. Results
Result of the Coliform test on various water samples from Girikerto village is presented in Table 1: In accordance with the coliform test result conducted in Table 1, it can be concluded that the least coliform amount in the water comes from Sumber Lanang sample, with 39 coliforms/100 ml. Sumber Lanang Spring is located the highest among the other four samples, thus making it the least “contaminated”. That is what makes drinking water directly from tap in areas around Sumber Lanang will be considered safe, by simply filtering it with filter sheet. With the recent fact, the development of BDW is going focused more on the spring below, which is Sumber Koso spring in Girikerto to maximize the water potential, which we will sample the water from Rudi.

The result of coliform test filtered water in Rudi from Sumber Koso spring is presented in Table 2:

Table 1. Laboratory result on Coliform test conducted from water samples in Girikerto village, Ngawi Regency, Indonesia

| Sample Name        | Source          | Parameter          | Measurement       | Method                                      | Maximum Standard of Clean Drinking Water | Lab Result |
|--------------------|-----------------|--------------------|-------------------|---------------------------------------------|------------------------------------------|------------|
| Sumber Koso        | Sumber Koso spring | Total Coliform     | MPN/100ml         | Double tube, APHA 9222.B,ED.23.2005          | 50                                       | 94         |
| Sumber Lanang, Jamus | Sumber Lanang spring | Total Coliform     | MPN/100ml         | Double tube, APHA 9222.B,ED.23.2006          | 50                                       | 39         |
| Lastri             | Gunung Gandhel spring | Total Coliform     | MPN/100ml         | Double tube, APHA 9222.B,ED.23.2007          | 50                                       | 430        |
| Diranto            | Sumber Kupang Spring | Total Coliform     | MPN/100ml         | Double tube, APHA 9222.B,ED.23.2008          | 50                                       | 220        |
| Rudi               | Sumber Koso spring | Total Coliform     | MPN/100ml         | Double tube, APHA 9222.B,ED.23.2009          | 50                                       | 350        |

Table 2. Laboratory result on Coliform test conducted from filtered water in Girikerto village, Ngawi Regency, Indonesia

| Sample Name | Source | Parameter | Measurement | Method                                      | Maximum Standard of Clean Drinking Water | Lab Result |
|-------------|--------|-----------|-------------|---------------------------------------------|------------------------------------------|------------|
| Rudi        | Sumber Koso | Total Coliform | MPN/100ml   | Double tube, APHA 9222.B,ED.23.2009          | 50                                       | 3          |
From Table 2, it is proved that by just installing decent water filter, the amount of coliform bacteria in the water could be terminated by 99.14%. It would not then be necessary to boil the water to be consumed, moreover, installing the water filter as well as producing bottled water will be possible and rather advantageous; as the cost of installing the water filter is an investment.

4. Discussion
Economic-wise, by calculating the financial components of producing BDW, the costs and advantages can be estimated. In applying the production of BDW, certain costs and estimations need to be counted:

In establishing a business, even a small-medium enterprise, costs that will occur before, after, or within the production needs to be calculated. Generally speaking, production costs can be differentiated into two costs: fixed costs and variable costs; fixed costs and variable costs are important in determining product costs, profit margin, to selling price; product costs comes from costs that is assigned to a product for a specific purpose [16]. Different purposes can result in different measures of product cost: profitability products and contracting with government agencies [16]. As to calculate the potential financial profit and growth of the BDW, several methods such as profit margin, return on asset, and break-even point can be used.

4.1. Fixed cost and variable cost
Fixed cost is a cost that is not changed in total for some period of time in spite of wide changes in activity or production volume. Unlike fixed cos, a variable cost fluctuates depending on changes in the total activity or production volume, or desired sales or profit [16]. Variable cost is usually similar to production cost. The fixed costs and variable costs incurred in producing BDW, assuming the targeted amount of each production is 5,000 units is presented in Table 3 and Table 4.

### Table 3. Variable cost of the bottled drinking water home production in Girikerto village, Ngawi Regency, Indonesia

| No | Goods                | Quantity | Price   | Total           |
|----|----------------------|----------|---------|-----------------|
| 1  | Bottle               | 5000     | Rp500.00| Rp2,500,000.00  |
| 2  | Bottle Cap           | 5000     | Rp80.00 | Rp400,000.00    |
| 3  | Bottle Seal          | 5000     | Rp35.00 | Rp175,000.00    |
| 4  | Cardboard            | 208      | Rp3.200.00| Rp665,600.00    |
| 5  | Bottle Brand Label   | 15000    | Rp60.00 | Rp900,000.00    |
|    | **Total Variable Cost** |          |         | **Rp4,640,600.00** |

| Variable Cost per unit: | Rp928,12 |

### Table 4. Fixed cost of the bottled drinking water home production in Girikerto village, Ngawi Regency, Indonesia

| No | Goods               | Quantity | Price   | Total           |
|----|---------------------|----------|---------|-----------------|
| 1  | Nanotec Housing     | 2        | Rp100.000.00| Rp200,000.00    |
| 2  | Nanotec Bracket     | 2        | Rp40,000.00| Rp80,000.00     |
| 3  | Wrench Housing      | 2        | Rp20,000.00| Rp40,000.00     |
| 4  | Screwdriver         | 2        | Rp10,000.00| Rp20,000.00     |
| 5  | DN 3/4”             | 1        | Rp5,000.00| Rp5,000.00      |
| 6  | SDL 3/4”            | 2        | Rp7,000.00| Rp14,000.00     |
| 7  | PVC Glue            | 1        | Rp10,000.00| Rp10,000.00     |
| 8  | Sediment Filter     | 1        | Rp40,000.00| Rp40,000.00     |
By calculating Fixed Cost and Variable cost, variable cost per unit or cost per unit can be obtained and the selling price can be made. In this case, since the fixed costs are also equipment and utility costs, the costs can be excluded in determining the cost per unit or else it would be overstated.

4.2. Estimated sales per production
Since the estimated production costs per unit is Rp 928.12, the selling price will be set at 100% to optimize the profit. Thus, it will be sold Rp 2,000. After determining selling price, the sales per production can be estimated.

\[
Sales = \text{selling price} \times \text{projected units sold}
\]
\[
= Rp \, 2,000 \times 5000 \, \text{pcs}
\]
\[
= Rp \, 10,000,000
\]

The estimated sales with selling cost at Rp 2,000 and production of 5,000 units is Rp 10,000,000.

Table 5. Estimated profit per production for bottled drinking water establishment in Girikerto village, Ngawi Regency, Indonesia (refer to last calculation for reference)

|                  | Sales        | Total Cost  | Filter Installment Cost | Profit       |
|------------------|--------------|-------------|-------------------------|--------------|
| First production | Rp10,000,000,00 | Rp4,640,600,00 | Rp1,704,000,00 | Rp3,655,400,00 |
| Next production  | Rp10,000,000,00 | Rp4,640,600,00 | -                       | Rp5,359,400,00 |

Table 6. Estimated profit margin per production for bottled drinking water establishment in Girikerto village, Ngawi Regency, Indonesia (Refer to last calculation and table for reference)

|                  | Net Profit   | Sales        | Profit Margin |
|------------------|--------------|--------------|---------------|
| First production | Rp3,655,400,00 | Rp10,000,000,00 | 0.37          |
| Next production  | Rp5,359,400,00 | Rp10,000,000,00 | 0.54          |

4.3. Profit estimation per production
According to Table 5, on the first production, the fixed cost of installing water filter will add up more costs. Meanwhile, after the first production, the costs of installing water filter will not incur until some period of time.

4.4. Profit margin
By calculating the profit/net income estimation, the profit margin can be calculated (Table 6). The profit margin shows the ratio of profit to revenue/sales [17]. Mathematically, profit margin net income generated by each dollar of sales. The higher profit margin is, the more promising business potential for obtaining optimal profit [18]. Profit margin counted in the first production and next productions, referring to the fact that the costs of water filter installment is only included in the first production. The profit margin of Bottled Water Production ranges from 0.3 to 0.54, which shows a good tendency towards the business potential since the closest profit margin to 1, the better [19].
4.5. Return on asset/RoA
Return on Asset is the net income divided by total assets [20]. RoA is calculated to figure whether or not the asset utilization to generate profit is effective [21]. An effective RoA is if it’s not fluctuating and increases each year [22]. Due to the assumption calculations of ROA in Table 7, ROA between the first production and the next production increases, indicating the asset utilization to generate profit effective.

Table 7. Estimated Return on Asset (ROA) per production for bottled drinking water establishment in Girikerto village, Ngawi Regency, Indonesia (Refer to previous calculation and tables for reference)

|                        | Net Profit       | Total Asset      | ROA  |
|------------------------|------------------|------------------|------|
| First Production       | Rp3.655.400,00   | Rp1.704.000,00   | 2,15 |
| Next Productions       | Rp5.359.400,00   | Rp1.704.000,00   | 3,15 |

4.6. Break-even point
Break-Even Point or BEP is the quantity of unit sold that will generate zero operating income; where the total revenues equal total costs [23]. With the following costs and selling price per unit, to generate zero income, it is needed to sell out 1,780 units (Table 8).

Table 8. Estimated Break-even Point (BEP) for bottled drinking water establishment in Girikerto village, Ngawi Regency, Indonesia (Refer to previous calculation and tables for reference)

|                        | Fixed Cost       | Cost Per Unit    | Variable Cost Per Unit | BEP   |
|------------------------|------------------|------------------|------------------------|-------|
|                        | Rp1.704.000,00   | Rp2.000,00       | 928,12                 | 1.780,12 |

5. Conclusions
Water resources in Girikerto village has a big potential to constructing home industry of Bottled Water Production. However, on its implementation, regulations and optimizations are needed; thus the Bottled Water Production can meet the standards set. BDW is also considered to provide solution to a healthier way of life due to more hygienic water consumption and lead to less health issues regarding microbacteria. Water Bottle production can be used as a local commodity local water product. local pride, longer economic value, and when the sales are low, products can be self-consumed. The economic calculation regarding the cost of producing water has generated promising income, boosting up economic advantages, as well as increasing the life standard of Girikerto village residents; that people would ensure either produced or consumed water in a good quality.

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