The water use for batik production by batik SMEs in Jarum Village, Klaten Regency, Indonesia: What are the key factors?

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Abstract. The Indonesian batik is a potential product to support the economy of Indonesia. In spite of its potential in supporting the economy of Indonesia, the water pollution caused by batik production by Small & Medium Enterprises (SMEs) needs to be addressed, as it leads to water scarcity since the batik production tends to consume a huge quantity of water. This research was conducted to identify key factors that influence water use for batik production among batik craftsmen, and explain those factors using the concept of circular economy. This study was conducted using qualitative method through focus group discussion (FGD) and in-depth interview as data collection strategies and quantitative data collected as secondary data. Our study found that some practices of the batik craftsmen have shown to fit to the circular cycle, although the dischargement of wastewater into waterways still fits to the linear model. Using secondary data, the direct water use for batik production were varies from 3.33 L/pc to 235 L/pc, depending on the craftsmen. If water footprint approach is to be used, the water use will be much higher. Finally, four key factors affecting the water use are discussed in this study and efforts that can be proposed to reduce the ratio water/product as well as maintaining water as a resource, as indicated by circular economy.

1. Introduction
The Indonesian batik is a cultural product which gets the attention of the government, particularly because of its potential to support the economy of Indonesia through the craft sub-sector. The craft sub-sector becomes one of the three sub-sectors within Creative Economy sector that contributes to the highest GDP, exports, and labor employment [1]. It is reported that contribution of craft sub-sector to Indonesia’s GDP reached 15.40% of total GDP from Creative Economy in 2016 [1].

In spite of its potential in supporting the economy of Indonesia, environmental issues induced by batik making process should also be addressed. In the context of water resources, the water pollution caused by batik production has been widely reported [2,3], which contaminates private water sources of the people [4]. While the pollution might cause the problem of scarcity, batik production by Small and Medium Enterprises (SMEs) is produced using a reasonable quantity of water.

There is a warning that the earth is a closed system, and hence a different economic principle which incorporate this view is required, mainly in the future. Therefore, instead of adoring production and consumption, this kind of economic emphasizes success as measurement of capital stock and its maintenance become very essential [5]. This view is considered to influence the circular economy concept, i.e. a relatively new concept which involves the slowing, closing, and narrowing loops of matter and energy in order to minimize resource input, wastes, emission, and energy leakage [6].
this concept, reuse, refurbishment, and remanufacturing materials are essential, and recovery should be done prior to those three activities [7]. This concept, therefore, is suitable for batik production, mainly regarding the minimizing input of resources.

Our previous studies in Jarum Village indicated that the batik’s water footprint among batik small & medium enterprises (SMEs) were different. We found the water footprint of batik making process of batik produced by a large-scaled SME reached 1,309 L/pc – 5,549 L/pc for a piece of batik fabric in size of 2.50 m x 1.15 m [8], which is equal to 455.30 L/m² – 1,930.09 L/m². On the small-scaled SME, the water footprint of batik making process was found to be 550.72 L/pc for a piece of batik fabric of 2.50 m x 1.05 m in size or equal to 209.79 L/m² [9]. Furthermore, the blue water footprint (BWF) of two large-scaled SMEs could reach 234 L/day [8] or equal to 4.68 L/pc [9] and 156.48 L/pc – 158.70 L/pc [10], respectively, in comparison to the smaller SME which BWF was 105 L/day or 1.55 L/pc [9].

The vast difference, in term of water use, for batik production among SMEs leads to a question on the factors attributing to this difference. An understanding on these factors will be useful in mapping the real problem around the water use among SMEs and efforts required to solve the problem. Therefore, the purpose of this research is to identify factors that influence the water use in batik production among batik craftsmen, and explain those factors using the concept of circular economy.

2. Method
This study is conducted in Jarum Village, Bayat sub-district, Klaten regency, Central Java province, Indonesia. This location is selected because this village has been for a long time become producers of batik by both of natural and synthetic dyeing. Furthermore, our previous studies have been also conducted here.

To address the aim of the research, we conducted a qualitative study. The qualitative study is preferable because the water use is related to human as the batik producer. In addition to the depth of the information it could gather, qualitative study might provide more understanding to the behavior of batik producer. This is the advantage of using qualitative study [11].

The data collected for this study consists of primary and secondary data. The primary data was collected from Focus Group Discussion (FGD) and in-depth interview, while secondary data was collected mainly to present quantitative aspect of water use for batik production. The qualitative data collection will be explained as follows.

First, we prepare a list of questions that will be discussed with the batik craftsmen. The questions were composed in order to gain the perspective of batik craftsmen in regard to the batik making process, such as the process that use water and the process that consumes water at most. Other questions include, for example, if the water used for the processes should be of fresh water or not, whether the batik craftsmen are usually measure the water or not, and if they could estimate roughly the water they use for production.

After the list has been prepared, we contacted four batik craftsmen from our previous studies to ask if they will to join our discussion. During this process, we also ask other batik craftsmen of their groups or relatives. Using this snowball technique, we could meet ten participants in total. Five of the participants were natural dye batik producers, while the rest were usually producing batik by synthetic dyeing. For more information, six participants among all participants were female, while the rest were male. About five days prior the discussion, we prepare information on how to join online meeting using a Google Meet platform and provide technical helps online in order to anticipate if they face difficulties to use the online meeting platform. About three days prior the FGD, the participants were sent the link for the discussion they could join. The FGD was conducted for two hours and the process was recorded by the permission of all participants. The result of FGD were transcribed and were coded. Based on the analysis, we conduct an interview in order to explore more deeply the opinion of participants and to explore the answers for some other questions arose from the FGD.

For this interview, five batik craftsmen were selected. The online interviews were conducted person to person and took an hour for each participant. All interviews were recorded by the consensus
of all interviewees. All recorded data from FGD and interviews were transcribed, coded, and put into 
categories. To protect the privacy of the participants, their name will be replaced by pseudonyms. The 
result was analysed descriptively and presented in narrative form. While the qualitative data was 
collected directly from informants by FGD and in-depth interview, the quantitative data on water use 
and water footprint of batik production was collected from literatures and our previous researches. The 
data was also analyzed in order to provide a more comprehensive result.

3. Results and discussion

3.1. The batik-making steps that involve water

This study found that water is usually used in most of batik production stages. Although most of 
the participants revealed that water is usually used for dyeing, fixation, and wax removal process, there 
were participants who said that it is only the drawing or pattern drawing and hand drawing process 
which do not involving water. Pak Sapta Radyanto, one of the participants, said “The steps in batik 
production which do not involve water use are nggambar (drawing) and nyanthing (hand drawing).” 
As reported in our previous study, batik is usually made from a white cotton fabric and the first step of 
the production stage is usually called mordanting, i.e. the fabric preparation step by soaking the fabric 
into detergent solution to remove the starch attached to the fabric [12].

Following this step is the drawing pattern step and hand drawing processes [12]. Since the pattern 
is usually drawn using a pencil, and hand drawing is usually done using a tool called canthing flowed 
with melted wax to cover the pattern, these processes do not involve the use of water, indeed. Water is 
always used for other processes, i.e. in preparing dye solution, both of synthetic and natural dyes, 
dyeing, wax removal, and washing. Among all the production steps, all participants said that water is 
mostly used for wax removal processes, which is usually followed by washing. This indicates that 
water is vital for batik production. If there is a problem related to water scarcity, it is very possible that 
batik production will be adversely affected by this situation, which might lead to the sustainability of 
the enterprises.

3.2. Clean water: when it is usually be used?

Although most of batik production steps require the use of water, in fact, not all steps require the use 
of clean water. Some processes might re-use some not-so-clean water. We found that the answers were 
varied among participants, because they tend to have different opinion and experience regarding to 
this issue. However, based on the data we collected, clean water is required mostly for preparing 
the dye solutions, wax removal, and washing.

For batik craftsmen, color quality is important aspect to be considered, as it influences the quality 
of the related product. Therefore, the craftsmen will not take a risk to use some not-so-clean water for 
dyeing, as it might affect the quality of the color. In regard to natural dyeing, participants said that 
clean water should be used particularly when they deal with indigo. If they do not use clean water in 
washing, some impurities might attach to the fabric and cover some part of the fabric. As a 
consequence, after the fabric is dried and the impurities are cleaned from the fabric, there must be 
some parts of the fabric which are not covered by the dyes because previously, they were covered by 
impurities from the water. Since the color of indigo is concentrated, which usually results in dark blue 
color, parts of the fabric which are not covered by the indigo will remain white, and the color 
difference will be clearly seen on the fabric. As a consequence, the product might be rejected by the 
consumers.

Another reason in using clean water is still related to product quality, but it deals with the durability 
of the product. According to our informant, as stated in the first part of this subsection, clean water is 
required to wash chemicals used for the fixation, as Pak Mulya Basuki said “If we use indigosol for 
dyeing, hydrochloric acid is usually added for fixation. The fabric has to be rinsed thoroughly and we 
have to make sure that the washing is perfect. Otherwise, the fabric will be easily damaged”. If the
washing is imperfect, the chemicals might be still attached to the fabric and this will adversely affect the fabric, as the fabric will be easily damaged. Nevertheless, not all participants use clean water for all steps of washing. Usually after wax removal process they have to wash the fabrics repeatedly for three to four times. Therefore, some of the participants prefer to reuse the water for the first to third times of washing, and they just use the clean water for final washing. Therefore, clean water is required mainly for dyeing and final washing in order to produce color as expected the craftsmen and maintain the durability of the fabric.

3.3. How much water?
The statement of the participant could represent other batik craftsmen in Jarum Village. The craftsmen were usually measure the weight of the dyes –both natural and synthetic– which are used for dyeing. This might be dealt with the concentration of the color, particularly of synthetic dyes, which is used to dye the fabric. However, the batik craftsmen do not always measure the volume of water they use, because it does not affect the color directly, except in preparing the dye solutions. As Pak Joko Sarwono said, “If I have to calculate how many liters of water I use for production in a day, actually I can’t. I cannot estimate of how much water I will need for one day use.”

When we asked the batik craftsmen regarding the water they use to produce a piece of batik fabric, the answers were vary and qualitatively answered, for example only one container – of 15 to 20 L in volume – according to Pak Fitri Yugianto – or that not much water was used to produce a piece of batik cloth as mentioned by Ibu Sari Endrawati. Other answers indicate the difference on the comparison of some processes, such as wax removal process requires water twice than the dyeing process as mentioned by Pak Fitri Yugianto, or that wax removal process requires water twice than the fixation as explained by Ibu Sunya Ruri, the participant. Nevertheless, these answers could not represent the description on how much water used by all batik craftsmen because differences on water usage among batik craftsmen are possible. Other batik craftsmen indicate they need water in certain quantity – with unit of containers instead of liters – for wax removal process and fixation, for example five containers of water are required for fixation as mentioned by Pak Sedya Rumeksa. Again, these answers could not provide a clear answer on how much water – in unit of liters – required by the batik craftsmen, unless we measure their containers – which are of different dimensions among batik craftsmen – to ensure the volume of water needed for production. This finding is in line to the report of Indrayani et al [13] which revealed the absence of detailed identification and calculation of waste from resources as the problems faced by batik group members from Sleman regency, Yogyakarta. If an accurate information is required, measuring the dimensions of the containers as conducted in our previous studies [9, 14] is a requirement.

Commonly, the concept of water use understood by the batik craftsmen is the water volume which is directly used for production. In regard to this understanding, Table 1 presents data on water used for batik production in some batik centers in Indonesia. Considering the unit for water consumption is L/month, this indicates that the water used in this context is direct water use as presented in Table 1.
Table 1. Water use for batik production in some batik centers in Indonesia [15].

| Batik center | SMEs | Output (pcs/month) | Water consumption (L/month) | Direct water use (L/pc) |
|--------------|------|--------------------|-----------------------------|------------------------|
| Pekalongan   | 1    | 7,350              | 40,000                      | 5.44                   |
|              | 2    | 8,245              | 31,500                      | 3.82                   |
|              | 3    | 200                | 10,000                      | 50.00                  |
|              | 4    | 400                | 22,500                      | 56.25                  |
|              | 5    | 2,375              | 13,500                      | 5.68                   |
|              | 6    | 1,000              | 5,000                       | 5.00                   |
| Yogyakarta   | 1    | 2,624              | 350,000                     | 133.38                 |
|              | 2    | 850                | 200,000                     | 235.29                 |
|              | 3    | 90                 | 3,000                       | 33.33                  |
|              | 4    | 950                | 10,000                      | 10.53                  |
|              | 5    | 700                | 150,000                     | 214.29                 |
|              | 6    | 1,000              | 30,000                      | 30.00                  |
| Solo         | 1    | 1,500              | 6,000                       | 4.00                   |
|              | 2    | 4,000              | 15,000                      | 3.75                   |
|              | 3    | 600                | 4,000                       | 6.67                   |
|              | 4    | 625                | 150,000                     | 240                    |

The data from Table 1 indicates a wide range on water use for batik production by SMEs, from 3.75 L/pc to 235.29 L/pc, while the production of a sheet of natural dye batik in Ciwaringin, Cirebon, West Java consumed 3.33 liters of water [16]. These indicates that water use for batik production depends heavily on how the SMEs use water in producing batik.

Our previous studies have been conducted to calculate the water footprint of batik-making process in batik enterprises in Jarum Village [8,9]. This approach brings advantage to map water use in batik production, because water footprint doesn’t only take direct water use or Blue Water into account, but also water required to dilute wastewater or Grey Water [17]. Table 2 presents data of water footprint in batik-making process in Jarum Village, Klaten regency.

Table 2. Water Footprint (WF) components of batik-making process by natural dyes in two enterprises in Jarum Village [8,9].

| SMEs | Blue WF (L/day) | Green WF (L/day) | Grey WF (L/day) | WF (from Blue WF & Grey WF) (L/day) | Output (pcs/day) | WF (L/pc) | WF (L/m²) |
|------|----------------|------------------|----------------|-------------------------------------|-----------------|-----------|-----------|
| 1    | 234.00         | not available    | 65,207.00      | 65,441.00                           | 50              | 1,308.82  | 455.30    |
| 2    | 105.63         | not available    | 37,343.15      | 37,448.78                           | 68              | 550.72    | 209.79    |

Based on Table 2, it is indicated that the water use for batik production by the water footprint approach is much higher than the data presented in Table 1, ranging from 550.72 L/pc to 1,308.82 L/pc. The Blue WF of batik making process were 105.63 L/day and 234 L/day, respectively, which are somewhat lower than that of Table 1. However, it is indicated that the bigger portion falls on Grey WF. As previously explained, the Grey WF indicates the clean water required to dilute the pollutants contained in the wastewater [17]. The characteristics of batik wastewater are provided in the Table 3.
Table 3. The characteristics of batik wastewater in comparison to acceptable limit regulated by the Ministry of Environment of Indonesia [18].

| Stages at batik-making process | Parameters | pH | TSS (mg/L) | COD (mg/L) | BOD5 (mg/L) | Source |
|-------------------------------|------------|----|------------|------------|-------------|--------|
| Soaking, wax removal, rinsing |            | 9.80 | 388        | 870        | 552         | [3]    |
| Wax removal                   |            | 9.40 | 3,581      | 25,280     | 120         | [9]    |
| Washing                       |            | 7.57 | 429        | 1,246      | 33.75       | [9]    |
| Dyeing, fixation, washing (mixed) |        | 9.40 | 1,890      | 5,280      | 278         | [14]   |
| Washing after wax removal     |            | 9.80 | 1,400      | 6,960      | 21.20       | [14]   |
| All process (discharged wastewater) |       | 6.70 | 1,470      | 4,000      | 209         | [14]   |
| Acceptable limit              |            | 6.00 – 9.00 | 50        | 150        | 60          | [18]   |

Our previous studies indicated the batik wastewater tends to be alkaline with high COD and BOD5 concentration as presented in Table 3. The high pH might relate to the use of lime in natural dyeing [9,14] and soda ash for wax removal process [9,14]. The COD of batik wastewater tends to be different among processes and among SMEs. Nevertheless, all the CODs measured were higher than the regulation set by the Indonesian Government [18]. The Total Suspended Solids (TSS) and BOD5 also show similar results to the COD in term that the concentration of TSS and BOD5 were higher than the standard of Indonesian Government [18]. This indicates the discharge of the wastewater into the environment could lead to pollution, which has been reported to cause eutrophication [14]. Eutrophication is a qualitative indicator for water quality which imply poor quality of the corresponding water body.

Based on Table 2, we also note that we exclude the Green WF from our calculation. Green WF is the volume of rainwater consumed during the production of the plants, and is usually used for agricultural or forestry products, and the determination of this component involves the calculation of the total rainwater evapotranspiration and the water incorporated into the harvested wood or crop [17]. Given that batik is produced using raw materials come from plants, such as indigo or Indigofera, tingi or spurred mangrove (Ceriops tagal), tegeran or Javanese wood (Cudrania javanensis), and myrobalan (Terminalia bellirica) as natural dyes [9], actually the water consumed by the plants should be taken into account. However, these plants are not of agricultural and forestry products, and most of the plants, such as tingi, tegeran, and myrobalan, are perrenials, therefore the data in regard to the water volume needed for the growth of those species are not yet available. Based on this reason, we exclude the Green WF from our studies, with an important note for us that the actual WF must be higher than the result of our studies if the Green WF is taken into account.

Our study has also found that most craftsmen do not calculate the cost for water in the price of the batik fabric. When they were asked the reason behind their decision, they just answered that the corresponding cost was ignored from their attention. In fact, most of craftsmen use water from their wells for production, and this might influence their decision in removing this component from the price. Therefore, we argue that cost for water did not taken into account because the craftsmen do not buy the water, or, if they buy, the price for water is very inexpensive.

3.4. Key factors that influence water use for batik production

There are factors that influence the water use by batik SMEs. According to Pak Joko Sarwono and Pak Mulya Basuki, one factor that might influence the water consumption for batik production is production scale. This means, the higher the production scale, the higher volume of water required for production. This argument could be compared to the data on water use presented in Table 1.

Data presented in Table 1 indicate different use of water for different quantity of batik produced by the SMEs in Pekalongan, Solo, and Yogyakarta. If SME 3 and SME 4 (both from Pekalongan) are going to be compared, it is indicated that 200 pcs of batik produced by SME 3 require 10,000 L of water, while SME 4 requires 22,500 L of water to produce 400 pcs of batik. This result fits to the
reason proposed by the Jarum Village batik craftsmen. Unfortunately, they ignore the term efficiency in the context of water use. Based on Table 1, it is clear that 40,000 L of water could be used to produce 7,350 pcs of batik (SME 1 Pekalongan), while SME 2 (Pekalongan) could produces 8,245 pcs of batik by a smaller quantity of water, i.e. 31,500 L. This comparison indicates that higher production of batik does not always followed by higher use of water. Instead, the water use of SME 2, i.e. 3.82 L/pc, was lower than other SMEs, indicating that SME 2 is more efficient in using water among all SMEs. This means that water efficiency is probably is a better indicator for water use rather than single indicator of water consumption.

Furthermore, our result shows that water footprint approach is probably is better option for water use assessment, because this approach doesn’t consider only to the direct water use. In 2019, The Ministry of Industry of Indonesia [19] has been declared a regulation regarding the limit of materials use for green batik production. According to the regulation, the maximum water use in natural dyeing is 10 L/m$^2$ batik, and 50 L/m$^2$/color for synthetic dyeing [19], which indicates the direct water use as previously discussed. However, if we use the WF approach, it is clearly indicated that the water use for batik production will be much higher, as WF consider the Grey WF and not only the Blue WF.

The difference on dyeing is also considered to be the second reason affecting the water use. According to participants who produce batik with natural dyes, batik produced by synthetic dyes will consume more water rather than the natural ones. The participants said that synthetic dye solutions cannot be reused for the next day production, and hence, they will be disposed. This is different from the use of natural dye extract which is usually kept for some days and re-boiled prior to their use on the next day. According to an informant, batik production by synthetic dyes required water in a large quantity because the fabrics have to be washed under running water. However, our observation on the production of batik by synthetic dye does not always fit to the statement of the informant, as the fabrics could be washed in a container filled with clean water. The point is that clean water is required to wash the fabrics.

A study conducted in two batik SMEs in Bogor indicates that batik SME which applied synthetic dyeing releases more wastewater rather than batik SME that use natural dyeing [20]. It is reported that synthetic dyeing process releases 614.38 kg/100 pcs of batik or equal to 25.28 m$^3$ wastewater per ton of batik, while the natural dyeing releases 550.60 kg/100 pcs of batik or equal to 19.11 m$^3$ wastewater per ton of batik produced [20]. This result fits to the information brought by the participants who stated that synthetic dyeing consumes more water than natural dyeing. Using a water footprint approach, it is found that a piece of batik produced by synthetic dyes needs 6.41 L of direct water [21], and about 4.68 L/pc for batik produced by natural dyes [9]. It seems that natural dyes and synthetic dyes, both affected the water use in producing batik, therefore.

The third factor affecting water use in production is the habit of the craftsmen and the workers in production process. Based on our interviews, it is indicated that the water use during production depends heavily on the individuals as mentioned by Pak Mulya Basuki “Well, sometimes, I do not always replace water in the wax removal container by fresh water. However, if you see Ibu Sunya Ruri [another batik entrepreneur], she always replaces the water in her wax removal container by fresh water prior to wax removal process. Hence, [the use of water] depends on the individuals themselves”. This is the challenging part of water consumption, as habit is usually formed during lifetimes and are usually difficult to change. As reported by Indrayani et al [13], change in attitude is required if batik will be produced in a cleaner way.

Although the craftsmen showed different habit in using water, it doesn’t mean that they do not try to preserve water. Batik craftsmen tend to reduce the frequency of wax removal, particularly to the craftsmen who produce small numbers of batik. Instead of conducted wax removal for a small number of fabrics each day, Ibu Sunya Ruri prefer to collect the fabrics to at least 80 sheets for the wax to be removed at once. By doing this, she could preserve the water required for wax removal, which might consume a large quantity of water if they do wax removal every day. Pak Mulya Basuki are usually diluting the water used for washing instead of replacing it by clean water. By doing this, he can reduce clean water consumption for washing. In addition, they are usually reusing water for washing as
explained by Ibu Sunya Ruri and Ibu Tantri Saptuti. This means they do not accustomed to simply dispose the water once they use it for washing but reuse it for times before finally it is discharged as wastewater. Other participant, i.e. Pak Fitri Yugianto, said that it is possible to prolong the wax removal process, therefore they could reduce clean water consumption. Nevertheless, this effort will result in a more energy consumption, which is not suggested.

The fourth factor implied from the discussion is the role of technology, particularly to treat the wastewater. The participants understood that wastewater should be treated prior to its disposal to the environment and they expect to obtain this technology for their batik wastewater. Some of the participants have been providing collecting tank, both by themselves and by the help of government. However, not all participants could provide wastewater collecting tank for their industries because of financial reason.

3.5. An issue on environmental awareness?

Given that water use for batik production is influenced by habit of the craftsmen and their workers, this raises an issue on environmental awareness as a question. In regard to the question on that issue, we got the answer from the statement of Pak Sapta Radyanto that “Perhaps they do not care of the water, so they just use it because they feel the water is provided abundantly. They don’t think “this should be enough”. In fact, they use water excessively. There are some people like that. Meanwhile, there also are people who can say “this is enough”, and they decided to use the water as how much it is needed.” This implies different habit on using water among craftsmen and this is related to the possibility if they care for the water or they may be careless with water resource. Their care for the water, based on the informant, related to the feeling that water is provide abundantly for the craftsmen and they do not think on how much water which is actually needed for production. In our opinion, the feeling of abundance on water implies an emotional state of the craftsmen regarding the water they can access, while thinking is strongly related to the knowledge they have on water. Those two emotional and knowledge represents the affective and cognitive aspects of environmental awareness which influence the behavior of the craftsmen, or conative aspect. The aspects on environmental awareness, i.e. knowledge, affection, and behavior have been reported [22, 23], although there are researchers who emphasize knowledge or cognitive aspect as the essential aspect of environmental awareness [24].

In our opinion, the experience of participants in regard to water might affect their behavior in using water. It is clear from our FGD and interviews that some craftsmen have ever experiencing water scarcity in Jarum Village for years, both because of the dry season or because there are some areas within the Village that lack of springs as mentioned by Ibu Sunya Ruri, Ibu Shanti Dewi, Pak Setya Lumintu, Ibu Tantri Saptuti, and Pak Joko Sarwono. This might affect how the people using water. During the difficult times of scarcity, they often ask fresh water from their neighbors who have wells as Ibu Sunya Ruri and Pak Setya Lumintu had done, digging the well deeper to get more water as mentioned by Ibu Tantri Saptuti, or collecting rainwater in wet season as explained by Ibu Sunya Ruri, Pak Mulya Basuki, Ibu Sari Endrawati, and Pak Sedya Rumeksa. This experience might influence their interaction with water, which might be different to those who do not experience scarcity. It is possible that people who have experiencing scarcity will use water wisely, knowing that water is not always easy to get. Even after they could get water more easily, it is possible that their habit in using water has been becoming a behavior in their daily life. However, considering that not all participants or not all batik craftsmen had an experience on water scarcity, this difference might influence their behavior as well, and further studies will be required to explain this issue more deeply.

3.6. Discussion

This study reveals that practices of some craftsmen have been conducted in line with the circular economy concept, but not for all. Reusing water for washing, collecting rainwater, and reducing clean water for batik production are some practices which fits to the concept of circular economy as those practices contribute to the minimization of water use and, consequently, wastewater. Nevertheless, the
disposal of the wastewater directly by some craftsmen into the environment indicates the linear model of extract – produce – use – dispose [7] instead of the circular model. This result fits to the study conducted at Ciwaringin batik that indicates the existing of several circular production, while many production practices are still unsustainable and causing environmental degradation [16]. Among some practices mentioned, the use of hazardous chemicals for dyeing, high volumes of water used for production, and dischargement of effluent directly via local waterways are the practices which are usually performed by the batik craftsmen [16].

In regard to effluent dischargement, there were participants who have built wastewater collecting tank, whether it is built by the help of government or they built by themselves. Although the collecting tanks tend to function as settling tank, this, however, indicates an existing effort from the craftsmen to treat the wastewater. It should be understood that wastewater treatment technology is a technology that needs to operate by a person with appropriate knowledge and skill. Given that most craftsmen having a formal education from primary to senior high school, it is very likely that they are limited to construct appropriate wastewater treatment plant, which also of high cost to them. Nevertheless, if there are stakeholders who could support the batik craftsmen a wastewater treatment plants to treat the wastewater which could recycle it into a good quality of water, the circular cycle of the water could be maintain. The circular economy promotes the avoidance of the extract-produce-use-dispose model because this model will end on significant losses of resource [25]. The wastewater treatment which focuses on reducing pollutants to certain standard followed by its disposal might still inadequate for circular economy. This practice might be suitable for the term of eco-efficiency, but not to eco-effectiveness which is indicated in circular economy. It is explained that eco-efficiency practices focused more on minimizing volume, velocity, and toxicity of material flow system, without altering the linear model, and the recycling process is actually downcycling instead of true recycling because the resource used is eventually downgraded [25]. Taking the previously explained wastewater treatment, the disposal of the treated wastewater indicates the linear flow of material instead of circular. In circular economy, the status of materials as a resource should be maintained through a process which generates a circular use of materials, or cradle to cradle production system [25]. However, water use efficiency in combination to effectiveness is also important to consider in production because efficient water use indicates the ability of the craftsmen to save water instead of using water excessively in producing batik.

Based on the participants of this study, we found four key factors which influence the water use for batik production, i.e. the production scale, the dyes used for production, behavior of the craftsmen and batik workers, and wastewater treatment technology. In regard to production scale, there are two possible ways to minimize the ratio of water/product, which will increase its efficiency in using water. First, by reducing water use to produce a quantity of products as they are usually produced; while the second is increasing the quantity of batik produced by a quantity of water as it is usually used. Both ways will lead to smaller ratio of water use per product in unit of L/pc.

Regarding the dyes, although we found that natural dye batik consumes less water than the synthetic dye ones, we don’t think that batik production should be shifted to dyeing by natural dyes. This happened due to the fact that shifting to natural dyes needs a lot of considerations in the level of batik craftsmen. Furthermore, there are reasons in using synthetic dyes, such as a more practical technique or less time consuming in comparison to natural dyeing, and more color variants. Color stability and wide spectrum of colors are reported as the advantages of synthetic dyes [26]. Currently, there are batik craftsmen in Jarum Village who operates in a flexible mode, i.e. to produce batik by using both synthetic and natural dyeing. Nevertheless, there are craftsmen who choose to produce batik by synthetic dyes only, and to provide natural dye batik in their showrooms, they order natural dye batik from other craftsmen. Moreover, the decision whether the craftsmen will produce batik by natural dyes or synthetic dyes is also affected by the consumers. Oftentimes, the craftsmen receive orders from consumers to produce batik by synthetic dyeing, for which the craftsmen will be very unlikely to refuse. Although it might inadequate to circular economy, minimization of materials used is probably could be performed, as well as replacement some materials. It is possible that some
materials or chemicals might consume more water compared to other chemicals which could eventually lead to higher consumption of water. It is reported that in textile processing, the water used is influenced by the type of textile fiber, the product, and processes and equipment [27]. Therefore, we put the materials characteristics as the second factor that influence the water use.

Based on the previous explanation, we found that behavior of batik craftsmen is the third factor that influence the water use. Therefore, increasing water use efficiency will need behavioral change that affect the craftsmen in using the water and dyes. By conducting capacity building of the craftsmen through providing knowledge, it is expected that environmental awareness of the craftsmen will be elevated and later the behavioral change could be expected. As the behavior is related to knowledge of the craftsmen as explained, therefore we put the human resource as the third factor that influence water use for batik production. Finally, to shift to circular economy, the role of technology is crucial, particularly for wastewater treatment. The four key factors that influence water use, i.e. production scale, materials, human resources, and technology, are finally concluded.

4. Conclusion
In batik production, water is used for most processes, except in drawing pattern and hand drawing batik. Some of the process involve the use of fresh water, while some others involve the use of not-so-clean water, which depends on the craftsmen. Using secondary data, we found the direct water use for batik production by batik SMEs were varies from 3.33 L/pc to 235 L/pc among batik craftsmen. However, the volumes will be much higher when water footprint approach is to be used. Finally, we found four key factors that influencing water use for batik production by batik SMEs, i.e. production scale, the type of materials used for production, the human resource, and technology. Efforts are required to increase the production scale or reduce the water consumption to minimize the water/product ratio. Other efforts are needed to replace certain water-consuming materials in order to reduce water consumption, to build the capacity of the human resource in order to change their behavior, as well as introducing appropriate technology in order to increase water use efficiency and maintain the treated wastewater as resource as implied by circular economy.

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