

Sustainable Batik Production: Review and Research Framework

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Abstract— Batik is one of the works of ancient art in some countries. This art has become closely associated with the identity of Southeast Asia particularly Indonesia. We define sustainable batik production as a batik production process that is non-polluting, conserving energy and natural resources, economically viable, safe for workers and consumers. The purpose of this study is to outline the results of a literature review on-field sustainability and batik production as well as to provide a conceptual framework for future studies. This study was conducted using a systematic review. The steps of systematic review process were suggested by Cronin, Ryan, and Coughlan (2008) including selecting a review topic, searching the literatures, analyzing and synthesizing the literature, and writing the review. Eighty-two (82) articles were found on sustainable batik production issues in the last ten years. Concerning the dimension of sustainable batik production addressed, four categories were formed: designing (17 papers), waxing (9 articles), dyeing (22 topics) and wastewater treatments (34 papers). From the resume of literature analysis, we found studies conducted in sustainable design (designing process) addressed in batik pattern drawing and pattern storing. Few studies examined waxing process, some studies conducted about utilize of natural dyes and numbers of studies about wastewater treatment of chemical dye. Some suggestions are also presented to stimulate future research of sustainability in batik production.

Keywords— batik, sustainable batik production, batik process, literature review, research framework

I. INTRODUCTION

Batik is one of the works of ancient art in some countries. The origins of batik are various in origin, but overtime this ancient art has become closely associated with the identity of Indonesia and several other neighboring countries like Malaysia and some parts of Thailand. The batik method was practiced in ancient Egypt and many parts of Asia, but in Java that the technique has reached the highest level of complexity [1]. In Malaysia, batik has existed around 1921 which contributed to Malaysian economic and business opportunities in a rural area [2]. Batik was already an ancient tradition of Javanese work appeared in the sixteen century [3]. The traditional skill was particularly well developed over hundreds of year in Central Java under the patronage of Sultan (king) and his court.

Batik designs were copies and certain designs were being used by certain people and occasions. Many patterns of batik are symbolic. Batik was a necessary item in Java people's daily life. The function was a part of the daily dress, it had been of use in countless other ways, beginning the moment a baby was born until the day they died [4]. UNESCO identified Indonesian batik a masterpiece of the *Oral and Intangible Heritage of Humanity* in 2009.

After UNESCO recognition of Indonesian batik, the Indonesian government asked Indonesian to wear batik on Friday. The popularity of batik spreads to the territory of Indonesia, government officials, students, also private company officials wear batik as an identity of Indonesian. Batik becomes the national culture based main industry. The innovation of batik including material and patterns by Indonesian designers has made batik to grow popular as fashion items. Modern batik can be found as souvenirs, household wares, and clothing [5]. Batik industry is small & medium enterprises (SMEs), currently more than 39 thousand business units throughout Indonesia and employment of more than 900 thousand [6].

However, batik industries give rise to some environmental problems. Batik is one industry whose process of production uses synthetic dyes which contained metals, chemical coloring, and wax that can contaminate river water and subsequently causes severe water pollution problems [7, 8]. Recently, due to the high requests and economic initiatives, industry players switched to affordable raw materials for cost-saving. However, these materials are very crude of low quality and unsustainable and cause pollution of water bodies. Unfortunately, this is a common practice by the SMEs in batik productions [9]. In this era, the industry is forced to recognize that it has an obligation to society to develop sustainable production system is environmentally friendly.

In 1992, sustainable production emerged at the United Nations Conference on Environment and Development and is related to the concept of sustainable development [10]. They have also mentioned that sustainable production is relevant to organizations and companies that make products or offering services. The concept of sustainable development is an effort to combine growing concern about a range of environmental issues with that of socio-economic problems [11]. It has 6-aspects of sustainable production: energy and material use, natural environment, social justice, and community development, economic performance, workers and product [10]. Environmental, economic and

social are the famous triple bottom line of sustainable development. We define sustainable batik production as a batik production process that is non-polluting, conserving energy and natural resources, economically viable, safe for workers and consumers as forms the dominant theme of this paper.

The purpose of the study is to outline the results of a literature review on the field sustainability and batik production as well as to provide a conceptual framework for future studies.

II. BATIK PROCESS

Batik is a technique of wax-resist dyeing applying to the whole cloth by drawing dots and lines of the resist with a tool called a canting or by printing with a copper stamp called a cap. Natural material such as cotton and silk are used for the cloth. The process of batik is cited from Trefois [12] that is described as followed. The first step is designing, waxing dyeing and eliminating the wax (Fig. 1). Waxing and dying are multi-process to get more than one colors. The final process is removing the wax to get overall finished batik.

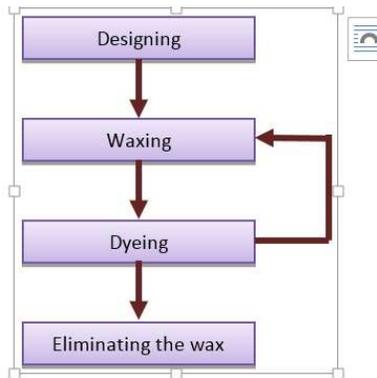


Fig. 1. The process of batik.

A. Designing

The word “mbatik” originated has come from the Javanese phrase; “*amba titik*”. It has meaning “drawing little dots”. The batik designs have functioned as fashion ornamentation. Traditional batik designs utilize patterns inherited over the generations. It is very rare that an artisan is so skilled that he can work from memory and would not need to outline the pattern/model before adjusting the wax. Frequently designs are traced from stencils or patterns called *pola*. The pattern of batiks is divided into different families of design, each with hundreds of variation within them. Repeating motifs is the process of designing to fill the entire cloth. Usually, batik pattern is developed manually [13].



Fig. 2. Designing trough traced from patterns.

(<https://abduhl.blogspot.com/2013/12/proses-pembuatan-batik.html>)

B. Waxing

Batik, as a traditional cloth, is made using a manual wax-resist dyeing technique. Wax is the material to apply over the areas of the design that the artisan wishes to remain the original color of the cloth using *canting* or *stamp*. *Canting* is a pen-like tool used to apply liquid hot wax (Fig. 3) and *Cap* stamp that make from copper (Fig. 4). The process of batik uses hot liquid wax, lines and shapes are drawn onto cloth with special tools (*canting*) or stamp. A worker sits on a low stool or on a mat to put the wax with a canting. The most experienced artisans usually do waxing first. Filling in of significant areas may be entrusted to less skilled artisans. The cloth that they are working on is draped over light bamboo frame called *gawangan* to let the freshly applied wax to cool and harden. Men normally do this procedure of the *cap* (stamp). The *cap* is dipped into the melted wax and pressed into the cloth until the design side of the stamp is faced with wax. Then stamped it onto the fabric. This process is duplicated until the entire cloth is covered. The combined method using cap and canting on the same piece of fabric often used.



Fig. 3. Applied the wax using a *Canting*

(<https://www.redduckpost.com/batik-an-ancient-indonesian-tradition/>)



Fig. 4. Applied the wax using a *Cap*.

(<https://www.gianeofficial.com/single-post/2016/09/01/Batik-Techniques>)

C. Dyeing

Dyeing is a method where a patterned area is blocked with wax. Batik can be dyed with many types of dye. In the dyeing process, cloth placed in indigo vat several times until the correct shade of blue is obtained [14]. In earlier batik work, natural dyes from vegetable sources were used, but after the advent of synthetic dyes were highly commercialized, the present batik work is mainly done with *naphthol* (chemical dye) and solubilized vat dye [15]. The waxed fabric is soaked in the dye bath of the first color. The amount of time that is left in the tube affect the hue of the color; darker colors require longer periods or numerous

immersions. The fabric is placed into cold dyeing. When the desired color has been achieved and the fabric has dried, the wax is reapplied over the areas. The number of colors in batik represents how many times it was immersed in the dye bath. A multicolor batik represents a lot more work than a single color of the piece. The price of the cloth is usually reflected in numerous dye processes.

D. Eliminating the Wax

At the end of the batik process, the wax can be eliminated in boiling water. In order to remove the wax, the fabric is boiled in water. Potato or cornflour is mixed with cold water and added to the boiling water. The flour will combine with wax and will make it easier to skim the wax off the surface of the water. Soda ash or sodium bicarbonate is also added to the water to elucidate the melted wax which rises to the surface. The cloth is then rinsed and hanged to dry. The aim is to remove the wax so the motifs that have previously drawn will be visible.

III. RESEARCH METHODOLOGY

This research was conducted using a systematic review. A systematic review means evaluating and interpreting all available research relevant to a particular research question, topic area, or phenomenon of interest [16]. The purpose is to bring the reader up-to-date with the latest literature on a topic and form the basis for another goal, such as the explanation for future research in the area [17]. The steps of systematic review process according to Cronin, Ryan and Coughlan are selecting a review topic, searching the literature, analyzing and synthesizing the literature, and writing the review.

A. Selecting the Review Topic

The topic is related to sustainability and batik production. The batik production includes some process such as designing, waxing, dying and eliminating the wax (Trefois 2010) also batik wastewater because this study concern about sustainability and environmental degradation. The topic only concerned about batik production and other topics such as batik management and marketing will not be covered.

B. Searching the Literature

The electronic database sources used in this review included those identified as relevant to information, such as Science Direct, ACM Digital Library, JSTOR, Wiley online library, IEEE Xplore Digital Library, Taylor & Francis; and Google Scholar. Articles were reviewed in the last ten years from 2008 to 2017 in English language journals. The keywords such as batik, batik production, batik technology, batik process, and batik design, batik software, batik fractal, batik wastewater are applied.

C. Analyzing and Synthesizing the Literature

This paper is based upon a systematic review of articles identified in a relevant topic about sustainability in batik production. To select, scan, and analyze the literature use a detailed description of the steps taken to choose to aim at reducing biases and increasing transparency. The authors use coding to categories articles base on the batik production process. We didn't find a lot of articles about batik production related to sustainability. Finally, eighty-two (82) studies were observed and are then extracted. Furthermore, each paper is classified according to the four

(4) main dimension of the batik production process: designing, waxing, dyeing and wastewater treatment. The extracted information on the task was grouped, summarized and tabulated including authors, research focus, disciplines and finding. The material is analyzed according to the structural dimension of sustainable batik production process and interpretation of results.

D. Writing the Review

The appraisal of the literature is completed deliberation must be given to how the review will be structured and written [17]. Understanding material is a basis for the writing of the study. All information collected and analyzed in the results section, including distribution across the years, a multi-discipline that conducted sustainable batik production and dimension of batik production.

IV. RESULT AND DISCUSSION

A. Distribution across the Years

The primary body of literature about sustainable production in the batik industry identified comprises 82 papers. The number of papers has been published in international journals (63 papers) and proceeding of international conferences (19 articles). The allocation of the publications in the research period is between 2008 and 2017, is shown in Figure 5. This figure shows a trend of research in batik production year by year. There is a constant increase in the number of publications. There are no specialized journals that publish about batik production, we found 51 different journals such as Journal of Theoretical and Applied Information Technology (4 papers), Advanced Materials (3 papers), Procedia Engineering (3 papers), Desalination and Water Treatment (2 papers), and number of papers published in different journals.

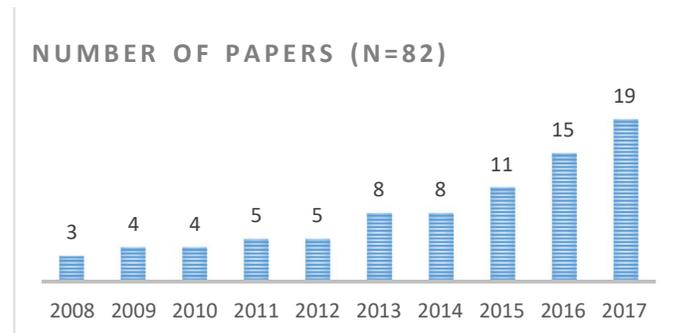


Fig. 5. Distribution across the years.

B. Multidiscipline that contributed sustainable batik production

papers), Art, Design, Craft (5 papers), Computational & Computer Science (5 papers), Electronic Multidisciplinary is more than one discipline working on the same problem [18]. In the Oxford dictionary, it means combining or involving several academic disciplines or professional specializations in an approach to a topic or issue. Based on the literature review, we found many subjects contributed to developing sustainable batik production. The Figure 6 illustrates number of disciplines support sustainable batik industries such as Chemical, Chemistry (16 papers), Biology, Life Science, Health Science (9 papers),

Environmental (7 papers), Informatics & Information Engineering (7 papers), Textile & Apparel (6 papers), Industrial & Mechanical Engineering (6 Engineering (5 papers), and other science (4 papers).

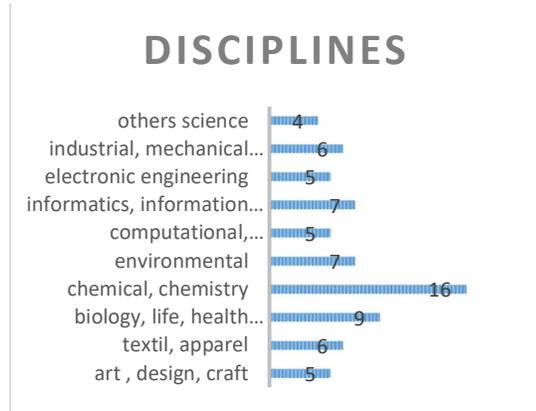


Fig. 6. Multidiscipline that Contributed to Sustainable Batik Production.

C. The dimension of sustainable batik production process

Concerning the dimension of sustainable batik production, four categories were formed (1) designing, (2) waxing, (3) dyeing and (4) wastewater treatments. Table 1 shows the result of these categories, while Table 2 additionally shows the distribution across the time period studied. Most of the articles (34) deal with wastewater treatments, 22 papers deal with coloring, 18 papers focused on batik designing, and only 9 papers focused on waxing process. Figures on waxing aspect are infrequent in publication number. For the wastewater treatment ones, it is interesting that in 2015 appears as trends. This reveals a clear deficit in sustainable production of batik industries issues mainly on four dimensions of batik production process.

TABLE II. THE DIMENSION OF BATIK PRODUCTION

Dimension	Number of papers (N=82)
Designing	17
Waxing	9
Dyeing	22
Wastewater treatments	34

TABLE III. DISTRIBUTION OF PAPERS ACROSS THE TIME PERIOD

Year	Designing	Waxing	Dyeing	Wastewater
2008	1		1	1
2009	3		1	
2010	1		2	1
2011	2		1	2
2012			3	2
2013	2		2	4
2014	5		2	1
2015		2	4	5
2016		4	1	10
2017	3	3	5	8

D. Discussion

The purpose of the study is to outline the results of a literature review on the field sustainability and batik production as well as to provide a conceptual framework for future studies.

Overall, we identified 82 papers in the sources that we searched. Thus, all of the studies are directly related to sustainable production in batik industries. Sustainable production significantly contributes to sustainable development [19]. Lowell Center for Sustainable Production, defined the sustainable production as a creation of services and goods using processes and systems which are non-polluting, preserving of energy and natural resources, economically viable, safe and healthful for employees, communities, and consumers, and socially and creatively rewarding for all working people [10].

The relevant literature can be categorized into four categories: designing process, waxing process, dyeing process, and wastewater treatment. In the area of the designing process, the papers present a computer-based system for batik design. The system can be used to keep up designer works for drawing motifs or patterns and applying color compositions. Scholars addressed a mathematical concept to design batik pattern is called batik fractal [20, 21]. Some software is used to classify batik image using texture future [22, 23, 24, and 25]. Other scholars also use

a different formula to generate an innovative batik-like pattern.

The technique of batik draws the picture by using the resist media to keep free from coloring matter during the dyeing process. There are 2 tools to bring batik traditionally: *canting* and *cap* (stamp). It has three types of articles that related to drawing batik using resist media (waxing): *canting*, stamp, and electric stove. *Canting* is a tool to make written batik, a kind of batik technique that is drawn or written by hand with high skill. It has two articles take on electric canting design [26, 27]. The electrical canting works using a heating element to melt the wax directly inside the canting tool. Total four (4) articles examine about batik stamped. Susanti et al. [28] and Suryanto et al. [29] assess about batik stamp design, while Anugraha [30] and Wibisono et al. [31] examine about ergonomic working table stamp batik. Stamp batik is made from copper designed with a specific motif. This tool is stamped on a cloth laid on the table. The purpose of these studies is to gain efficiency in the batik production process. Then three articles mention the electric stove. A stove is a tool used to heat the wax in the batik process. In these studies, artisans still use a traditional tool (*canting*), but they offer an electric stove to melt the wax using green energy.

Batik can be done used many types of dyes. Natural dyes are known for use in the coloring of food substrate, leather, as well as natural fibers since pre-historic times.

Twenty-two literature reviews were observed using a natural dye of textile. Sixteen articles mention about material and source of natural dyes on textile, especially in batik coloring. Another six articles reference to dyeing technique of natural colors such as to utilize of mordant, methods, and extraction time. All of these studies related to sustainable development, they use natural resources to reduce pollution. Natural dye is a renewable and sustainable resource with minimal environmental impact [32], low toxicity and allergic effects [33]. Most of the batik industries in Indonesia use chemical dyeing that containing heavy metals, therefore utilization of natural dye is suggested into protecting the environment.

However the utilize of chemical dye is to get the lower prices and variety of colors, so most of the batik industries still chose this dye to reduce production cost. Some scholars investigate about wastewater treatment to deal with pollution problems. Batik industries consume large amounts of discharged effluents during dyeing and finishing operations [34]. Thirty-four papers were observed on batik wastewater treatments (most articles that concern sustainable production in batik industries). They used a different method to treat batik wastewater such as physical treatments, chemical oxidation, electrochemical, Nanofiltration membrane, and bacterial lactobacillus and so on. We impress that many ways of wastewater treatments have been offered by scholars, but it needs support how to implement in the real batik industries. The fact that a few batik industries apply wastewater treatment. Individual wastewater treatment is often costly [35].

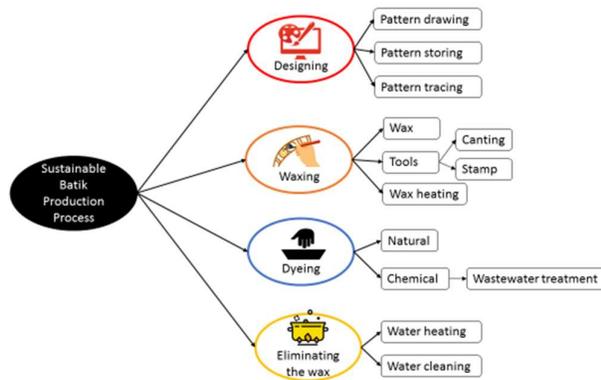


Fig. 7. The Framework of Sustainable Batik Production.

Based on the topics identified in the literature review on sustainable batik production, we now proceed towards the development of a research framework. Further, in this framework, we highlight the potential broader pathways for future research. There are several studies to support sustainable batik production, but there are some dimensions that are still minimal even none at all. We further explore the framework suggested in Fig. 7 by identifying sustainable batik production process. The batik production process consists of designing, waxing, dyeing and eliminating the wax. Fig. 8 presents a detailed framework that represents four batik process and sub-dimension every process. Issues, as recognized by Veleva and Ellenbecker [10] the highlight of the primary aspect of sustainable production, are energy and material use

(resources), natural environment (sinks), social justice and community development, economic performance, workers and products.

The additional issues of batik production are identified during the analysis of studies impacting the development of the literature on sustainable batik production. Some cases were identified in previous research on sustainable batik production but were only mention about specific dimensions: sustainable for an entrepreneurial system [36], improving sustainable batik stamp using life cycle assessment analysis and developing a framework of sustainability one in region of Indonesia [9, 37]. The present study adds significant value to the existing literature by presenting an integrated structure that captures all of the dimension of the sustainable batik production process (Fig. 8), while table 3 is resume the literature analysis. Some aspect of batik production is missing in current studies.

Studies conducted in sustainable design only addressed in batik pattern drawing and pattern storing, no paper mention about pattern tracing. In the designing process, pattern tracing is processing to move batik pattern from a database or paper to fabric surface. All the time this process is done by a manual that takes a long time and needs particular workers, so it's required innovation technology how to trace batik pattern on fabric surface efficiently.

Few studies examined the waxing process (only nine papers). Wax is a special material which distinguishes batik from other textile decorations. No paper examined how to reuse wax for sustainability. It's also needed more exploration how melted the wax for efficient waxing process. Some studies conducted about utilizing of natural dyes and numbers of studies about wastewater treatment of chemical dye, but the application of natural dye for batik take a lot of time.

So further studies are needed oh how to process dye from nature easier to use. The final process of batik making is eliminating the wax. We found no papers in this area. This process needs heat and water resources. Boiling water is the way to remove wax from batik cloth, water, a big pan, and big fire are used in this process. Then a lot of water is used to clean the whole of the material, so the batik cloth becomes clean and free of the rest of the wax. Exploring water heating for boiling batik cloth and water cleaning for reusing the water for cleaning the batik cloth is an important matter to gain sustainable batik production. Water is the most challenging sustainability challenges facing humans in the modern era [38].

This research provided an outline of review from previous researches and developed framework of sustainable batik production. It is similar with other researchers such as Govindan (2018) who developed a conceptual framework of food supply chain by identifying the indicators, drivers and barriers based on the stakeholder theory [39] Alwan et al. (2017) who developed framework of sustainable strategic development in UK construction industry using building information modelling [40], and Hospes et al. (2017) who developed an interdisciplinary framework for sustainable pathways of palm oil production [41].

TABLE IV. RESUME THE LITERATURE ANALYSIS

Process	Finding	Missing
Designing	Some studies addressed in the computer-based system for sustainable batik designing process especially in pattern drawing and pattern storing	No paper mention about pattern tracing
Waxing	Some studies addressed in tools (canting and stamp) and wax heating	No papers mention the material (wax)
Dyeing	Some studies addressed in natural dyes and numbers of studies inspected wastewater treatment of chemical dye	Is natural dye efficient?
Eliminating the wax		No paper mention about eliminating the wax

V. CONCLUSION

This study has taken a broad look at sustainable batik production although the spread of the topic is fairly limited. Only 82 articles were found on sustainable batik production in the last ten years. We found various international journals and conference proceeding that had been published on this topic. We found multidiscipline contributed to developing sustainable batik production. Concerning the dimension of sustainable batik production addressed, four categories were formed: designing (17 papers), waxing (9 articles), dyeing (22 topics) and wastewater treatments (34 papers).

Our proposed framework helps to understand the potential broader pathways for future research. The form of framework based on batik production process including (1) designing, (2) waxing, (3) dyeing and (4) eliminating the wax. From the resume of literature analysis, we found studies conducted in sustainable design (designing process) only addressed in batik pattern drawing and pattern storing, no paper mention pattern tracing. Few studies examined waxing process, some studies conducted about utilize of natural dyes and numbers of studies about wastewater treatment of chemical dye. We found no paper investigating about process of eliminating the wax. Overall, we discover that sustainable batik production still lacks both number and innovation. Based on resume of literature analyses of this study suggested:

- The need for innovative technology on how to trace batik pattern on fabric surface efficiently
- The need for future research on how to reuse the wax and innovation technology how to melt the wax
- The need for future research on how to make natural dye easy to use
- The need for innovative technology to produce water heating for eliminating the wax and to process water so that it can be reused.

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