MATERIAL FLOW COST ACCOUNTING FOR A TRADITIONAL COTTAGE INDUSTRY: BATIK

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RESEARCH REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF [SAFETY, HEALTH AND ENVIRONMENT]

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Name of Degree: Master of Engineering (Safety, Health & Environment)

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Material Flow Cost Accounting for a Traditional Cottage Industry: Batik

Field of Study:

Environmental Management Accounting

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ABSTRACT

The pursuit of achieving optimal productivity has always being the primary objectives of any business or manufacturers. There are numerous ways to achieve optimal productivity and one of the initiatives is by applying the concept of Material Flow Cost Analysis (MFCA) to manufacturing processes in assessing material losses, thus reducing manufacturing cost. Furthermore, application of MFCA to manufacturing processes creates positive impacts to the environment and in the long run, benefits the company involved by optimizing productivity without compromising the environmental condition.

In Malaysia, batik industry is categorized as a cottage and handicraft industry because it involves the use of traditional methods and tools. The nature of business of batik makers are usually family oriented and as expected, the margin of profit is relatively small compared to commercial batik makers that utilizes high technology machineries and methods to provide customers with cheaper and consistent supply of batiks. Nevertheless, the traditionally produced batiks always has its customers due to its uniqueness and intricate design since the design created depended on the batik artisan creativity and this makes traditionally made batiks appealing to the local and international customers.

This research shows the application of MFCA in the traditional batik making processes in a small batik making enterprise, ABC Batik Kraf which mainly still utilizes traditional means of methods and processes to make batik. By conducting MFCA analysis on the processes done in ABC Batik Kraf, material losses were identified in terms of monetary and physical unit. Identification of these losses enables reduction of material loss and reduced wastage for each process during the batik making.

The study was carried out on the specific batik making technique, which is making batik with block print. The associated cost of products and material losses of each process

are identified and combined into one cost centre for ease of calculation. The MFCA results shows that material cost accounted for 56.67% of the total production cost while other cost such as the energy cost comprises of 0.69% of the total production cost and 42.64% which is the system cost, covers the remaining total production cost. The cost allocated for material losses was 24.44% of the total production cost

Prior to the MFCA analysis, the batik makers from ABC Batik Kraf believed in their capability to produce batik kraf with minimum of 95% product yield rate, however based on MFCA analysis, this number is not achievable and ABC Batik Kraf have to implement improvements in order to increase its productivity and reduce material loss. Improvements can be made via various steps, such as reducing material loss, optimizing energy usage and improvising steps involved during batik making.

ABSTRAK

Objektif utama bagi kebanyakan perniagaan atau pengeluaran adalah mencapai produktiviti optimum. Terdapat pelbagai cara untuk mencapai produktiviti yang optimum dan salah satu cara tersebut adalah dengan menggunakan konsep Kos Bahan Aliran Perakaunan (MFCA) untuk mengenalpasti kos kerugian bahan, sekaligus mengurangkan kos pembuatan. Dalam jangka masa panjang, aplikasi MFCA kepada proses pembuatan mewujudkan kesan positif kepada alam sekitar dan memberi manfaat kepada syarikat yang terlibat dengan mewujudkan produktiviti optimum tanpa menjejaskan alam sekitar.

Di Malaysia, industri batik dikategorikan sebagai industri kotej dan kraftangan kerana ia melibatkan penggunaan kaedah dan alatan tradisional. Kebiasaannya industri batik merupakan industri kecil-kecilan dan dikendalikan oleh keluarga terdekat sahaja, maka keuntungan yang diperolehi adalah agak kecil berbanding dengan perniagaan batik komersil yang menggunakan teknologi yang lebih tinggi dan dapat membekalkan batik pada harga yang lebih murah dan konsisten. Walau bagaimanapun, batik yang dihasilkan secara tradisional sentiasa mempunyai pelanggannya tersendiri kerana batik yang dihasilkan secara tradisional adalah lebih unik dan menarik kerana reka bentuk yang dibuat bergantung pada kreativiti artis batik dan ini menjadikan batik tradisional sentiasa menjadi pilihan penggemar batik diperingkat tempatan dan antarabangsa.

Kajian ini mengaplikasikan penggunaan MFCA dalam proses pembuatan batik tradisional bagi syarikat ABC Batik Kraf. Berdasarkan kajian MFCA yang telah dijalankan, kerugian bahan telah dikenal pasti dari segi kos dan fizikal. Pengenalpastian kos kerugian ini membolehkan pengurangan kehilangan bahan dan mengurangkan pembaziran bagi setiap proses semasa membuat batik.

Bagi kajian ini, teknik pembuatan batik dengan menggunakan blok penerap telah dipilih. Kos berkaitan produk dan kerugian bahan bagi setiap proses dikenalpasti dan

digabungkan didalam satu pusat kos bagi memudahkan pengiraan. Pengiraan daripada aplikasi MFCA menunjukkan bahawa kos bahan menyumbang 56.67% daripada jumlah kos pengeluaran manakala kos lain seperti kos tenaga terdiri daripada 0.69% dan 42.64% untuk kos sistem daripada jumlah kos pengeluaran. Kos kerugian bahan dalam proses ini ialah 24.44% daripada jumlah kos pengeluaran.

Sebelum analisis MFCA dijalankan , pembuat batik dari ABC Batik Kraf yakin dengan kemampuan menghasilkan batik dengan hasil minimum 95%, namun berdasarkan analisis MFCA, angka ini tidak dapat dicapai dan ABC Batik Kraf harus melaksanakan kaedah-kaedah penambahbaikan untuk meningkatkan produktiviti dan mengurangkan kehilangan bahan. Penambahbaikan boleh dibuat melalui pelbagai langkah, seperti mengurangkan kehilangan bahan, mengoptimumkan penggunaan tenaga dan mengimprovisasi langkah-langkah yang terlibat semasa membuat batik.

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LIST OF SYMBOLS AND ABBREVIATIONS

MFCA	:	Material Flow Cost Accounting
EMA	:	Environment Management Accounting
COD	:	Chemical Oxygen Demand
TSS	:	Total Suspended Solids
SME	:	Small Medium Enterprises
kg	:	kilogram
m	:	metres
QC	:	Quantity Centre

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Background of Research

Batik is one of the most well-known traditional art form known for its beauty and intricacy. In Malaysia is dominated by the two in east coast states of Malaysia, in Kelantan and Terengganu. It is classified as a cottage and handicraft industry because it involves the use of means, methods and tools used are still traditional. As expected, the margin of profit generated by the traditional batik makers is relatively meagre if compared to commercialized batik industry players that offer cheaper and consistent supply via utilization of machine to produce batiks.

Therefore, to increase the profitability of the traditional batik industry, processes and activities involved in producing batik must be appropriately conducted in order to keep the processes remain efficient and cost effective to ensure the competitiveness of traditional batik makers.

Utilization of MFCA as a productivity improvement tool in the traditional batik making industry can help to boost the batik makers economic and even the environmental performance. With the adoption of the MFCA, traceability of wastes generated, emissions and even product losses can be clearly quantified, enabling the batik makers to achieve more profits with lesser environment impact thus ensuring the sustainability of the traditional batik industry in the modern world.

1.2 Problem Statement

Batik industry is one of the oldest industries in Malaysia. Even though the industry faces challenges that threaten the survival of the batik industry, it survive due to the attractiveness and the intricacy of the art itself, however over the years, traditional batik makers faces two main groups of competitor. One is the batik competitors from China and Indonesia where their batik textile penetrates Malaysian market with competitive prices. Two, is the competitors from modern manufacturers where they imitate batik by producing machine printed textile which are more saleable and cheaper compared to traditional handmade batiks.

In order to increase the competitiveness of the traditional batik makers, productivity improvement tools such as MFCA can be used to assess the input materials that are flowing through the production process and the output in finished products and waste can be measured. This enables the batik makers' ability to increase the profits generated and while maintaining optimal environmental performance.

1.3 Aim and Objectives

AIM

Analyze the inefficiencies incurred due to resource usage within the traditional batik production process and application of MFCA concept to the batik making processes in order to reduce material consumption and minimize waste.

OBJECTIVES

1. Identification of losses in traditional batik production process which will be quantified in physical and monetary unit.

2. To suggest and recommend improvement based on MFCA calculation output thereby enabling reduction of losses and waste.

1.4 Scope of Study

The selection of the traditional batik makers is based on the criteria below;

1. Batik manufacturers only.
2. Full operation process of batik.
3. The process of making block print batik.

1.5 Thesis Outline

This research report consists of five main chapters. The chapters are stated below:

a) Chapter 1: Introduction
b) Chapter 2: Literature Review
c) Chapter 3: Methodology
d) Chapter 4: Results and Discussion
e) Chapter 5: Conclusion and Recommendation

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction to Material Flow Cost Accounting (MFCA)

In Environment Management Accounting (EMA), one of the most basic tools of management accounting used is Material Flow Cost Accounting (MFCA) (Zhifang Zhou, 2017). Via MFCA method, material flows into the process through to the final output of its positive and negative products can be physically traced, thus enables organization suppliers to monitor the output of final product and minimize waste generated (Farizah Sulong, 2015). Calculation of MFCA involves detailed quantification of material and energy usage and the monetary value attached to them. Application of the MFCA is flexible depending upon the company's own capabilities by determining the process boundary. The boundary of MFCA can be a single process, multiple process, a single product, multiple products, the entire plant, the whole company and even to the extent of the supply chain (Farizah Sulong, 2015). The resulting transparency and substantial amount of material losses visible via MFCA analysis allows the organization to identify process or material inefficiency problems. Once the problem has been clearly identified, possible improvements and solutions can be made to improve productivity and reduce waste generated. These MFCA features enables it to become one of the most basic management accounting tool that can assist organization to better understand the potential environmental and financial consequences of the material and energy use practices and seek opportunities to achieve both environmental and financial improvements via changes in current practices (ISO14051, 2011).

2.2 Differences between Traditional Cost Accounting and MFCA

Differences between MFCA and conventional cost accounting can be seen in process control and goal management. MFCA process classifies materials, energy and system cost as positive and negative products. Whenever the highest negative product is identified, organization personnel have clearer understanding on relative improvement in cost reduction (Chompoonoot Kasemset, 2015). By contrast, conventional accounting is based on the use of monetary and physical units, but the two are often not consistently or effectively linked. With regard to goal management, traditional accounting systems typically do not provide a sufficient quantity of information to manage the systemic environment (Schmidt, 2015). The MFCA method examines the relationships among accounting, the environment and information management to better achieve decision-making and accountability. Hence, MFCA extends the scope of conventional accounting to include the practical environment, as well as the economic implications of concepts such as corporate sustainability and eco efficiency, making goal management more scientific and systematic (Yoke Kin Wan, 2015).

2.3 Batik Industry in Malaysia

Batik is one of the oldest cottage textile industries in Malaysia. Over 1000 batik factories are scattered mainly throughout Kelantan and Terengganu on the east coast of Malaysia (Hamid Reza Rashidi, 2013). Microenterprises dominated Malaysian batik industry by as 86% of 1,897 batik producers in Malaysia remained at the micro level. Most of the batik microenterprises reside in the east coast of the Malaysian peninsular which happens to be the birthplace of the Malaysian batik (Hanitahaiza Hairuddina, 2012).

Batik is a decorative cultural artefact produced by artistic work inspired by the batik artist's natural environment and is considered as one of Malaysia's prized heritage. Process of making batik involves the use of stamped candle technique to produce designs which then is dipped with mixture of colors. Batik industry evolves from the skills and techniques inherited by generations of batik maker families to team effort within an organization to produce batik textile for a more diversified and larger consumer communities (Hanitahaiza Hairuddina, 2012). Majority of batik makers still practices traditional batik making methods such as free style hand drawing or block printers to produce design on batik cloths to ensure the originality and quality. However the use of traditional method is a lengthy process and insufficient to cope with market demands (Hanitahaiza Hairuddina, 2012).

2.4 Issues in Malaysia Batik Industry

It is a well-known fact that the textile industry and consequently batik industry process consumes large amounts of water, thus generating harmful wastewater. Batik making has been known to be linked with series of negative environmental impacts such as water pollution (Payam Moradi Birgani, 2016), (Mohd Rafi Yaacob, 2016) and (Yaacob, 2016). During the batik making process, there is a substantial amount of wastewater produced during the soaking, boiling and rinsing steps without being properly treated prior discharged to the environment. This situation involves large volumes of water and chemicals such as waxes, dyes, and fixing agents like silicate, resulting in a high pH, chemical oxygen demand (CODCr), total suspended solids (TSS), and heavy metals. Presence of various chemicals in the effluents poses negative threat to aquatic organism due to their toxicities and non-biodegradability. Treatment of water is challenging due to the complexity of pollutants mixture in water (Payam Moradi Birgani, 2016). Majority of batik makers are relatively small family-based facilities unequipped with appropriate treatment units and due to its sporadic locations, establishment of a centralized large-scale treatment system proves to be difficult to be done. This industry has a high pollution potential because of its unregulated nature, spatial location, lack of in-house environmental control and nature (Archina Buthiyappan, 2016).

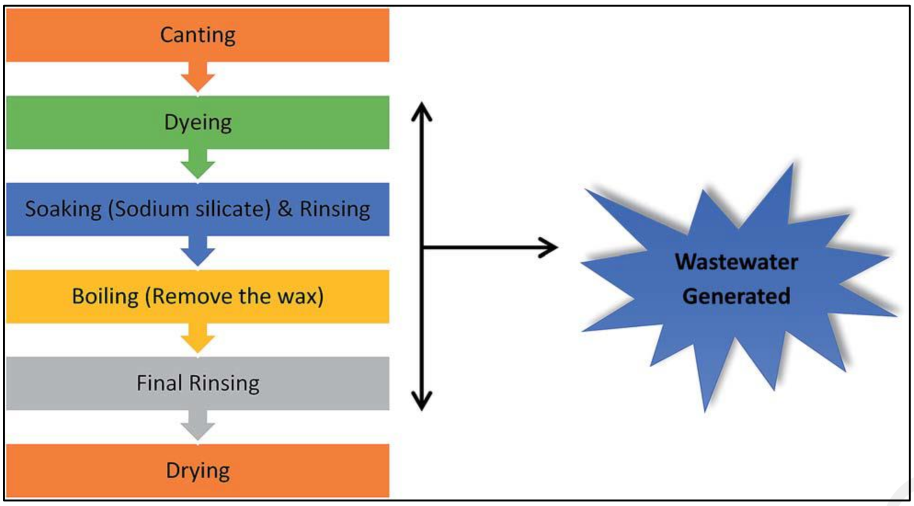


Figure 2.1 Processes involved in batik making and wastewater produced (Archina Buthiyappan, 2016)

Being one of the oldest cottage industries established in Malaysia, batik making has long been a source of income for batik microenterprises mainly throughout the east coast of Malaysia. It is a cottage industry which is largely run by small Malay entrepreneurs, largely in the two Malay belts state of Kelantan and Terengganu. This industry not only provides income for entrepreneurs but at the same time employed thousands workforces in both downstream and upstream of the industry. The future of Malay craft relies on the survival of the very industry (Yaacob, 2016) In order to meet with the market demand, batik makers have to increase productivity of manufacturing processes to produce sufficient amount of products demanded by market.

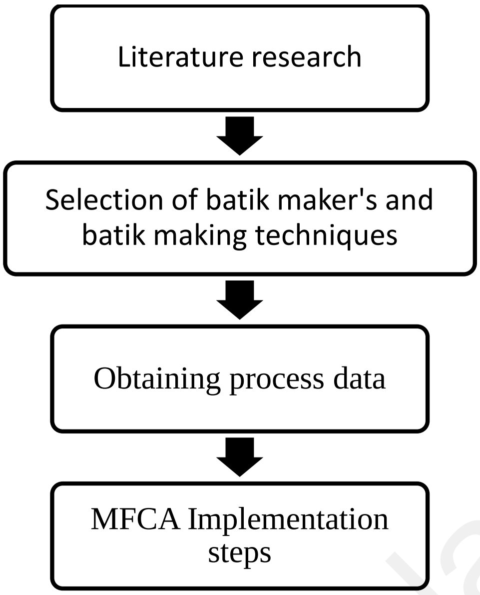
CHAPTER 3: METHODOLOGY

For the purpose of this research report, methodology is adapted from ISO 14051: Environmental Management – Material Flow Cost Accounting (MFCA) - General Framework. MFCA can be implemented in organizations with or without an Environment Management System (EMS) in place (ISO14051, 2011), which means, albeit most of local batik makers is still unequipped with Environment Management System (EMS), the MFCA methodology is still applicable to analyze the potential financial and environmental impacts of the processes involved.

The MFCA implementation methods will be divided into few general phases:

1. Literature research
2. Selection of batik maker's and specified batik making techniques (block print batik)
3. Obtaining material flows and its monetary units
4. MFCA calculation output and analysis

3.1 Flow Chart



3.2 Literature Review

The concept of Material Flow Cost Accounting (MFCA) arises from environmental management system. It can be classified as a management tool that interlinks accounting and management system. MFCA concept appeared in ISO 14051 standard as logical consequence from an environmental projects in Germany in the late 1980s and early 1990s (Wagner, 2015). MFCA implementation was also highly prevalent in Japan on production process improvement and waste reduction and this was presented in the MFCA case study examples published by the Ministry of Economy, Trade and Industry, Japan (Ministry of Economy, 2011).

In Malaysia, the concept was relatively new and was first introduced in 2010 under a project organized by the Malaysia Productivity Corporation (MPC) in small and medium enterprises (SMEs). As an environmental management accounting tool, MFCA can assist local companies to address both environmental and profitability issues thus enables local industries to become more competitive and maintain environmental sustainability (Farizah Sulong, 2015). For the purpose of the research report, all the research papers and journals will be used as guidance and the same concept will be implemented in the data analysis of batik making processes.

3.3 Selection of Batik Maker's and Batik Making Technique

Generally most MFCA implementation was implemented on manufacturing industries to assess the loss of materials through inefficient use of resources and identify possible savings that could bring about economic and environmental benefits. The idea is to use material as efficiently as possible and to reduce harmful effect to the environment, this concept is in line with the notion for a greener and more sustainable batik industry in Malaysia. Greening involves improving efficiency on production techniques, minimizing waste and redesigning production systems to be environmentally friendly (Yaacob, 2016).

The chosen batik maker's is located in the east coast of Malaysia and the process of batik making is made using traditional methods. An official visit was made to the selected batik maker's work site to have a better understanding on the process and material involved. Subsequently interviews were conducted with the batik maker's and workers to gain information on the material usage and waste generated. The batik making techniques chosen is the making of block print batik.

3.4 Obtaining Process Data

After the specified batik making techniques has been chosen, selected data on each step in processes involved was obtained. The data includes volume and cost of materials and any wastage in the middle of processes.

3.5 MFCA Implementation Steps

1. Engaging management involvement and determination of role and responsibilities

2. Specification of scope and boundary and establishing a Material Flow Model

3. Allocation of Cost

4. MFCA data summary and interpretation

5. Improvement opportunities and reducing material loss through MFCA analysis

3.5.1 Engaging Management Involvement and Determination of Role and Responsibilities

In order to be effectively implemented, MFCA should be strongly supported by the management. In this particular research report, the batik maker's has given full cooperation and given the researchers the needed data and details of the processes involved during the process of making block print batik. Official visit was made to the selected batik maker's work site and interviews were conducted with the batik maker's workers to obtain information on the material usage and waste generated.

3.5.2 Specification of Scope and Boundary and Establishing a Material Flow Model

Prior any MFCA analysis can be undertaken; specification of MFCA boundary has to be specified. In this particular research report, the process was specified on the process of making block print batik utilizing the traditional batik making method. The cost and of products and material losses were monitored for monthly period in the year 2015. The process of making block print batik is specified in Figure 4.1.

3.5.3 Allocation of Cost

Data from the batik makers were collected and calculated. Cost will be categorized into four categories, the material cost, energy cost, system cost and waste management cost. After the cost were identified and calculated, each of the cost were allocated to product and material losses, except for waste management cost.

3.5.4 MFCA Data Summary and Interpretation

Data obtained during MFCA analysis has to be summarized in format that is suitable for further interpretation, e.g. in material flow cost diagram. MFCA analysis will provide information on material losses throughout the whole process, waste generated at each steps and energy and system cost. Through identification of issues that leads to material losses and amount of waste generated, batik makers can identify the economic losses which was usually went unnoticed when relying on conventional cost accounting. Physical and monetary quantification of material flow will be summarized in material flow cost matrix.

3.5.5 Improvement Opportunities and Reducing Material Loss through MFCA Analysis

MFCA analysis enables batik makers to have better understanding on the magnitude, consequences and drivers of material use and loss. Batik makers may review the data obtained from MFCA analysis and utilizes these data to find ways to improve environmental and financial performance.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Batik Makers and Batik Making Technique Information

In this research report, the batik maker's chosen is a cottage industry run by Malay entrepreneur. It provides income for entrepreneur's family and employed workforces from the local community. The identity of the batik makers remain disclosed as requested by owner of the batik making company and for the purpose of this research report, here to be known as ABC Batik Kraft. The process of making block print batik in ABC Batik Kraft is attached in Appendix A.

Batik making technique that was chosen is block print batik. Block print batik is a technique using copper stamps to create repetitive pre-made patterns. The coppers are shaped up to make the desired batik designs. Each copper stamp is used to apply a design to the entire piece of cloth, saving a great deal of painting time. Block print batik allows batik artists to make high quality designs and more homogenous patterns much faster compared to hand-painted batiks.

4.2 Identification if Cost Centres

The flow of materials throughout the process of making block print batik starts with the delivery of the white cotton fabric to process area. For this particular process, the type of material that was used for the white cloth was cotton viscose. The white cloth (cotton viscose) will undergo preparation step where it will be cut to standardized size. Next, wax will be applied to the standardized pieces of cloth, this process is known as stamping block print where molten wax and resin is stamped on the cloth. After application of wax, dye is applied on the cloth and will be left to dry. To ensure dye applied to the cloth stays, a process call fixation will be done where the dyed cloth will be treated with sodium silicate for 6 to 12 hours and will be washed later to remove the sodium silicate residue. Subsequently, the dyed cloth will be undergoing wax removal process whereby the cloth will be boiled to remove wax and dye residue. Further additional clean-up of cloth in clean water is usually done twice to ensure unwanted residues are removed from the dyed cloth. Finally the dyed cloth is left to dry under the sun and folded into desired package. The finished product, batik is ready to be distributed to the batik traders. A constructed material flow for the process of making block print batik is described further in Figure 4.1.

4.2.1 Preparation of White Cloth

The cost associated with this centre makes use of the basic material in the whole block print process which is cost of material for the white cotton cloth (cotton viscose). Another material cost to be added is the material cost for detergents to clean the white cloth prior any application of wax or dyes to the cloth. Other important cost items include energy cost (for fuel) and material cost (scissors for cutting cloth).

4.2.2 Application of Wax to Cloth

This centre involves application of wax to cloth. Mixture of wax, resin and oil is heated up prior application to white cloth. Wax, resin and oil are material cost.

4.2.3 Application of Dye to Cloth

For this centre, cost associated within it varies between batik makers or even different between batches of batiks made. This is due to the design and variations of colors used by the artisan to create the batik. For this study, basic dyes used as colorant will be quantified as material cost such as the black, red, yellow, blue and brown dye. Further cost added will be the material cost for the amount of water used to prepare the dye mixtures.

4.2.4 Drying of Dyed Cloth (First Time)

After application of dye, dyed cloth will be left to be dried. This process is usually will be done in open space area where the dyed cloth will be hanged and dried by the sunlight and wind. For this centre, there will be no cost associated, since in traditional batik making methods, this technique is considered sufficient to dry the dyed cloth.

4.2.5 Fixation Process

In this cost centre, associated cost will come from material and energy cost. Material cost comes from usage of sodium silicate for color fixation to the dyed cloth and water usage.

4.2.6 Washing Process (First Time)

Cost associated with this centre is usage of water to rinse of the sodium silicate residue from the dyed cloth. Additional cost will be added to the cost centre if waste management is conducted for treatment of batik wastewater.

4.2.7 Wax Removal Process

Similar with previous cost centre, cost associated with this centre is usually associated with usage of substantial amount of water to remove the wax and dyes in the cloth. The dyed cloth will have to be boiled and this add up energy cost which is usage of firewood. Additional cost for waste management cost will be added to the cost centre if any treatment is done for the batik effluent prior release to environment.

4.2.8 Washing Process (Second Time)

For the second washing process, similar procedure is repeated and cost associated with this step is usage of water that will be quantified for energy usage. Additional cost on waste management shall be added if the batik wastewater undergoes any treatment process.

4.2.9 Drying of Dyed Cloth (Second Time)

Similar like the first process, the dyed cloth will be left to dry by sunlight and wind. For this cost centre, there will be no cost associated.

4.2.10 Packaging and Distribution

At the end stage of the process, this centre ensures that all the finished product is presentable whereby the batik cloth will be ironed and folded neatly into plastic packages prior distribution to suppliers. Energy cost will be quantified from usage fuel for transportation during product distribution. Other material losses such as usage of plastic for batik packaging are negligible and will not be quantified in the MFCA calculation.

4.3 Cost Calculation and Allocation

4.3.1 Calculation of Material Cost

Material associated with batik making process in ABC Batik Kraf is described in Figure 4.1. The material flow model describes the material used and material loss during the process.

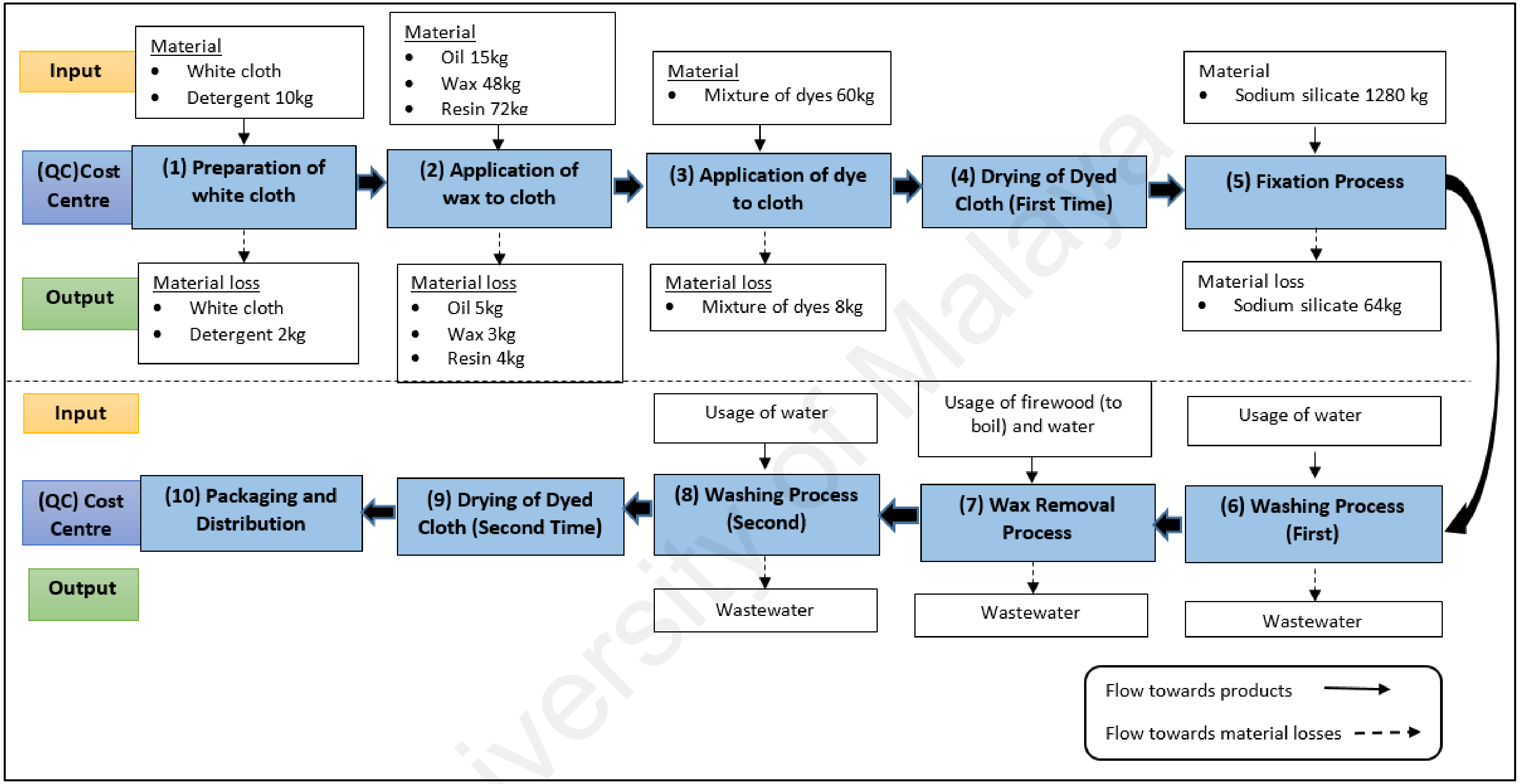


Figure 4.1 Constructed Material Flow for ABC Batik Kraf

4.3.2 Description of Material Losses

Overall in the batik making process, there are 10 quantity centres (QC) involved. Material cost was calculated for four quantity centres which include QC 1, 2, 3 and 5. For simplification of calculation, all the materials were listed under one quantity centre (QC).

The type of material losses included those outlined below:

- In QC 1, the basic material which is the white cloth (cotton viscose) has to be trimmed by scissors. In this trimming process, white cloth remnants are solid waste (material loss) that is produced.

Figure 4.2 Trimming of white cloth prior application of wax to cloth

- This is followed by QC 2, whereby the wax is applied to the white cloth. This process produced solid waste of wax and resin (material loss). Oil that was added up to the mixture of wax and resin also adds up to the material loss produced during this process.

Figure 4.3 Application of wax (using desired block print) to white cloth

- In QC 3, mixture of dyes is applied to the cloth. After application, the dyes residue was collected as liquid waste (material loss).

Figure 4.4 Mixture of dyes is applied to cloth (according to the design stamped)

- QC 5 involves usage of sodium silicate for the fixation process. In this process, used sodium silicate is produced as solid waste (material loss).

Figure 4.5 Cloth is soaked in sodium silicate to ensure color fastness

Total material inputs in this process	Composition of products and material losses	Quantity Centre (QC)	Result of production (mass)
	Products	6760m	6760m
	Direct		
	1. White cloth	6760m	
Materials: *Direct: 7098m* *Indirect: 1485kg*	*Indirect*	1399kg	1399kg
	1. Detergent	8kg	
	2. Oil	10kg	
	3. Wax	45kg	
	4. Resin	68kg	
	5. Mixture of dyes	52kg	
	6. Sodium silicate	1216kg	
	7.Water	$118m^3$	
	Material losses		
Direct	*Direct*		
1. White cloth: 338m	1. White cloth	338m	338m
Indirect	*Indirect*	86kg	86kg
1. Detergent: 10kg	1. Detergent	2kg	
2. Oil: 15kg	2. Oil	5kg	
3. Wax: 48kg	3. Wax	3kg	
4. Resin: 72kg	4. Resin	4kg	
5. Mixture of dyes: 60kg	5. Mixture of dyes	8kg	
6. Sodium silicate: 1280kg	6. Sodium silicate	64kg	

Table 4.1 Material Quantities and Composition in ABC Batik Kraf (2015)

Total material inputs in this process	Quantity Centre (QC)			Result of production (mass)	Total
Products	Mass	Unit Costs	Costs	*Direct: 6760m*	RM50,552.04
				Indirect: 1399kg	
Direct					RM47,320.00
1. White cloth	6760m	RM7.00	RM47,320.00	6760m	RM47,320.00
Indirect				1399kg	RM3,232.04
1. Detergent	8kg	RM3.00	RM24.00	8kg	RM24.00
2. Oil	10kg	RM2.80	RM28.00	10kg	RM28.00
3. Wax	45kg	RM6.80	RM306.00	45kg	RM306.00
4. Resin	68kg	RM13.00	RM884.00	68kg	RM884.00
5. Mixture of dyes	52kg	RM9.80	RM512.00	52kg	RM512.00
6. Sodium silicate	1216kg	RM1.10	RM1,337.60	1216kg	RM1,337.60
7. Water	–	–	RM140.44	–	RM140.44
Material losses	Mass	Unit Costs	Costs	*Direct: 338m*	RM2,607.20
				Indirect: 86kg	
Direct					RM2,366.00
1.White cloth	338m	RM7.00	RM2,366.00	338m	RM2,366.00
Indirect				86kg	RM241.20
1. Detergent	2kg	RM3.00	RM6.00	2kg	RM6.00
2. Oil	5kg	RM2.80	RM14.00	5kg	RM14.00
3. Wax	3kg	RM6.80	RM20.40	3kg	RM20.40
4. Resin	4kg	RM13.00	RM52.00	4kg	RM52.00
5. Mixture of dyes	8kg	RM9.80	RM78.40	8kg	RM78.40
6. Sodium silicate	64kg	RM1.10	RM70.40	64kg	RM70.40
Total material cost in this process					RM53,159.24

Table 4.2 Material Cost for the Constructed Flow Model Process (2015)

In total of a month period, ABC Batik Kraf has produced 6760m of the finished batik product (direct product) with approximately 338m of material loss. Meanwhile 1399kg of batik indirect products such as dyes and wax was produced with estimated 86kg of material loss identified.

For this material type (cotton viscose), the cost associated with material losses was found to be around RM2, 607.20 while the cost associated with products was RM53, 159.24.

4.3.3 Calculation and Allocation of Energy Cost, System Cost and Waste Management Cost

Existing cost data for each quantity centre from the whole batik making process are used to determine the energy cost, system cost and waste management cost. Table 4.3 shows the allocation of energy, system and waste management costs to products and material losses leaving quantity centres (QC).

Type of cost	Quantity Centre (QC)	Total
Energy cost	a. Fuel RM322.00	RM322.00
System Cost	a. Wages RM20,000.00	RM20,000.00
Waste Management Cost	NA	

Table 4.3 Allocation of Energy, System and Waste Management Cost

4.3.4 Calculation and Allocation of Energy Costs, System Costs and Waste Management Costs to Products and Material Losses in Quantity Centres (QC)

4.3.4.1 Calculation of Material Distribution Percentage in Quantity Centre (QC)

For this study, it was found that the material distribution percentages are 95.24% for direct products and 5.00% for material losses. Meanwhile for the indirect products, the material distribution percentages are 94.20% and 5.79% for material losses.

Table 4.4 shows the summary of material distribution percentage for the quantity centre (QC). The percentages are calculated based on Table 4.1.

Type of cost	Quantity Centre (QC)
Products	Direct: 6760m (95.24%) Indirect: 1399kg (94.20%)
Material Losses	Direct: 338m (5.00%) Indirect: 86kg (5.79%)
Total	Direct: 7098m (100.00%) Indirect: 1485kg (100.00%)

Table 4.4 Summary of Material Distribution Percentages in All QC

4.3.4.2 Allocation Criteria for Energy Cost

In this study, the only energy usage that has been assessed is the usage of fuel. Usage is only assessed in term of the amount of energy used (fuel) during the batik making process. Additional information on the energy efficiency of machinery used in every quantity centre is unavailable since the batik making industry is a traditional and cottage industry, therefore there is no accurate data or measurements made to measure energy efficiency in each process. Energy efficiency will not be taken into consideration for the purpose of calculation in this study.

4.3.4.3 Allocation Criteria for System Cost

Since batik industry is a traditional cottage industry, the system cost is not fixed and varies significantly between batik makers. For the same batik maker, the system cost can even vary differently between each consignment due to the different payment for the different type of task done by workers. Generally for task involving experience and creativity (such as dying the cloth), only two or three workers are assigned compared to higher number of workers (around seven to eight workers) will be assigned to do the washing and drying process. Depending on the job consignment, the workers are usually paid hourly/daily basis for a simpler task job such as washing/drying and experienced workers are usually paid according to the amount of batik product made. For this study, the estimation of system cost is based by monthly basis for ABC Batik Kraf for production of the amount of material quantities and composition in Table 4.1.

4.3.4.4 Allocation Criteria for Waste Management Cost

For this study, wastewater treatment process was not conducted during the batik making process, therefore there is no data available for waste management cost calculation.

4.3.5 Integrated Presentation of Cost Data

The material, energy, system and waste management cost data calculated from MFCA analysis was summarized in a material flow cost matrix (Table 4.5) illustrating data from the quantity centres (QC) from figure 4.1.

	Quantity Centre (QC)				
	Material Cost (RM)	Energy Cost (RM)	System Cost (RM)	Waste Management Cost (RM)	Total (RM)
Products	50,552.04	322.00	20,000.00	NA	70,874.04
Direct	47,320.00	—	—		—
Indirect	3,232.04	—	—		—
Material Losses	2,607.20	322.00	20,000.00		22,929.20
Total cost (RM)	53,159.24	644.00	40,000.00		93,803.24

Table 4.5 Material Flow Cost Matrix in ABC Batik Kraf (material: cotton viscose)

Based on the material flow cost matrix obtained, material cost accounted for 56.67% of the total production cost and the energy cost accounted for 0.69%, while the system cost, cover the remaining 42.64% of the total production cost.

Cost allocated for material losses amounts to RM22, 929.20 which makes up 24.44% of the total production cost.

4.3.6 Integrated Analysis of Cost Data

Prior to MFCA analysis, the batik maker's believed in their capability to produced batik kraf with minimum of 95% of product yield rate.

Conventionally, the batik maker's depended on the final product yield data as compared to the amount of material used. In this case study, usually the end product volume made (the batik kraf) is compared with the volume of white cloth used. Because according to the initial amount of white cloth used (for this study, the monthly volume would be around 6760m) and the defective amount of cloth at the end of batik making process was estimated to be around 5% from the total initial volume, the product yield rate was considered to be 95%.

In order to measure accurately the capability of ABC Batik Kraf in producing batik, instead of measuring directly the product yield rate, MFCA analysis was conducted to the batik making process whereby mass of all input and output materials were measured in combined quantity centre. In addition, the material, energy, system and waste management cost incurred were allocated to the final products and material losses. MFCA analysis includes the cost allocated for the purchase of the white cloth, other materials (such as wax, resin, dyes and sodium silicate) also contributes to the incurred cost during the batik making process. MFCA results shows that the material loss cost was approximately 25% of the total batik making process. This was by far greater than the estimated 5% loss of material that ABC Batik Kraf predicted prior the MFCA analysis.

Based on the MFCA result, ABC Batik Kraf realized there are improvements that can be made where material loss cost of the total production cost can be reduced to improved productivity and company's profit. Improvements can be made via various steps, such as reducing material loss, optimizing energy usage and improvising steps involved during batik making.

4.3.7 Other Assumptions for MFCA Calculation

4.3.7.1 MFCA Data Projection in 2017

All data used for the research is based on the production cost of batik approximately in June 2015. Projected to year 2017, the cost has risen significantly due to price increase of materials especially for the price of white cloth (which is imported and depends on the currency exchange rate) and the other incurred cost such as implementation of GST to other material cost. The inflation rate will also be taken into account whereby the inflation rate for the year 2016 is 2.1% and the inflation rate for the latest month in 2017 (July) is about 3.2% (B. N. Malaysia, 2017). For the purpose of this calculation, only addition of inflation cost and GST cost will be added up to the calculation. Energy cost and system cost increment will not be added due to the complexity of the calculation and for the purpose of this calculation, only material cost increment will be taken into consideration for calculation.

	Quantity Centre (QC)				
	Material Cost (RM)	Energy Cost (RM)	System Cost (RM)	Waste Management Cost (RM)	Total (RM)
Products	50,552.04	322.00	20,000.00	NA	76,783.19
2016 (2.1%)	51,613.63				
2017 (3.2%)	53,265.27				
6% GST	56,461.19				
Material Losses	2,607.20	322.00	20,000.00		23,233.96
2016 (2.1%)	2,661.95				
2017 (3.2%)	2,747.13				
6% GST	2,911.96				
Total cost (RM)	59,373.15	644.00	40,000.00		100,017.15

Table 4.6 Material Flow Cost Matrix in ABC Batik Kraf (2017 projection)

Material cost over total cost: 59.36%

Energy cost over total cost: 0.64%

System cost over total cost: 39.99%

Cost of material losses over total cost: 23.23%

4.3.7.2 MFCA Data for other Material (White Cloth)

For this study, materials (white cloth) used for costing is cotton viscose. Material type for batik making varies differently on the customers preferences. Other types of materials that can be used to make batik are linen, silk, chiffon, jacquard and satin. The cost of batik making is mainly dominated by the price of material (white cloth) used. The cost for each of the material is obtained from a local supplier and price quoted was for purchase of cloth for bulk amount with minimum amount ordered for each material is 200metres.

If the same costing for indirect material cost, energy cost and system cost were used for different materials, the material flow cost matrix will be as stated:

	Quantity Centre (QC)				
	Material Cost (RM)	Energy Cost (RM)	System Cost (RM)	Waste Management Cost (RM)	Total (RM)
Products	131,672.04	322.00	20,000.00	NA	151,994.04
Direct	128,440.00	—	—		—
Indirect	3,232.04	—	—		—
Material Losses	6,663.20	322.00	20,000.00		26,985.20
Total cost (RM)	138,335.24	644.00	40,000.00		178,979.24

Table 4.7 Material Flow Cost Matrix in ABC Batik Kraf (material: linen)

Material cost over total cost: 77.29%

Energy cost over total cost: 0.36%

System cost over total cost: 22.35%

Cost of material losses over total cost: 15.08%

	Quantity Centre (QC)				
	Material Cost (RM)	Energy Cost (RM)	System Cost (RM)	Waste Management Cost (RM)	Total (RM)
Products	141,812.04	322.00	20,000.00	NA	162,134.04
Direct	138,580.00	—	—		—
Indirect	3,232.04	—	—		—
Material Losses	7,170.20	322.00	20,000.00		27,492.20
Total cost (RM)	148,982.24	644.00	40,000.00		189,626.24

Table 4.8 Material Flow Cost Matrix in ABC Batik Kraf (material: silk)

Material cost over total cost: 78.57%

Energy cost over total cost: 0.34%

System cost over total cost: 21.09%

Cost of material losses over total cost: 14.50%

	Quantity Centre (QC)				
	Material Cost (RM)	Energy Cost (RM)	System Cost (RM)	Waste Management Cost (RM)	Total (RM)
Products	182,372.04	322.00	20,000.00	NA	202,694.04
Direct	179,140.00	—	—		—
Indirect	3,232.04	—	—		—
Material Losses	9,198.20	322.00	20,000.00		29,520.20
Total cost (RM)	191,570.24	644.00	40,000.00		232,214.24

Table 4.9 Material Flow Cost Matrix in ABC Batik Kraf (material: chiffon)

Material cost over total cost: 82.50%

Energy cost over total cost: 0.28%

System cost over total cost: 17.23%

Cost of material losses over total cost: 12.71%

	Quantity Centre (QC)				
	Material Cost (RM)	Energy Cost (RM)	System Cost (RM)	Waste Management Cost (RM)	Total (RM)
Products	216,172.04	322.00	20,000.00	NA	236,494.04
Direct	212,940.00	—	—		—
Indirect	3,232.04	—	—		—
Material Losses	10,888.20	322.00	20,000.00		31,210.20
Total cost (RM)	227,060.24	644.00	40,000.00		267,704.24

Table 4.10 Material Flow Cost Matrix in ABC Batik Kraf (material: jacquard)

Material cost over total cost: 84.82%

Energy cost over total cost: 0.24%

System cost over total cost: 14.94%

Cost of material losses over total cost: 11.66%

	Quantity Centre (QC)				
	Material Cost (RM)	Energy Cost (RM)	System Cost (RM)	Waste Management Cost (RM)	Total (RM)
Products	280,392.04	322.00	20,000.00	NA	300,714.04
Direct	277,160.00	—	—		—
Indirect	3,232.04	—	—		—
Material Losses	14,099.20	322.00	20,000.00		34,421.20
Total cost (RM)	294,491.24	644.00	40,000.00		335,135.24

Table 4.11 Material Flow Cost Matrix in ABC Batik Kraf (material: satin)

Material cost over total cost: 87.87%

Energy cost over total cost: 0.19%

System cost over total cost: 11.94%

Cost of material losses over total cost: 10.27%

Based on the material flow cost matrix obtained, the trend obtained is when the material price increases (the cloth material) the material cost increases. The cost of making batik is mainly influenced by the price of material and batik makers have to conduct market study prior making batik on different materials to know the material that is sellable to the customer.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Batik making is a traditional cottage industry and are often operated by families and sometimes within the family home vicinity. Due to this nature, cost estimation for batik making process is rather simple whereby the end product yield (finished batik) is compared to the material used (white cloth). This data does not represent the material losses that occur during the batik making process. By conducting MFCA analysis, material losses can be identified clearly and ABC Batik Kraf can utilize data from MFCA analysis to decrease production cost, increase productivity and reduce pollutants release to the environment.

Conclusions can be drawn from the objectives that have been set up in the beginning of the study:

1. Material losses in the traditional batik production process is quantified in physical and monetary unit. The physical unit involved in the batik making process are classified to two type, the first physical unit (direct) is the amount of white cloth used in metres (m) and the second physical unit (indirect) is the mass of wax, resin, dyes and sodium silicate used in kilograms (kg). The monetary unit is quantified in Ringgit Malaysia (RM) which is the national currency used in Malaysia.

2. In this study, MFCA has enables identification of material losses that occur during the traditional batik making process. From ten quantity centres, four quantity centres (QC 1, 2, 3 & 5) has been identified and material losses from these centres were listed under one quantity centre for simplification of calculation. Based on the data obtained,

suggestions can be made to ABC Batik Kraf to reduce material loss, optimizing energy usage and improvising steps during batik making.

5.2 Recommendations

MFCA calculation focuses on reducing the production cost through reduction in quantities of consumed materials and apart from cost reduction, helps to create positive environmental impacts. It is recommended for ABC Batik Kraf to take initiatives to tackle the material loss and wastage that occur during the batik making process, and to further emphasize initiatives on QC 1 (preparation of white cloth), QC 2 (application of wax), QC 3 (application of dye) and QC 5 (fixation process). Initiatives on improvements can be made via various steps, such as reducing material loss, optimizing energy usage and improvising steps involved during batik making.

In this study, material losses amounts to almost 25% of the total production cost, if this amount can be lessen, productivity can be increased. Material losses arise from inefficient usage of white cloth and other materials such as wax, resin, dyes and sodium silicate during the batik making process. One of the ways that can be done to manage material loss is to recycle the back these materials, which is applicable to the wax, resin, and sodium silicate. Repeated usage of these materials can decrease material losses and optimize usage of materials. Recycling of materials can also reduce the amount of wastage or pollutants in wastewater released to the environment since the batik maker's did not conduct any treatment on the released wastewater.

For this study, system cost accounted for approximately 42.64% from the total cost. It is the cost of wages to be paid to experienced and general workers involved during the batik making process. Since batik making is considered a traditional cottage industry, the system cost varies significantly between each batik makers and even between the job consignments for the batik maker itself.

Energy cost makes up about 0.69% of the total production cost, the amount is considered small compared to other cost such as material loss and system cost. Most of the energy cost is allocated for the usage of fuel for transportation and usage of substantial amount of water for washing and soaking (removal of wax from cloth). For example in usage of water, batik makers can optimize the amount of water used by containing water in huge container instead of using tap water continuously. By this way, the amount of water used can be reduced and a more accurate estimation of water for each process (washing and soaking) can be made according to the amount of cloth used. Any wastewater that can be recycled is used back in the washing process. Optimization of water usage can also reduce the amount of pollutants released to the environment.

Approximately there are ten steps involved in making block print batik. With the numerous amounts of steps taken, material losses or wastage can arise from any process done during the batik making. For example, during the preparation of the white cloth, material loss can happen if there is any error happened during the cutting process and wastage of cloth will cause material loss. Error can also occur during the stamping and dying process whereby the design error will lead to defect batik products that will be rejected and considered as material loss. In order to reduce the amount of material loss, a more experienced worker is often hired to increase the efficiency of work done and less error made during the batik making process. However, since batik making is a form of art itself, batik maker's often make these "allowable errors" to create new designs or patterns to create batik with higher aesthetical value due to the uniqueness and intricacy of its design.

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APPENDIX A

Process of Making Block Print Batik in ABC Batik Kraf (J. A. S. Malaysia, 2013)