Batik Artisans' judgment of batik wax quality and its criteria: An application of the Many-facet Rasch Model[1]

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Abstract
Batik is a traditional dyeing technique that uses hot melted wax on natural fabric. The wax is applied to fabric, left to dry then dyed using cold water dyes. Wax quality is central to the batik process and there are ten standard criteria used to measure the batik wax quality. This study used five batik wax samples tested by twenty batik artisans according to the standard criteria. The data analyzed using the many-facet Rasch Model. The study found that certain criterion like the cost of wax making is sensitive for the batik artisans. Two criteria of batik wax quality, namely 'easy to freeze' and 'not sticky' are two items that make the judgments' result that created unexpected responses from raters.

Keywords
batik wax, batik artisan assessment, batik wax testing, multi-rater assessment, many-facet rasch model

Introduction

The Indonesian batik has a place in world fashion. It is originated from Java and regarded by UNESCO in 2009 as one of the Representative Lists of the Intangible Cultural Heritage of Humanity (Unesco, 2009). The use of batik by Indonesian can be seen from different garments worn by women and men, such as a head cloth (*iket kepala*), shawl (*selendang*), two kinds of wrapped skirts (*kain panjang* and *sarongs*), and drawstring pants (*celana*) (Boehlke, n.d.). The Indonesians use batik apparel for casual wearing or in a formal occasion which shows that batik is part of their cultural life.

Batik is a proces of making motifs or ornaments on certain materials, mostly cotton fabric, by hot wax as a dyes repellent (McCabe, 2004). The batik wax is a material used for covering fabric's surface following the motifs so that the surface of the fabric can resist the given color on the fabric (Richards, 2004). After the wax is applied, the fabric is left to dry for a week or two then dyed using cold water dyes. When the substance is removed the resulting motif contrasts with the dye, where the part of fabric was covered by wax retains its original color. A repeated application of resist and dye, where another element of the design waxed, can create a complex and unique design of beautiful batik.

The technique of making batik firstly known by European in the early 1800s from Raflles' book, 'The History of Java' (Raffles, 1988). It illustrated where Javanese women created resist patterns on the cotton fabric in both sides, by gliding molten hot wax from a copper stylus called a *canting*, which just barely touches the cloth. This process of using *canting* to create hand-drawn batik is called *tulis* ('writing'), which is still practiced up to now (Susanto, 1980). In the middle of the nineteenth century, another process called *cap* was developed, which a copper stamp instead of *canting* used to transfer the wax to the cloth (Boehlke, n.d.).

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The use of wax cannot be separated from the batik making process. In order to produce good quality Batik, thus, it needs good quality of wax. The batik artisans are require to understand and to master the use of batik wax ingridients, also be capable for making wax mixture formulation in order to produce good quality of batik wax. Disappointingly, little is understood about how batik artisans judge the quality of the batik wax (Francis & Sundara, 1988; Nilghaz et. al., 2011). For this reason there is a need to investigate the batik wax tested by the batik artisans who applied certain quality criteria that used multi-rater assessment. This study provides an overview of making of the batik wax from its ingredients and the standard criteria to judge batik wax quality. An outline of the methodology is followed by the presentation of and the discussion about our findings, with a concluding section to close the paper.

The making of batik wax and the characteristics of good quality batik wax

Initially batik artisans use available batik wax in the market. They did not consider how it was made and its ingredients. However, the high demand of good quality batik required them to produce good quality batik wax by themselves. The formulas ingredients used in the batik wax making are different. Generally, the wax used in the batik *tulis* process (for making lines motifs on hand-written batik with *canting*) the quality of the batik wax must be better than the wax for stamping process (or *cap*). Batik wax is also strongly influenced by weather conditions and local air temperature environment. For instance, the batik production in an coastal area where it is located near the beaches will use different wax compared to the batik wax used by batik artisans who live in an plateau area where the weather is quite cold and cool.

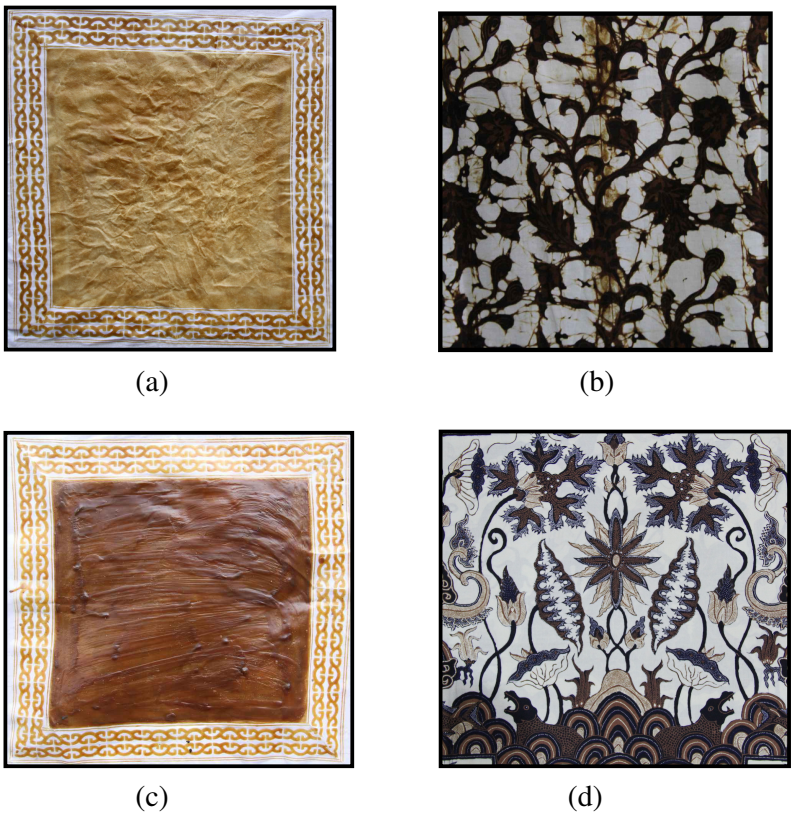
The making of the batik wax by the batik artisans use the composition from seven ingredients, namely paraffin, beeswax (*kote*), residue of pine-gum distillation (*gondorukem*), cat's-eye resin (*damar*), microwax, recycled wax (*lilin gladhagan*), and animal fat. All ingredients are available in Indonesia except for the microwax (Susanto, 1980). All of the ingredients have different prices. Beeswax is the most expensive component which is usually used in the formula to produce the finest quality of batik. Another researcher, Bowen (2007), has also tried another source, such as from soy wax.

When making the batik wax, knowledge of materials melting points is crucial because it starts from the material with the highest melting points. For example, after deciding the composition of each amount of the batik wax ingredient, a batik artisan heats the stove and starts the process with cat's-eye resin (melting point 85^{o}C), followed by the residue of pine-gum distillation (melting point 80^{o}C) when the first ingredient starts melting, then continues with other ingredients until to animal fat (45^{o}C, the lowest melting point). When all ingredients mix well, usually added by kerosene to make the wax dissolve properly, then pours the melted wax into metal-pan, leaves the wax until it freezes completely. It is best to leave the wax for 48 hours to freeze. Then the batik wax is ready to be used with re-heated, and is applied it to the fabric.

According to Susanto (1980), there are several standard criteria to measure the batik wax quality. First, the batik wax should be resistant and not be easy to brittle by alkali where usually comes from chemical/synthetic dyes which is becoming more common nowadays for its practical benefits; second, the good wax is high in durability in wetness penetration usually when the fabric dye uses cold and hot water; third, the batik wax is flexible which is not easy to break in any condition; fourth, motif with sharp lines should be obtained from batik wax; fifth, a good batik wax does not provide an additional color to the fabric. Other

characteristics of a good batik wax also have to: sixth, be easy to be removed from the fabric; seventh, be easy to freeze; eight, be not sticky when use; ninth, be easy to make by the batik artisans; and tenth, be not expensive in terms of cost of production.

An example of good and poor batik wax quality is shown by the figures below. Figure 1(a) shows an example of a poor quality batik wax which is easily to break in a long period of time and to result unwanted added color to the fabric and to have unclear motifs (1b). Compare to the batik wax shown by Figure 1(c) that is resistant to the alkali, flexible, durable in wetness penetration and not sticky that leads to good quality batik cloth (1d).



(a) (b)

(c) (d)

Figure 1. Samples of batik wax applied in the fabric and its end product

Method

The procedure

The researchers prepared the batik wax samples for the study which were composed from the seven raw materials. The entire batik wax samples come from various mixed materials with the total at least 1 kg each, and created five batik wax samples coded A, B, C, D and E to be tested. For each sample, except the composition of raw materials, all the procedures are all the same, where every sample composition was poured into a pan-wax maker and heated with stove, then the wax was melted and mixed perfectly. The wax sample then poured into metal-pan, left it over until it frozen. The next step is to provide the five batik wax samples to the batik artisans and inform the cost of the production of each sample without informing the batik wax composition.

There were 20 professional batik artisan participated in the study as raters (R1 to R20). All the batik artisans had experienced of making batik for more than 10 years both with printing

and mostly with hand-drawn batik. They came from West Java, Indonesia. Five wax samples that had been prepared was given to the batik artisans, where the batik artisans heated wax the samples and poured it into *canting*. The batik artisans then streaked the batik wax using canting on white cotton cloth with a size of 30 cm x 30 cm. The fabrics that had been given to the batik wax samples by the rater then hung on a clothesline, then observed for 2 weeks. The coloring process has to be done for testing the wax condition on the resistance to alkaline chemicals, as well as to observe the resulting colors on the fabric whether there is the onset spots or cracks in the fabric or not.

During the whole process all the batik artisans rated each of the wax samples used the ten standard criteria of the good quality batik wax which are 'alkali' (resistant and not easy brittle with alkali), 'resist' (high durability in wetness penetration), 'flexible' (flexible, not easy to broke in any condition), 'motif' (motifs with sharp lines), 'Ncolor' (do not leave color to the fabric), 'Eremove' (easy wax removal), 'Efreeze' (easy to freeze), 'Nsticky' (not sticky), 'Emake' (easy to make) and 'cost' (cost of production); and put their opinion on rating score from 1 (very disagree), 2 (disagree), 3 (neutral), 4 (agree) to 5 (very agree) regard to each batik wax sample's quality. Every batik artisan assesses five batik wax samples with the ten test items criteria, which resulted 50 rating result for each of the rater. All the raters provide the ratings needed, and no missing data happened.

Many-facet Rasch Model

Many-facet Rasch Model (MFRM) was developed by Linacre (1989) which can adjust variability that is introduced in ratings through the use of multiple raters. The MFRM can be used in this study to provide fair and an accurate estimation of the batik wax samples' quality based on the batik artisans' rating, a kind of more robust measurement model. A further advantage of MFRM is that each judge can be modelled according to the manner where each rater uses the rating scale, which can be defined with its own scale, which means the model not expect the raters to rate identically (Englehard, 2013; Boone, Staver & Yale, 2014; Bond & Fox, 2015). The MFRM has been used in many studies for handling rater-related variability and errors in many fields (Abu Kasim, 2011; Parra-Lopez & Oreja-Rodriguez, 2014; Wang & Stahl, 2012; Basturk, 2008).

The simple general form of MFRM can be formulated as follows (Linacre, 1989):

$$\log\left[\frac{P_{nijk}}{P_{nijk-1}}\right] = B_n - D_i - C_j - F_k$$

Where:
P_{nijk} is the probability of examinee n being awarded on item i by judge j a rating of k
P_{nijk-1} is the probability of examinee n being awarded on item i by judge j a rating of $k-1$
B_n is the ability of examinee n
D_i is the difficulty of item i
C_j is the severity of judge j
F_k is the extra difficulty overcome in being observed at the level of category k, relative to category $k-1$

The MFRM can measure the interaction between facets, which may signal an unexpected response or bias in the rating process. Further, the model "is able to detect other rater effects, such as restriction of range, halo effect and internal consistency through the use of particular fit statistics" (Abu Kasim, 2011). The study used FACETS version 3.71.3 that was

developed by Winsteps.com (Linacre, 2013), a computer software program that implements MFRM.

Result and Discussion

FACETS analysis

Table 1 shows the logit for each wax sample (A to E) based on ten batik artisan assessment. Batik wax D has the highest logit (+2.14) which means the best quality compares to other samples, followed by batik wax C, B, A and the least is E.

Table 1. Batik Wax Measurement Report

Total Score	Total Count	Model Measure	Model S.E.	Infit MnSq	Infit ZStd	Outfit MnSq	Outfit ZStd	Correlation PtMea	Correlation PtExp	Wax
638	200	-1.11	.07	1.38	4.3	1.32	3.4	.25	.43	A
813	200	-.13	.09	.43	-5.9	.52	-4.4	.37	.39	B
874	200	.44	.11	.86	-1.0	.82	-1.4	.08	.32	C
964	200	2.14	.18	.73	-1.9	.60	-2.9	.69	.19	D
586	200	-1.34	.06	1.02	.3	.97	-.3	.60	.42	E

Figure 2 gives a graphic presentation the quality of each batik wax sample, items of the standard quality wax testing and the rater's severity which are generated by FACETS program. The first column on the right is the logit scale, the measurement unit where batik wax, testing the items and the raters are measured. The second column gives the distribution of each batik wax quality, the second column is distribution of the wax testing item; the distribution of both columns are resulted from raters's responses to the batik wax samples based on the wax testing standard items. Then the fourth column presents the distribution of the batik artisans as raters. All of the distributions of the wax samples, the wax testing items and the batik artisans' columns are modelled with a mean of zero logit, which means it is the average batik wax quality, average wax testing items are agreeable in terms of quality and an average severity for the raters (batik artisan).

At the second column, as informed in the Table 1, showing range of batik wax samples' measure, from the highest quality (wax D) to lowest quality estimate (wax E) that has a measure of approximately -1.34 logits. Three out of the five batik wax samples (B, A and E) are below 0.0 logit which means below average wax quality. Undoubtedly, wax D is the finest batik wax according to the batik artisans. From the distribution of wax sample logits, it is evident that there is a considerable amount of variation in batik wax samples quality which ranges about 3 logits. This is desirable as the variability of the wax sample quality is the aim of the measurement process.

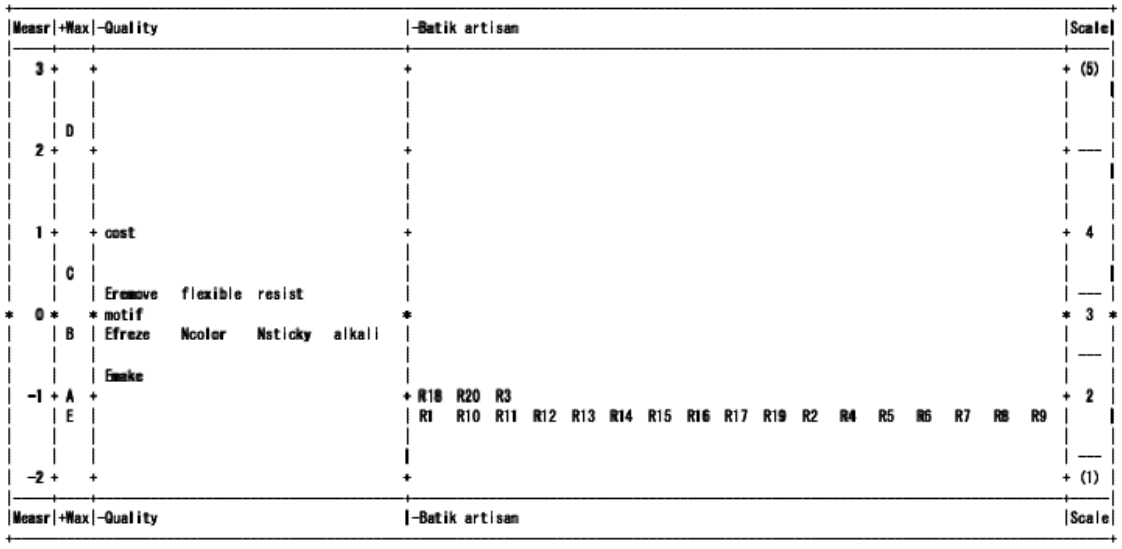


Figure 2. Batik wax quality, wax testing items and rater severity distribution

The third column in the Figure 2 shows the distribution of the testing items which are considered from easy to difficult to agree with regard to the wax quality according to the raters. The difficulty to agree the measurement was adjusted for the differences in items and ordered along the logit scale with the most difficult at the top and the easiest at the bottom of the scale. It shows that 'cost' is the most difficult item to agree (measure of approximately +1.04 logits) for the raters to agree. This means that the cost of making batik wax is the most sensitive factor for the batik artisans to decide about making the batik wax. Certainly the production cost of the batik wax is the main concern for the batik artisans who have years of experiences in the industry. Meanwhile the item of easy to make (Emake) is the easiest item to be agreeable by the rater (measure of approximately -0.66 logits). This also understandable, with background work experience more than ten years, the batik artisan already practiced and experimented many batik wax compositions in their carrier that making it is part of their daily work.

There are four testing items that higher than average difficult to agree (more than 0.0 logit) which are respectively item easy to remove (Eremove) with measure of approximately +0.22 logits, 'resist' (+0.16 logit), flexible (+0.14 logits) and 'motif' (+0.10 logits). All of the four items considered are something that above average in terms of the difficulty to agree by the batik artisan though it is still below item of the cost production of the batik wax. Another four batik wax testing item was below 0.0 logit which is not sticky (Nsticky), easy to freeze (Efreeze), not easily vulnerable to alkali, and do not leave color on fabric (Ncolor); all of these four testing items somewhat easy to agree by the rater in terms of measuring batik wax.

The severity level of raters which appears in the fourth column in Figure 3 is modelled with the most severe at the top and the most lenient at the bottom of the logit scale. As shown in the Figure 3, the range of the rater distribution is not wide as the quality of the batik wax samples (column 2) or agreement to testing items (column 3). This indicates that these raters did not differ considerably in their severity level. All batik artisan as rater considers as lenient raters, which means there is no big difference level of the severity between raters. The analysis shows that all the batik artisans who have work experiences more than ten

years are professional as they know better about the batik wax quality, which they can provide considerably not different result.

An accuracy of estimation of the batik wax quality

In the measurement process, an accurate estimation of performance or quality is something vital for valid measurement. The good thing about MFRM is that it can provide information about bias and unexpected response of the raters, either the rating given is too high or too low. Table 2 displays the difference in rater severity which has affected the estimation of the batik wax sample quality which is derived from the FACETS program of the MFRM analysis.

Table 2. Unexpected rater responses of batik wax rating

Cat	Score	Exp.	Resd	StRes	Nu	Bat	N	W	Nu	Quality
1	1	3.6	-2.6	-2.5	5	R5	1	A	6	Nsticky
1	1	3.5	-2.5	-2.4	2	R2	1	A	6	Nsticky
1	1	3.5	-2.5	-2.4	10	R10	1	A	6	Nsticky
1	1	3.5	-2.5	-2.4	12	R12	1	A	6	Nsticky
1	1	3.5	-2.5	-2.4	13	R13	1	A	6	Nsticky
1	1	3.5	-2.5	-2.4	16	R16	1	A	6	Nsticky
1	1	3.4	-2.4	-2.3	6	R6	1	A	4	Efreze
3	3	4.4	-1.4	-2.3	6	R6	2	B	10	Emake
1	1	3.4	-2.4	-2.3	7	R7	1	A	4	Efreze
1	1	3.4	-2.4	-2.3	8	R8	1	A	4	Efreze
1	1	3.4	-2.4	-2.3	14	R14	1	A	4	Efreze
1	1	3.4	-2.4	-2.3	15	R15	1	A	4	Efreze
4	4	4.8	-.8	-2.3	18	R18	4	D	4	Efreze
1	1	3.4	-2.4	-2.3	19	R19	1	A	4	Efreze
4	4	4.8	-.8	-2.3	20	R20	4	D	4	Efreze
1	1	3.4	-2.4	-2.2	1	R1	1	A	6	Nsticky
1	1	3.4	-2.4	-2.2	3	R3	1	A	4	Efreze
3	3	4.4	-1.4	-2.2	3	R3	2	B	10	Emake
1	1	3.4	-2.4	-2.2	4	R4	1	A	6	Nsticky
1	1	3.4	-2.4	-2.2	9	R9	1	A	6	Nsticky
1	1	3.4	-2.4	-2.2	11	R11	1	A	6	Nsticky
1	1	3.4	-2.4	-2.2	17	R17	1	A	6	Nsticky
3	3	4.3	-1.3	-2.1	2	R2	3	C	3	Eremove
1	1	3.3	-2.3	-2.1	3	R3	1	A	6	Nsticky
3	3	4.4	-1.4	-2.1	5	R5	3	C	3	Eremove
1	1	3.4	-2.4	-2.1	6	R6	1	A	6	Nsticky
1	1	3.3	-2.3	-2.1	18	R18	1	A	4	Efreze
1	1	3.3	-2.3	-2.1	20	R20	1	A	4	Efreze
Cat	Score	Exp.	Resd	StRes	Nu	Bat	N	W	Nu	Quality

There are 28 ratings given (out of total 1000 ratings) given by the batik artisans which consider contain bias in their judgments. From the first row of the Table 2, it can be read as, in the column 2 rating score given is '1', but according to the model, the expectation (Exp.) it should be around 3.6 (which is 4 to be precise), which is given by batik artisan no 5 (R5) when the rater provided rating to the batik wax A for the 'not sticky' (Nsticky) item. All of the above unexpected raters' responses lists in Table 1 demonstrate that MFRM can predict the consistency of each rater and in which item to any samples they rate. As shown in the table that the batik wax A is the most difficult to rate by the batik artisans, in terms of 'not sticky' (Nsticky) and 'easy to freeze' (Efreeze) item. This is because the batik wax A position is not in the average quality but is not easily distinguished like in the lowest quality (batik wax E). Another point is that two batik artisans (R3 and R6) gave a lower rating than expected regarding to 'easy to make' (Emake) item of the batik wax B. Meanwhile the batik artisan R2 and R3 provided lower rating to the batik wax C in 'easy to remove' (Eremove) item. All of this information indicates that several testing items, such as Nsticky and Efreeze, are potential the data gathered from the items, needed to be handle carefully or could be improving testing items instrument to make it more accurate measurement.

Conclusions

Batik wax is central to make batik clothing. Good quality wax measured by ten testing items that become the standard criterion which have to be done by batik artisans who act as the raters in this study. This study was conducted using a many-facet Rasch model (MFRM) which at the same time measures the quality of the batik wax, the quality of the testing items and the severity level of the raters. The result of the data analysis indicates that good quality wax samples easily obtained by given logit unit using FACETS program that shows the distribution of the batik wax quality in which the batik wax D is the excellent one. With regard to the ten testing items to measure the batik wax quality, the cost of production is something which is the most difficult thing to agree by the batik artisans, whereas the item of 'easy to make' is something that all the raters agree that it is the easiest item. It is also found that the rater distribution (batik artisans) range is not wide like the batik wax quality or the testing items. The analysis of the unexpected raters' responses and bias show that two test items, not sticky (Nsticky) and easy to freeze (Efreeze), are the items which are not easy to judge for the batik wax quality by the raters. This finding informs that the improvement of the test item of the quality for batik wax is needed to get a more accurate result. In conclusion, MFRM can provide a useful analysis with regard to the batik wax quality using multiple-raters techniques, it is also resulted an accurate estimation for valid measurement regarding to the quality of the batik wax, the quality of test items, the raters' severity and the indication of the raters' bias.

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