An affective design for jenang packaging in Indonesia

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Abstract. Affective design is today’s focus in the packaging design development process. It’s very important to develop the affective packaging that can make the customer feels good by seeing it. Affective design can support other qualities of the product, and influence customer purchasing decisions. Furthermore, it should be the main focus in product marketing especially Small and Medium Enterprises (SMEs) product. Low ability in packaging matters is one of the problems in most SMEs in Indonesia. The improvement of SMEs product packaging design should be done and it will increase the SMEs product sales. This research proposed a framework to design an affective packaging design based on customer needs. Jenang packaging is used as a research object. The objectives of this research are (1) to determine the relevant design elements of Jenang packaging and (2) to formulate the Jenang packaging design. Relief algorithm was used to extract the relevant design elements and resulted in six most important elements (shape, brand, color of brand name, image, material, and size). Association Rule Mining (ARM) is used to formulate the affective Jenang packaging design. Based on ARM, top ten rules are resulted and can be used to be the guideline for SMEs to improve their Jenang product packaging. The SMEs owner must choose the rules that have positive emotion. For example, if SMEs owners want to develop Jenang packaging design with curvy shape, the brand name should be traditional and packaging material is plastic.

1. Introduction
Affective design is today’s focus in product development processes. Customers not only choose products that can function well but also products that can fulfill their affective needs. Affective design is a process of designing by involving emotions, customers’ feelings towards a product [1, 2]. An affective design is created to meet the needs of customers emotionally. Affective design of a product can support other qualities of the product, and will also influence customer purchasing decisions [3]. The design of a product can stimulate a variety of emotions from potential customers. These emotions are divided into two, namely negative and positive emotions. Products that can cause positive emotions will be chosen by customers, in more detail is a product that can make the users feel happy [4].

Packaging is the first thing seen in a product and currently, many companies have focused on developing their product packaging designs. Packaging is considered to be important in product marketing and it is very important to be able to attract customers’ buying interest with the packaging
design [5]. Affective packaging design becomes more important to develop than before. Affective packaging design must begin to be the main focus in product marketing for business people, especially Small and Medium Enterprises (SMEs) owners. Global market competition is currently increasingly stringent demanding SME to improve the quality of their products, especially packaging. Low ability in packaging matters is one of the problems in most SMEs in Indonesia [6]. Improved packaging design, especially food products must be done so that SME products can target a wider market. One of them is by creating a packaging design that is oriented to customers [7]. Improved packaging design will also increase SME product sales. Improved packaging design does not have to be done for all design elements. Research must be done to get which design elements will be improved. One example is the graphic design elements (brand name, color, typography, and image) is the only one design element that influences “Monggo” chocolate customer purchasing decisions [8]. Each product has its own important packaging design elements.

This research proposed a framework for packaging design element extraction and formulation of the packaging design based on customer needs. Jenang packaging product is used as a research object. Jenang or dodol is a traditional product found in Java. Jenang is the most widely found SME product in almost all of the Indonesian island of Java. In developing Jenang products, packaging design becomes one that must be made more attractive based on customers need [9]. Relief algorithm is used to extract Jenang packaging design elements and Association Rules Mining (ARM) is used to formulate the Jenang packaging design. Our objective of this research is (1) to determine the relevant design elements of Jenang packaging and (2) to formulate the Jenang packaging design. The design formula can be used by the Jenang SMEs owner in improving their Jenang packaging design.

2. Methods
2.1. Research framework
The research began with identified the Jenang packaging design elements from literature and the expert packaging designers. The design elements were collected through the 1st questionnaire. Relief algorithm was used to extract the relevant Jenang packaging design elements based on customers perception. For the second objective, Jenang packaging samples were collected and the 2nd questionnaire was built. The 2nd questionnaire was distributed to the customer to collect the customer perception about Jenang packaging based on the relevant elements. The customer perception was analyzed using Association Rules Mining (ARM). The result are rules that can be used to maken the Jenang packaging design formula.

![Figure 1. Research framework.](image-url)
2.2. Data collection
This study selected a purposive sampling technique to collect the data and with several criteria of respondents as follows: (1) they have bought Jenang product, (2) they have experience with Jenang packaging. Purposive sampling was chosen as a sampling technique with consideration of the important of success in achieving research objectives. Jenang packaging sample was used to identify the relevant design element. The samples were collected by observation of the whole world via market survey and internet. Next phase was determination of the important elements such as color, size, and shape of the packaging specimens. The samples were analyzed to identify the similarity and dissimilarity between them.

2.3. Extraction of Jenang packaging design elements
Identification of the important packaging design element starting from identifying the design elements that have been done in the previous stage. After these design elements obtained, it would be assessed the level of importance by 30 respondents and would be reduced using relief method.

Relief is a typical algorithm in Filter model. It is efficient, aware of the contextual information, and can correctly estimate the features/variables quality in the problem with strong dependencies between them. The key idea of the relief algorithm is to estimate the quality of the features according to how well their values distinguish between instances that are close to each other [10]. Given training data \( \delta \), sample size \( m \), and a threshold of relevancy \( \tau \), relief detects those variables which are statistically relevant to the target concept. \( \tau \) encodes a relevance threshold \( 0 \leq \tau \leq 1 \). We assume the scale of every variable is either nominal or numerical. Differences of variable values between two instances \( X \) and \( Y \) are defined by the following function \( \text{diff} \).

When \( x_k \) and \( y_k \) are nominal,

\[
\text{diff}(x_k, y_k) = \begin{cases} 
0 & \text{if } x_k \text{ and } y_k \text{ are the same} \\
1 & \text{if } x_k \text{ and } y_k \text{ are different}
\end{cases}
\]

When \( x_k \) and \( y_k \) are numerical,

\[
\text{diff}(x_k, y_k) = \frac{(x_k - y_k)}{\text{nu}_k}
\]

Where \( \text{nu}_k \) is a normalization unit to normalize the values of \( \text{diff} \) into the interval \([0,1]\)

Relief \((\delta, m, \tau)\)

Separate \( \delta \) into \( \delta^+ = \{\text{positive instances}\} \) and \( \delta^- = \{\text{negative instances}\} \)

\( W = (0,0,...,0) \)

For \( i = 1 \) to \( m \)

- Pick at random an instance \( X \in S \)
- Pick at random one of the positive instances closest to \( X \), \( Z^+, \delta^+ \)
- Pick at random one of the positive instances closest to \( X \), \( Z^-, \delta^- \)
- If (\( X \) is a positive instances)
  - Then \( \text{Near-hit} = Z^+; \text{Near-miss} = Z^- \)
  - Else \( \text{Near-hit} = Z^+; \text{Near-miss} = Z^- \)

Update-weight \((W, X, \text{Near-hit}, \text{Near-miss})\)

For \( i = 1 \) to \( p \)

\[
W_i = W_i - \text{diff}(x_i, \text{near-hit}_i)^2 + \text{diff}(x_i, \text{near-miss}_i)^2
\]

Relief calls a routine to update the variable weight vector \( W \) for every sample triplet and to determine the average variable weight vector Relevance (of all the variables to the target concept). Finally, relief selects those variables whose average weight (‘relevance level’) is above the given
threshold τ. The following theoretical analysis shows that relief is different from other feature weight based algorithms in that it can handle feature interaction, or that it is more autonomous [11].

2.4. Formulation of Jenang packaging design

In order to accomplish the third objective, firstly, we collected the customers' perception about each packaging sample. The calculation of impression was grouped into positive and negative emotion. After that, generated the relation between design element and customers' perception and analyzed using association rules mining to find the rules about affective design of the jenang packaging.

The Association Rules Mining (ARM) method was adopted by [12]. Now, let \( I = \{i_1, i_2, \ldots, i_m\} \) be a set of literals, called attributes. Let \( P \) denotes the set of positive integers. Let \( I_P \) denotes the set \( I \times P \). A pair \((x, v) \in I_P\) denotes the attributes \( x \), with the associated value \( v \). Let \( I_R \) denotes the set \( \{(x, l, u) \in I \times P \times P|l \leq u, \text{if } x \text{ is quantitative}; l = u, \text{if } x \text{ is categorical}\} \). Thus, a triple \((x, l, u) \in I_R\) denotes either a quantitative attribute \( x \) with a value in the interval \([l, u]\), or a categorical attribute \( x \) with a value \( l \). We will refer to this triple as an item. For any \( X \subseteq I_R \), let \( \text{attribute}(X) \) denote the set \( \{x|(x, l, u) \in X\} \). Note that with the above definition, only values are associated with categorical attributes, while both values and ranges may be associated with quantitative attributes. In other words, the values of categorical attributes are not combined.

Let \( D \) be a set of records, where each record \( R \) is a set of attribute values such that \( R \subseteq I_R \). We assume that each attribute occurs at most once in a record. We say that a record \( R \) supports \( X \subseteq I_R \), if \( \forall(x, l, u) \in X(\exists(x, q) \in R \text{ such } l \leq q \leq u) \). A quantitative association rule is an implication of the form \( X \Rightarrow Y \), where \( X \subseteq I_R \), \( Y \subseteq I_R \), and attributes \( (X) \cap \text{attributes}(Y) = \varnothing \). The rule \( X \Rightarrow Y \) holds in the record set \( D \) with confidence \( c \) if \( c\% \) of record in \( D \) that support \( X \) also support \( Y \). The rule \( X \Rightarrow Y \) has supports in the record set \( D \) if \( s\% \) of records in \( D \) support \( X \cup Y \). Given a set of record \( D \), the problem of mining quantitative association rules is to find all quantitative association rules that have support and confidence greater than the user-specified minimum support (called \( \text{mins up} \)) and minimum confidence (called \( \text{minconf} \)) respectively. Note that the fact that items in a rule can be categorical or quantitative has been hidden in the definition of an association rule.

3. Results and Discussion

3.1. The relevant Jenang packaging design elements

Ten Jenang packaging design elements that have been collected from literature and expert perception were analyzed using Relief algorithm. In this study, Relief is very powerful full elements selection method that help researcher to select the most important design elements. Also, Relief is flexible and efficient to compute complex data and different data types [13]. The result shows the weight of each element as shown in Table 1. From ten elements, there are six elements that have highest weight, namely shape, brand, color of brand name, image, material, and size. Those elements are used as variables in the formulation of affective design rules to improve the packaging design of jenangs.

| Attribute             | Hit  | Rank |
|-----------------------|------|------|
| Shape                 | 0.2299 | 1    |
| Brand                 | 0.0933 | 2    |
| Color of brand name   | 0.0700 | 3    |
| Picture on packaging  | 0.0200 | 4    |
| Material              | 0.0100 | 5    |
| Size                  | 0.0000 | 6    |
| Font                  | -0.0233 | 7    |
| Color combination     | -0.0299 | 8    |
| Logo                  | -0.0466 | 9    |
| Label                 | -0.0566 | 10   |
Table 2 shows the six relevant design elements were extracted from forty packaging sample of jenangs. There were six categories with 16 variants of Jenang packaging design elements.

| Design Element | Type       |
|---------------|------------|
| X1: Shape     | Curvy      |
| X2: Brand     | International |
| X3: Color of brand | Colorful |
| X4: Image     | Full       |
| X5: Material  | Paper      |
| X6: Size      | Big        |

3.2. Formulation of Jenang packaging design

Formulation of affective Jenang packaging design is an important role of affective design framework. In this section, the design formula was formulated using the rules of ARM result. The data for ARM analysis was the relationship between the design elements of jenang packaging sample with customers perception as shown in Table 3.

| No | Shape  | Brand    | Color of brand | Image   | Material | Size | Class |
|----|--------|----------|----------------|---------|----------|------|-------|
| 1  | Curvy  | International | Colorful      | Full    | Paper    | Big  | Negative |
| 2  | Curvy  | International | Colorful      | Full    | Paper    | Small | Negative |
| 3  | Curvy  | International | Colorful      | Full    | Plastic  | Big  | Positive |
| 4  | Curvy  | International | Colorful      | Full    | Plastic  | Small | Positive |
| 5  | Curvy  | International | Colorful      | No-image | Paper    | Big  | Negative |
| ... | ...    | ...       | ...            | ...     | ...      | ...  | ...    |
| 40 | Straight | National  | Transparent   | No-image | Plastic  | Small | Positive |

The formulation result is the rules that can be used to formulate affective SMEs product packaging design. All rules are shown in Table 4.

| No | Rule combination                                             | Conf | Lift | Lev | Conv |
|----|--------------------------------------------------------------|------|------|-----|------|
| 1  | {Brand =traditional, Class =positive→ material =plastic}    | 1    | 1.48 | 0.09| 3.58 |
| 2  | {Image=half-image→ shape =curvy}                             | 1    | 1.33 | 0.06| 2.50 |
| 3  | {Image =half-image, material =plastic→ shape =curvy}        | 1    | 1.33 | 0.06| 2.25 |
| 4  | {Image=no-image, class=positive→material=plastic}           | 1    | 1.48 | 0.07| 2.92 |
| 5  | {Shape=curvy, brand=traditional, class=positive→material=plastic} | 1    | 1.48 | 1.48| 2.92 |
| 6  | {Image=half-image, class=positive→shape curvy}              | 1    | 1.33 | 0.05| 2.00 |
| 7  | {Image=full, class=negative→material paper}                 | 1    | 3.08 | 0.14| 5.40 |
| 8  | {Image=half-image, class=positive→material=plastic}        | 1    | 1.48 | 0.07| 2.60 |
| 9  | {Material=paper, size=big→class=negative}                  | 1    | 2.22 | 0.11| 4.40 |
| 10 | {Image=half-image, material=plastic, class=positive→shape=curvy} | 1    | 1.33 | 0.05| 2.00 |
Table 4 shows the combination of Jenang packaging design elements in each rule. In association rules, rules are interpreted only by rules that have a lift value > 1. Lift value > 1 of each rule means that the rules are active and valid. Lift is the ratio of rule’s consequence of probability, where it can be a positive or negative correlation between antecedent and consequence rules [14]. Also, in determining the Top-10 rules the association of values used as a material consideration is the value of conviction. The value of conviction is a value that measures the level of implications of a rule. Based on the result in Table 4, 10 rules were obtained with a support value of 0.2 and a confidence value of 1.0. Table 5 shows the interpretation of the top-10 ranking associations. Based on these rules can be obtained associations between shapes, brand, image, material, size, and class of customers perception.

Table 5. The result of association rules.

| Antecedent | Consequent |
|------------|------------|
| Shape      | Brand      | Image | Material | Size | Class | Shape | Material | Class |
| Traditional| Half-image | Plastic | Positive |      |       | Curvy  | Plastic  |       |
| Curvy      | Half-image | plastic | Positive |      |       | Curvy  | Plastic  |       |
| No-image   | Positive   | Plastic | Positive |      |       | Curvy  | Plastic  |       |
| Full       | Negative   | Paper  | Positive |      |       | Curvy  | Plastic  | Negative|
| Half-image | Positive   | Paper  | Plastic  |      |       | Curvy  | Plastic  |       |

The Jenang packaging design classification is performed by positive and negative class association rules. The class means the positive and negative customers emotion to the Jenang packaging design samples. The goal of the affective design is to improve the customers acceptance so its very important to make customers feel happy with the packaging design. The right combination of some packaging design elements can lead to positive emotions from customers [15]. So, the SMEs owner must choose the rules that have positive emotion. For example, if SMEs owners want to develop Jenang packaging design with curvy shape, the brand name should be traditional and packaging material is plastic. This rule have positive emotion class. From all the rules, there are top ten rules Jenang packaging design. These all rules can be used by SMEs owner to be the guideline for developing Jenang packaging design. The positive rules that have the highest lift value are rules 1, 4, 5 and 8. These rules are the main rules to consider for SMEs owners in designing Jenang packaging.

4. Conclusion
This research is focused on Jenang packaging design in Indonesia to demonstrate how Relief and Association Rules Mining can be used to formulate an affective packaging design based on customer needs. The result of extraction Jenang packaging design elements used Relief algorithm is six relevant design elements namely shape, brand, color of brand name, image, material, and size. These six elements were used to analysis the Jenang packaging samples. And the result of formulation Jenang packaging design is top ten rules. These rules can be used be used by SMEs owner to be the guideline to develop an affective Jenang packaging design. The SMEs owner must choose the rules that have positive emotion. For example, if SMEs owners want to develop Jenang packaging design with curvy shape, the brand name should be traditional and packaging material is plastic.

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