Construction of business intelligence in dadih product affective design

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Abstract. Business intelligence is a primary system for almost all conditions that involve business decision making and strategy formulation. Manufacturers usually want to collect more information about the product before being traded. They consider the opinions of consumers in making decisions on consumer purchases. Among the entire spectrum of consumer needs, functional and affective needs have been recognised as of primary importance. In this study, we focused on the affective design of the dadih product. Dadih is one of the typical fermented milk products from West Sumatera and potentially develops as the functional food. However, the obstacle of the dadih product today is not yet in the modern mass commercialisation way due to less attractive packaging that makes it difficult for marketing and market expansion. The main challenges are to understand consumers’ affective needs accurately and then design a dadih product by consumers’ needs. The objectives of this research are to identify the construction of business intelligence architecture, to identify consumers' affective needs for dadih products and to map the need for the affective design of dadih products based on consumer opinion. The architecture of business intelligence was compiled from data sources, data warehousing, analytical techniques, subject analysis, and decision making. The analysis techniques used to map consumer affective needs were Naive Bayes Classifier and Association Rules Mining. The results of the analysis shown the orientation of consumer opinion and the rules of affective design of dadih products.

1. Introduction

Business intelligence is a primary system for almost all conditions that involve business decision making and strategy formulation. Business intelligence does not directly solve various challenges but can identify a solution and move forward. This is done by providing relevant and easily integrated information. This is what other computer systems cannot do. The fact that business continues to change gives the role of business intelligence in adapting to all changes [1]. In the previous study business intelligence has been applied in twitter’s sentiment analysis on GSM service [2], real time business analytics for buying and selling transaction [3], the colour indicator for smart packaging and diary product quality [4], research on business intelligent with data mining application [5], and sentiment community detection on social networks [6].
At present, satisfying consumer needs is of particular concern to almost every company [7]. Among the entire spectrum of consumer needs, functional and affective needs have been recognised as the primary interests. Traditional product design has focused on the functional aspects of user needs, making products easy to understand, easy to handle, and so on. However, affective needs that emphasise the aspirations of customers' emotional responses generate more attention than functional needs. In this case, emotional performance is considered an extra quality was increasing the value of the physical product and empowering the company's competitive advantage [8].

Dadih is a regular Indonesia fermented milk which is produced and consumed by the West Sumatran Minangkabau ethnic group. Dadih is also indicated as one of the essential foods of Minangkabau culture. According to its characteristic, dadih resembles yoghurt and kefir [9]. Generally, dadih has distinctive characters: thick consistency, smooth texture, and pleasant flavor; it also has provided safety, portability, and novelty of milk nutrients for indigenous people in West Sumatera [10]. Marketing difficulties and the limited shelf life of dadih products in bamboo tubes is a constraint to market expansion. Therefore, modification through packaging is expected to increase the marketing of dadihs and maintain shelf life as well as other fermented milk [11]. In fact, the dadih development should increase the attractiveness of the product and also should support dadih dissemination for selling power improvement [9].

Manufacturers usually want to collect more information about the product before being traded. They consider the opinions of consumers in making decisions on consumer purchases. Collecting all reviews helps producers know the weaknesses and advantages of the product so that quality can be improved. Opinion mining can determine difficulties in interpreting the number of studies on product attributes or components from consumers. Opinion mining aims to determine whether the review sentences given by consumers are oriented positively, negatively or neutral [12].

Opinion is critical and one of the needs in making decisions. This applies to individuals and organisations. Mining opinion technology has a vast scope in practical applications. If individuals want to buy a product, mining opinion is useful to see a summary of available user opinions that the individual is helped in making decisions. This is better than reading many reviews that form an overview of the advantages and disadvantages of the product. For producers, mining opinions provide information on how consumers perceive the product. This information is not only useful in marketing and benchmarking products but also useful for product design and product development [13].

Based on the above, the primary challenge today is to understand consumers' affective needs accurately and then design a dadih packaging that suits the needs of consumers. Therefore, this paper aims to identify the construction of business intelligence architecture of affective product design of dadih products, identify consumers' affective needs for dadih products and to map the need for the affective design of dadih products based on consumer opinion.

2. Methods
2.1. Framework
In this paper, dadih products are chosen as the product domain to be developed. The development of dadih product was focused on the affective design of product packaging. The first stage that was carried out in the development of the affective design of the dadih product was to analyse and construct the business intelligence system architecture. Construction of the business intelligence system in this paper consists of data sources, data warehouses, data analysis, data subjects, and decision makers. Furthermore, data analysis was developed from the construction of the business intelligence system.

2.2. Construction of business intelligence architecture in the affective design of dadih products
The purpose of system construction is to facilitate decision making in the affective design of dadih products. The construction of the business intelligence system analysed in this paper consists of the data source section, the data warehouse section, the data analysis section, the data subject section, and the decision maker section.

2.3. Identify the need for affective design of dadih products
The data used in this study is data on the web that provides consumer reviews of the affective design of *dadih* product packaging. This research used samples of *dadih*, yogurt, and kefir. This was done due to the limitations of *dadih* product samples in the market. The samples were collected by observation via market survey and internet. Based on the consumer's opinion on the product, the relevant adjectives are determined and then classified into positive and negative opinions. The word adjective obtained was used to identify the features of the affective needs of the *dadih* product.

Data obtained from consumer review of *dadih* products is a collection of respondents/consumers defined as $O \rightarrow 1, 2, \ldots, k$. Then, the results of the identification of the product affective needs obtained the affective design features in the form of F1 colour, F2 label, F3, texture, F4 form, F5 ergonomic, F5 font. The data structure of consumer opinion can be seen in Table 1.

| No  | F1  | F2  | F3  | F4  | F5  | F6  |
|-----|-----|-----|-----|-----|-----|-----|
| $C_1$ | $X_{11}$ | $X_{12}$ | $X_{13}$ | $X_{14}$ | $X_{15}$ | $X_{16}$ |
| $C_2$ | $X_{21}$ | $X_{22}$ | $X_{23}$ | $X_{24}$ | $X_{25}$ | $X_{26}$ |
| \ldots | \ldots | \ldots | \ldots | \ldots | \ldots | \ldots |
| $C_k$ | $C_{ki1}$ | $C_{ki2}$ | $C_{ki3}$ | $C_{ki4}$ | $C_{ki5}$ | $C_{ki6}$ |

2.4. Mapping consumer affective needs

Adjectives derived from consumer opinion on *dadih* products are classified according to positive or negative orientation. The classification method used is the Naive Bayes Classifier (NBC). In the first stage, for each review document to be classified, positive and negative orientations are calculated [14]. Independent assumptions lead to the simplification of a combined probability mass function that can be written as [15]:

$$P(x | c_i) = \prod_{j=i}^{d} P(x_i | c_i) = \prod_{j=i}^{d} f(x_j = e_{rij} | c_i)$$  

Where $(x_j = e_{rij} | c_i)$ is probability mass function for $X_j$ which can be estimated from $D_i$ as follows:

$$f(v_j | c_i) = \frac{n_i(v_j)}{n_i}$$  

$n_i(v_j)$ is the observed frequency of the value $v_j = e_{rij}$ according to the categorical value $a_{rij}$ to $r_j$ for $X_j$ attribute $c_i$ class. As in the case of Bayes, if the number is equal to zero, it can use the pseudo-count method to get the prior probability. Estimates adjusted to the pseudo-count are shown as:

$$f(v_j | c_i) = \frac{n_i(v_j) + 1}{n_i + m_i}$$  

$$m_i = |\text{dom}(X_i)|$$  

Here's the Naive Bayes Classifier algorithm [15]:

Naive Bayes $(D = \{(x_i, y_j)\})$

For $i = 1, \ldots, k$ do

$D \rightarrow \{x \mid y_i = c, j = 1, \ldots, n\}$ //class specific subsets

$n_i \rightarrow |D|// cardinality$

$P(c_i) \rightarrow \frac{n_i}{n} // prior probability$

$\bar{\mu}_i \rightarrow \frac{1}{n_i} \sum_{x_j \in D_i} x_j //mean$
$$Z_i = D_i - 1.\bar{\mu}_i^T$$ // centered data for class $c_i$

for $j = 1, ..., d$ do // class specific variance for $X_j$
$$\hat{\sigma}_{ij}^2 \rightarrow \frac{1}{n_i} Z_{ij}^T Z_{ij}$$ // variance
$$\hat{\sigma}_i = (\hat{\sigma}_{i1}^2, ..., \hat{\sigma}_{id}^2)^T$$ // class-specific attribute variance
Return $\hat{\mu}_i, \hat{\sigma}_i, \bar{\mu}_i, \bar{\sigma}_i$ for all $i = 1, ..., k$

Testing $(x, \hat{\mu}_i, \hat{\sigma}_i)$ for all $i \in [1, k]$

$$\hat{y} \rightarrow \arg\max_i \{\hat{\mu}_i \prod_{j=1}^d f(x_j = \mu_{ij}, \sigma_{ij}^2)\}$$

Return $\hat{y}$

The next step after obtaining orientation on each adjective from the consumer review of the dadih product, the rules for getting the affective design of the dadih product were determined based on the data obtained at the identification stage and the results obtained in the NBC method. The method used is Association Rule Mining (ARM).

The ARM is a data mining method to find new associations or correlations between a broad set of data items. The threshold required to calculate association rule mining is support and confidence. Support represents the frequency of occurrence of an element or the presence of a transition record. Confidence represents the degree to describe how strongly an item from subset $X$ implies another $Y$ subset item. The ARM can be formulated as follows for two affective design domains [16]:

$$d_1 & d_2 & ... & d_k \rightarrow e_1 & e_2 & ... & e_\kappa$$

Where,

$$d_1, d_2, d_\kappa \in D, 1 \leq i < j < k \leq n, d_{ane}, e_1, e_\kappa$$

Based on thresholds support and confident:

$$s = \frac{\text{count}(d_1 & d_2 & ... & d_k \rightarrow e_1 & e_2 & ... & e_\kappa)}{\text{count}(DB)}$$

$$c = \frac{s(d_1 & d_2 & ... & d_k \rightarrow e_1 & e_2 & ... & e_\kappa)}{s(d_1 & d_2 & ... & d_k)}$$

$$= \frac{\text{count}(d_1 & d_2 & ... & d_k \rightarrow e_1 & e_2 & ... & e_\kappa)}{\text{count}(d_1 & d_2 & ... & d_k)}$$

3. Results and Discussion

3.1. Analysis of business intelligence architectural construction on the affective design of dadih products

Business intelligence architecture is analysed in the form of data sources, data warehousing, technical analysis, subject analysis, and decision makers. The data needed in this study are consumer opinion data sourced from a web. The consumer opinion is extracted, transformed, and loaded to produce a data warehousing. Technical analysis used in data processing is supervision, reporting, visualisation, and data mining. In data mining analysis, NBC and ARM techniques are applied. Data subjects on the study were consumers of dadih products, and decision making was carried out by the management of product development. The construction of the architecture of the extraction of consumer opinion data from the data source with the orange application can be seen in Figure 1.
3.2. Affective needs of dadih products

Data obtained from consumer reviews of dadih products are a collection of respondents/consumers defined as \( C_0 \) where \( (o = 1,2,\ldots,50) \). Affective design features are colour (F1), label (F2), texture (F3), form (F4), ergonomic (F5), and font (F6). Based on the results of the identification, an adjective from each element of consumer opinion is obtained as can be seen in Table 2.

| No | F1    | F2      | F3     | F4    | F5    | F6  |
|----|-------|---------|--------|-------|-------|-----|
| 1  | Bad   | Uncomplete | Hard   | Traditional | No   | Small |
| 2  | Bad   | Uncomplete | Hard   | Complex  | No   | Small |
| 3  | Colorfull | Complete | Appear | Simple  | Yes  | Big  |
| 4  | Beautiful | Complete | Appear | Simple  | Yes  | Big  |
| 5  | Bright | Complete  | Hard   | Simple  | Yes  | Big  |
| ... | ...   | ...      | ...    | ...     | ...  | ...  |
| 50 | Colorfull | Uncomplete | Appear | Complex | No   | Big  |

3.3. Affective design of dadih product

Affective design of dadih products is obtained from the results of classifying consumer opinion based on positive and negative orientations using NBC then looking for the rules of affective design utilising the ARM to obtain an affective design that has a positive impression that can be used by decision-makers in designing dadih products. The data used is 50 consumer opinion data taken from web and extraction, transformation and loading have been carried out into data warehousing as seen in 2. Then using the orange application, the results are obtained as shown in Table 3. Based on Table 3, the weight of each word classified into positive and negative orientations. The attributes or features of the label can be seen as complete with positive values 92% and negative 31% while uncomplete has positive values 8% and negative 69%. Therefore, complete classified into positive opinions, and incomplete becomes negative opinions.
Table 3. Positive and negative weights for each adjective in the opinion.

| Attribute | Class | Positive | Negative |
|-----------|-------|----------|----------|
| Color     | Dark  | 4%       | 31%      |
|           | Bright| 17%      | 4%       |
|           | Dull  | 0%       | 35%      |
|           | Beautiful | 33%    | 0%       |
|           | Colorful | 17%     | 8%       |
|           | Elegant | 13%      | 0%       |
|           | Good   | 17%      | 4%       |
|           | Bad    | 0%       | 19%      |
| Total     |       | 100%     | 100%     |
| Label     | Complete | 92%     | 31%      |
|           | Uncomplete | 8%     | 69%      |
| Total     |       | 100%     | 100%     |
| Texture   | Hard  | 13%      | 38%      |
|           | Rough | 17%      | 19%      |
|           | Soft  | 42%      | 8%       |
|           | Appear| 29%      | 35%      |
| Total     |       | 100%     | 100%     |
| Form      | Simple| 63%      | 31%      |
|           | Traditional | 17%  | 35%      |
|           | Complex| 21%     | 35%      |
| Total     |       | 100%     | 100%     |
| Ergonomic | Yes   | 79%      | 15%      |
|           | No    | 21%      | 85%      |
| Total     |       | 100%     | 100%     |
| Font      | Big   | 88%      | 46%      |
|           | Small | 13%      | 54%      |
| Total     |       | 100%     | 100%     |

After obtaining the data as in Table 3, also can be obtained an evaluation of the method used based on the accuracy of the results as seen in Table 4. Based on table 4 positive class accuracy is 96%.

Table 4. NBC evaluation value.

| Class     | True Negative | True Positive | Class Precision | Class Recall |
|-----------|---------------|---------------|-----------------|--------------|
| Negative  | 25            | 1             | 96.15%          | 9615%        |
| Positive  | 1             | 23            | 95.83%          | 95.83%       |

After classifying each of the adjectives of consumer opinion on the features of the *dadih* product packaging, the rules of affective design are determined by packaging the *dadih* products using the ARM. The association rules mining is adopted to obtain the mapping relationship between affective words item set and affective design features. The data used is based on the data set in Table 2, so that the results of the design rules are obtained. The results obtained are the ten best rules based on the highest support value and confidence as can be seen in Table 5. The confidence value is a measure of the rule’s strength while the support value corresponds to statistical value. A rule ‘A⇒B’ is called a
strong rule to differentiate it, if it has support and confidence greater than the user-specified minimum support threshold (called minsup) and minimum confidence threshold (called minconf) [17]. The following rules presented in Table 5 were found for a minsup of 35% and minconf of 92%. The rules have been expressed in form IF ⇒ THEN.

| Antecedent | Consequent |
|------------|------------|
| Complete   | Font       | Class    |
| Complete   | Yes        | Big      | Positive |
| Complete   | Yes        | Big      | Positive |
| Complete   | Yes        | Positive | Complete  |
| Complete   | Big        | Positive | Big       |
| Complete   | Yes        | Positive | Big       |

Based on the rules that have been obtained, it can be known as the orientation of each ARM rule based on the results of the NBC values that have been received previously. Furthermore, it can be seen that the affective design of dadih products that if a complete label, an ergonomic, a big font, then positive opinion. Whereas, the affective design rule that if an uncomplete label, then get negative opinion. Based on this, the positive opinion of ARM results can be used as an affective design of dadih products.

3.4. Advantages and disadvantages
The advantage of this paper is that it can determine the affective design that is needed by consumers towards dadih products so that it helps management of product development in making decisions. While the drawback is that the data used is dummy data that will be used directly from the internet to obtain more accurate consumer opinions on dadih products.

4. Conclusion
Consumer affective needs for the development of dadih products are classified by colour, label, texture, form, ergonomics, and font. Based on these affective needs, there are top-10 rules of analysis using ARM, the affective design of dadih products is obtained based on positive opinion, a complete label, an ergonomic, and a big font.

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