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Developing Food Sensory Test System with Preference Test (Hedonic and Hedonic Quality)

Wheat Bread Case Study

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***Abstract*—** Bread is a food source of carbohydrates that are often consumed by the community. Various types of bread were produced to meet consumer's curiosity, one of which is wheat bread. Manufacturers must be able to produce quality wheat bread and liked by consumers. Increasing the quality of bread will certainly have an impact on sales to be generated. One of the efforts in improving the quality of wheat bread is by doing the Hedonic test and Hedonic Quality test. This study aims to develop a system capable of providing an assessment of wheat bread. This study develops machine learning system with supervised learning algorithm, then using the results of the initial Organoleptic test as Knowledge-Based (KB). This test involved detection, recognition, discrimination, scaling and ability to express likes or dislikes (hedonic quality), using expert judgment. Hedonic quality is used as a variable for assessing wheat bread products with 4 variables, which include flavor, taste, appearance, and texture. While the hedonic test using two classes: likes or dislikes. This KB used as Naive Bayes Classifier algorithm initial knowledge, The test results using 10 fold shown average accuracy 98.8%, while the final goal of the development of this system will create a system capable of providing an assessment of a wheat bread product.

Keywords—organoleptic, hedonic, machine learning, NBC

I. INTRODUCTION

Bread is a food source of carbohydrates that are often consumed by the community. Various types of bread were produced to meet consumer's curiosity, one of which is wheat bread. Manufacturers must be able to produce quality wheat bread and liked by consumers. Increasing the quality of bread will certainly have an impact on sales to be generated. One of the efforts in improving the quality of wheat bread is by doing the Hedonic test and Hedonic Quality test.

The organoleptic test becomes the science field after the assessment procedure is standardized, rationalized, connected with objective assessment, so that data analysis becomes more systematic. Organoleptic tests are widely used to assess the quality of the food industry and other agricultural products. Sometimes this judgment can give very careful assessment results. In some sense appraisal exceeds even the most sensitive tool accuracy [1].

This study aims to develop a system capable of providing an assessment of wheat bread. This study develops machine learning system with supervised learning algorithm, then using the results of the initial Organoleptic test as Knowledge-Based (KB)[2][3]. This test involved detection, recognition, discrimination, scaling and ability to express likes or dislikes (hedonic quality), using with expert judgment. Hedonic quality is used as a variable for assessing wheat bread products with 4 variables, which include flavor, taste, appearance, and texture. While the hedonic test using two classes: likes or dislikes. This KB used as Naive Bayes Classifier algorithm [4] initial knowledge, The final aims of the development of this system will create a system capable of providing an assessment of a wheat bread product.

II. RELATED WORK

The research [5] resulted the organoleptic test studies with the Data Mining approach when the Data Mining technique is combined with traditional introduction methods such as touch, odor, etc., proven to provide new wealth in exploring the wealth of treatment China. Similar research was found in [6] who developed a system capable of assessing the quality of bread with SVM algorithms. Research [7] shown IT approach using Fuzzy algorithm able to increase organoleptic assessment ability, and also improve agricultural production. There is also more specific research, namely the development of systems that detect moldy bread, as shown by the paper [8]. In its development, this field research also penetrated the world of IoT (Internet of Thing).

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The current organoleptic studies tend to use IoT, shown by research [9], this study explains what techniques may be used in IoT research in Food Quality, including the increasingly massive IoT application today. Concrete research in this field includes papers [10] that develop passive sensors for monitoring food quality, the ingredients of a food base, to provide a choice of suitable substitutes. There also research that aims to develop food inspectors by mimicking the concept of ontology-based context modeling, shown by papers [11]. Then the research done on research [12], the test is done if the artificial tongue has been able to recognize some basic flavor for food is limited, but further testing still needs to be done.

The conclusion that can be drawn from the research mentioned above, that the IT approach is good in the use of Data Mining applications, until the application of IoT verification proved able to give added value. The added value is either a speed or a wider identification capability. But the current technological development is not yet fully capable of representing the ability of the human tongue, on the one hand, the favor of a person/group of people to a product not only with one set of the same variables, sometimes some who like soft bread, but sometimes some like crunchy, etc. Considering that this study aims to develop a system that combines human assessment with IT, so it is expected to produce a system that can provide an image relevant to the circumstances of local communities.

III. DISCUSSION

The Sensory or organoleptic test is a science that uses the human senses to measure the texture, appearance, aroma, and flavor of food products. Consumer acceptance of a product begins with its assessment of appearance, flavor, and texture. Because ultimately the goal is consumer acceptance, the organoleptic test using panelists (the trained taster) is considered the most sensitive and therefore is often used in assessing the quality of different types of food to measure its storability or in other words to determine food expiration dates. Approach with organoleptic valuation is considered to be the most cost-effective practical [1].

Sensory testing (panel test) plays an important role in product development by minimizing risk in decision making. Panelists can identify the sensory properties that will help to describe the product. Sensory evaluation can be used to assess any desired or undesired changes in product or formulation materials, identify areas for development, determine whether optimization has been obtained, evaluate competitors' products, observe changes occurring during processing or storage, and provide necessary data for product promotion. Acceptance and consumer preferences, as well as correlations between sensory and chemical or physical measurements, can also be obtained by sensory evaluation [13].

In principle, there are 3 types of organoleptic test, namely discriminative test, descriptive test and affective test. This study used a differentiation test to check whether there are differences among the examples presented. The description test is used to determine the nature and intensity of the difference. Both of the above test groups require a trained or experienced panelist. While affective test is based on the measurement of likes (or acceptance) or measurement of relative pleasure level. Affective Tests that test preference and / or acceptance of a product and require a large number of untrained panelists that are often considered to represent a particular consumer group.

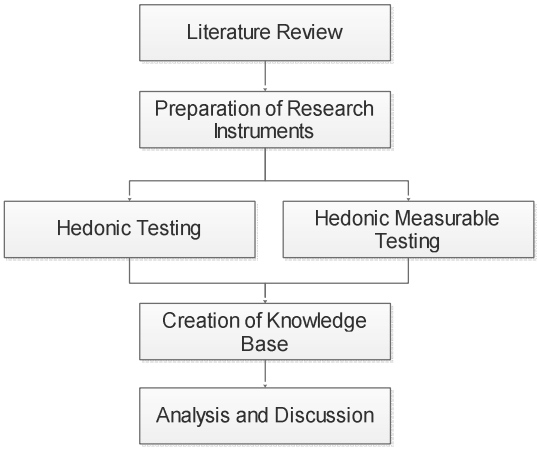

Fig. 1. Research Method

The description test is used to identify the important sensory characteristics of a product and provide information about the degree or intensity of the characteristics. The descriptive test consists of Scoring or Scaling Test, Flavor Profile & Texture Profile Test and Qualitative Descriptive Analysis (QDA). Scoring and scaling tests are performed using a scale or score approach that is linked to specific descriptions of product quality attributes. In the scoring system, the numbers are used to assess the intensity of the product with the arrangement increased or decreased. The results of the test were used as variables in the determination of food sensory test.

The research methodology is shown in Figure 1, the first stage of research is the literature review that used to determining the state of the state-of-the-art of research topic and composing research instruments. The next step is collecting the data, then divided into two classes based on the type of class, then the data is stored for later comparison. The result of data trainer test process is a knowledge base. Data analysis in this research using expert judgment.

The results of the QDA Test are then used as a class. The incorporation of hedonic and hedonic quality will also result in a knowledge base for the food sensory test system. The use of the next hedonic quality test will be used as input on the system, this input is useful for testing new bakery products. Further benefits through this system can be predicted whether a bakery product is likely to be liked or disliked by the community.

This research using NBC as Machine Learning (ML) algorithm. NBC is an algorithm that adopts Bayesian theorem, this algorithm began to be developed in the 1950s. Bayes is a simple probabilistic-based prediction technique based on the application of Bayes Theorems with strong (naive)

independence assumptions. In other words, in Naïve Bayes, the model used is an independent feature model, so a feature on a data is not related to the presence or absence of other features in the same data. Bayes's theory uses a fundamental statistical approach to pattern recognition. This approach is based on quantifying trade-offs between various classification decisions using the probabilities and costs incurred in those decisions [4][14][15][16]. This research uses NBC algorithm because of this algorithm fast processing capability and has a high accuracy [14][16]. The equation of NBC is shown in Equation 1.

$$Posterior = (prior\ x\ likehood)/evidance$$

$$p(A|B) = \frac{p(B|A) \times p(A)}{p(B)} \quad (1)$$

The next step is to classify data by using the Naïve Bayes Classifier (NBC) shown by Equation 1. NBC implementation conducted by the research begins with the transformation of the questionnaire's data, by using 1-6 criteria, following the questionnaire assessment. The population used in this research was the random 25 people taken as sample and also 10 Bread Merck. The next step is to validity and reliability test, the validity shown by equation 2, reliability shown by equation 3 using SPSS. The questioner is shown by Table 1 and data shown in Table 2.

TABLE I. QUESTIONER

Type	113	452	672	846	567	431	875	986	254	481
Flavor										
Taste										
Appearance										
Texture										
Like/Dislike										

TABLE II. DATA

#	Type	Flavor	Taste	Appearance	Texture	Class
1	113	2	3	4	5	Suka
2	113	3	2	3	4	Agak Suka
3	113	2	3	2	3	Sangat Suka
4	113	1	2	3	4	Agak Suka
…	…	…	…	…	…	…
114	567	3	2	2	4	Agak Suka
115	567	5	5	3	2	Suka
116	567	5	1	3	3	Agak Suka
…	…	…	…	…	…	…
206	254	3	3	4	3	Agak Suka
207	254	6	3	2	2	Tidak Suka
208	254	5	2	3	2	Suka
209	254	4	4	4	2	Agak Suka
…	…	…	…	…	…	…
247	481	3	3	3	2	Agak Suka
248	481	4	3	2	1	Agak Suka
249	481	2	3	3	2	Agak Suka
250	481	4	4	5	4	Suka

TABLE III. TEST RESULT USING 10 FOLD

Name	Result
Time taken to build model	0.03 seconds
Correctly Classified Instances	(247) 98.8%
Incorrectly Classified Instances	(3) 1.2%
Kappa statistic	0.9837
Mean absolute error	0.0048
Root mean squared error	0.0596
Relative absolute error	1.9388 %
Root relative squared error	16.9977 %
Total Number of Instances	250

Table 2 shown same time with pilot project test, only need 0.003 sec. But, have more Correctly Classified Instances 98.8% (247 data) using 10 Fold Technique form 250 data, Cross-validation is a technique to evaluate predictive models by partitioning the original sample into a training set to train the model, and a test set to evaluate it. For classification problems, one typically uses stratified k-fold cross-validation, in which the folds are selected so that each fold contains roughly the same proportions of class labels. In repeated cross-validation, the cross-validation procedure is repeated 10 times, yielding 10 random partitions of the original sample. The 10 results are again averaged (or otherwise combined) to produce a single estimation. Data visualization is shown in Figure 2.

Fig. 2. Data Visualization Test Result

$$r_{xy} = \frac{n\sum XY - (X)\left(\sum Y\right)}{\sqrt{\left\{n\sum X^2 - \left(\sum X\right)^2\right\}\left\{n\sum Y^2 - \left(\sum Y\right)^2\right\}}} \quad (2)$$

$$r_i = \frac{k}{(k-1)}\left\{1 - \frac{\sum \sigma_i^{\,2}}{\sigma_t^{\,2}}\right\} \quad \left| \quad \sigma_t^{\,2} = \frac{\sum total^2 - \frac{\left(\sum total\right)^2}{n}}{n} \right. \quad (3)$$

IV. IMPLEMENTATION

The interaction in the implementation of this system is shown in Figure 3. Figure 3, shows two entities that access the system, the first entity is the system user and the second is the administrator, in this system the administrator is only a moderator, so that it does not affect or change system judgment. The developed system is based on all the artificial intelligence, so it is expected to provide an objective assessment of a new product being assessed.

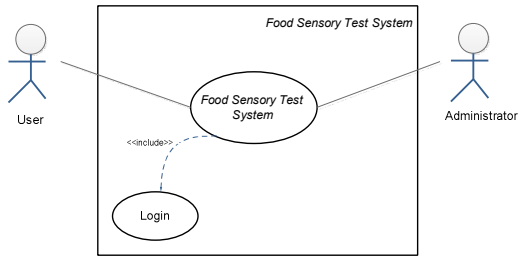

Fig. 3. Use Case Food Sensory System

This system is divided into two parts. The first process is a questionnaire interface that will process the data in such a way that it can be processed or used as data in the NBC algorithm. The next process is the classification of the input results of the user, the output is a hedonic quality assessment, with a range of 6, which consists of very-very like, very like, likes, likes, dislikes, and very dislike.

The process performed by the system is illustrated more clearly in Figure 4. Figure 4, shows the activity diagram of the system, which in this diagram illustrates that the user must complete the Hedonic questionnaire questioning first, if it is completed then it can continue by filling the Hedonic Quality questionnaire. The results of the two questionnaires are then translated by the system, and given output in the form of predicting market acceptance of a new bread product.

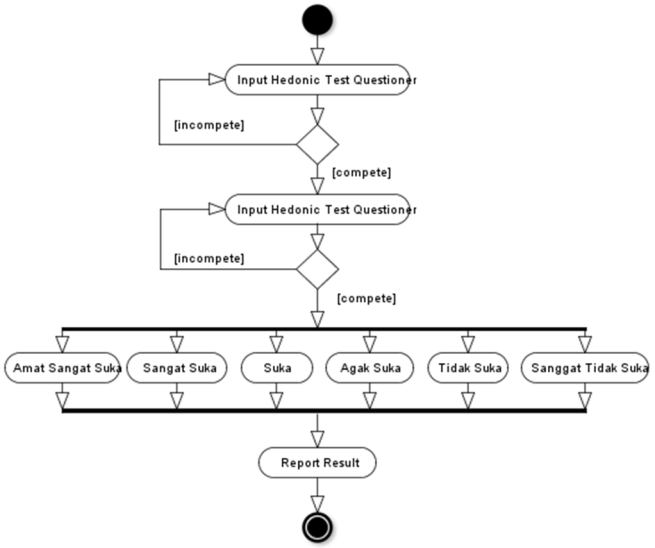

Fig. 4. Activity Diagrams Food Sensory System

With the process undertaken by the system is expected to be able to provide predictions or estimates of market acceptance of a bread product. So that the bread company is able to produce products that can be accepted by the market.

V. CONCLUSION

Bread is a food source of carbohydrates that are often consumed by the community. Increasing the quality of bread will certainly have an impact on sales to be generated. One of the efforts in improving the quality of wheat bread is by doing the Hedonic test and Hedonic Quality test.

The Sensory or organoleptic test is a science that uses the human senses to measure the texture, appearance, aroma, and flavor of food products. Consumer acceptance of a product begins with its assessment of appearance, flavor, and texture. Because ultimately the goal is consumer acceptance, the organoleptic test using panelists (the trained taster) is considered the most sensitive and therefore is often used in assessing the quality of different types of food to measure its storability or in other words to determine food expiration dates. Approach with organoleptic valuation is considered to be the most cost-effective practical [1]. Sensory testing (panel test) plays an important role in product development by minimizing risk in decision making.

Test results using 10-fold technique showed 98.8% accuracy. These results form the basis that the use of the NBC algorithm can provide accuracy with a low error value. In addition the average time required to complete 250 data based on research trials, showing the figure of 0.003 seconds. So with high accuracy value and low time of execution, then the implementation of this system is expected to be able to give an accurate modeling of market bread product acceptance, or in other words, can minimize the risk.

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