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BahanbaKu: intuitive mobile application for buying recipe ingredients

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ABSTRACT

Many solutions were proposed to help people get their food or recipe ingredients easily without having to go to the market in person. Especially for people who have limited time and energy to go out and buy groceries. However, the existing solutions still lack the intuitiveness for users to get the ingredient information of a food recipe and still can't facilitate the customers to have an all-in-one solution to get the needed ingredients. This study aims to combine the machine learning modalities and image recognition approach to provide a mobile app that can help people find food recipes intuitively and provide a digital ecosystem that can accommodate collaboration between various business actors including the micro, small, and medium enterprises (MSMEs). Instead of users buying items separately, the unique value of the proposed app (BahanbaKu) is that each of the ingredients needed by the user will be delivered in a single package. The preliminary evaluation result reveals that the accuracy of the proposed app is promising to assist people while getting recipe information for a particular food. The proposed app is also considered intuitive to the users with 81.7 SUS score.

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1. INTRODUCTION

In Indonesia, buying ingredients and other raw materials for cooking and food are the largest portions of the monthly per capita expenditures [1]. The interesting fact is in the emergence of the internet era, Indonesian people still appear to prefer purchasing ingredients by going to the market or store in person. In 2022, shows that 85% of the respondents prefer shopping for ingredients straight from the store and only 33% from e-commerce [2]. We also conducted a validation survey to students and housewives in the Malang region area about food ingredients purchasing. The result of the survey shows that only 5.9% of the respondents purchase food ingredients from online platforms. This insight is also supported by the digital readiness index in the convenience section is only 3.06 on a scale of 1-5 [3]. This customer habit supports the food commodities MSME business in most of Indonesia's regions.

The COVID-19 pandemic brings a significant impact on the decreasing amount of micro, small, and medium enterprises (MSME) sales. The gradually rising prices of food ingredients and commodities including beef, cooking oil, wheat flour, and red chili (an average annual increase from 2018 to 2021 is 13.29%) have also had an impact on the running of MSME business operations in the culinary sector [4]. This price increase also makes it difficult for buyers to collectively find the cheapest ingredients. Many

MSMEs have lost customers due to a decrease in people's purchasing power who prefer to cook at home. As many as 69% of people choose to cook at home after the pandemic [5].

Many solutions were proposed to help the MSMEs owners and customers get their food ingredients easily without having to go to the market in person and carry cash which can be too complicated and risky [6]-[8]. Some of the solutions also implemented artificial intelligence (AI) and machine learning (ML) techniques to provide automation features [9]-[11]. However, the current solutions for online grocery shopping lack intuitiveness for users to easily access ingredient information for particular food recipes, and customers can only search for recipes of food they already know the name of [12]. Additionally, product price, shipping costs, and the quality of raw food ingredients are concerns for customers as they cannot inspect the products in person before they are delivered [13]. Studies have shown that product quality is a major concern for customers when using online grocery stores supported by the perceived social norms, compatibility, and relative advantage also play a role in consumer adoption of online grocery shopping for MSMEs [14].

Based on the existing problems, the authors propose a mobile app that can help people find food recipes easily and intuitively and provide a digital ecosystem that can accommodate collaboration between business actors to optimize the productivity of culinary raw materials MSMEs. With a good digital ecosystem, MSMEs are suppliers of raw materials and will be exposed to potential buyers who are looking for cooking ingredients at the cheapest prices. With this application, transactions between suppliers and customers will become efficient because the selection of materials can be done collectively according to needs and customers can choose suppliers with competitive prices so that mutual relationships occur profitable for sellers and buyers. In this research an Android-based application will be developed called BahanbaKu [15], this application aims to make it easier for users by implementing computer vision and ML technology and an ecosystem of MSME partners who provide food ingredients to be able to sell their commodities through the mobile application. With this application, buyers can get raw materials from various MSME food suppliers at the lowest prices. This application can also provide the location of the nearest food seller so that food ingredient MSMEs can also be exposed to increase customer segmentation.

2. METHOD

The methodology used in this research involved conducting a preliminary study to gather requirements for the system. This was followed by conceptualizing the system and designing the algorithm to meet the identified requirements. To evaluate the impact of the system, a simple accuracy test was conducted to determine its effect on the ease and confidence level of detecting food images and purchasing ingredients online. The detailed task and development activities will be presented and discussed in the subsequent section.

2.1. Preliminary study and requirement elicitation

We conducted a field study by exploring individual responses about their awareness and knowledge of their experience in the recipe and cooking process. The requirements analysis for this research is done by doing surveys and interviews on the targeted market which is students and housewives that cook quite frequently so that the needs for getting ingredients can be gathered. The surveys will contain questions as shown in Table 1.

The result of the surveys and interviews are used to identify user and system requirements so that the developed system can be a solution to the problem that exist [16]-[18]. The survey was conducted using Google Forms and successfully gathered 34 respondents. One of the most important insights of the survey is to know the preferences of the place to buy ingredients. Based on the results of the survey, it is found that online purchasing preferences are only 2.8% of the total percentage. This indicates the distrust of people in buying groceries online is still very low. Figure 1 presents the detailed results of the user preferences.

The price of buying ingredients online with the shipping cost is often more expensive. There are also more ingredients sold in sachets or packages which are generally more expensive than fresh ingredients because the quality of fresh ingredients is relatively quick to decrease. In addition, the quality of the ingredients can only be inspected directly at the store, so buying online requires stronger convincing. Therefore, this research will develop an application for purchasing cooking ingredients that has a system to guarantee the quality of ingredients and provide lower prices similar to buying in a store.

2.2. The system concept and architecture

The unique value of the proposed app (BahanbaKu) is that each recipe ingredient that is needed by the user will be provided in a single package. In order to ensure the availability of the ingredients stock, BahanbaKu has partnerships with local farmers, ingredients producers, or distributors in local MSME. This all-in-one approach stands out from the existing online groceries marketplace in terms of efficiency. While in the marketplace, customers frequently take time to choose and buy every recipe ingredient in a specific store manually [19], BahanbaKu provides all the ingredients that customers need from a particular food recipe.

The main function of the proposed system is to help people get information about the ingredients and other information about a particular food recipe. The system provides an intuitive feature to capture or upload an image of a food then the proposed system will do some cloud-based recognition methods and get a recipe and detailed ingredients from the scanned food. The system architecture and data flow of this application are shown in Figure 2.

Table 1. The question used in the elicitation process

No	Question	Type	Purpose
A. Recipe and ingredients questions			
1	How many times do you cook in a week?	Close-ended	Find out how frequently students and housewives cook in an interval time
2	What is your motivation to cook?	Open-ended	Find out the reason why students and housewives choose to cook meals by themself
3	How many types of food do you cook in a week?	Close-ended	Find out how many kinds of food are cooked by students and housewives choose
4	What kind of food do you cook often?	Close-ended	Find out what food that students and housewives often cook
5	Where do you find the recipe when you want to cook a food you've never cooked before?	Close-ended	Find out sources that students and housewives usually check for food recipe
6	Where do you usually buy ingredients?	Close-ended	Find out a place that students and housewives usually visit to buy their food ingredients
7	Why do you choose to buy from the place you usually go to?	Open-ended	Find out the reason why students and housewives choose a specific place to buy their food ingredients
8	What would you do if the ingredients you're looking for are not found at the place?	Open-ended	Find out what they usually do when the specific place doesn't have the ingredients that they're looking for
9	What are your considerations when choosing the right ingredients to buy?	Open-ended	Find out the important things to consider in buying food ingredients
B. Online ingredients shopping questions			
10	How fluent are you in operating mobile applications? (1-10)	Close-ended	Find out the capability of students and housewives to operate mobile applications
11	What is your opinion on buying food ingredients online?	Open-ended	Find out the positives and negatives of buying food ingredients online according to students and housewives
12	What drives you to buy food ingredients online?	Open-ended	Find out the possible reasons for students and housewives choose to buy food ingredients online

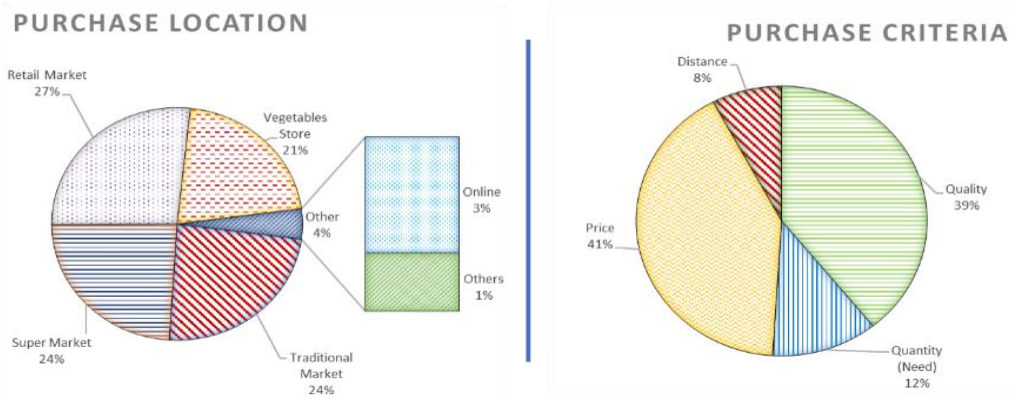

Figure 1. The correspondence data

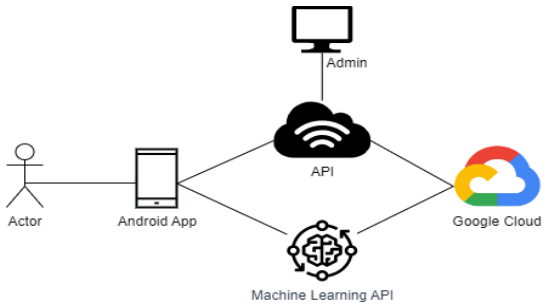

Figure 2. The proposed system architecture

There will be two application programming interfaces (APIs) that the app communicates with, which are the regular API for data-related operations and the ML API to obtain the data for ML-related features in the application. The API components will handle communication between the application and the databases and other APIs provided in the Google Cloud architecture. With API, the data requested and sent will be centralized in a web service so that there will be no redundant development for the back end of the system. The ML API will handle the communication between the application and the AI computations that will be done in Google Cloud.

2.3. Food classification method

The food recognition system consists of three layers: the hardware layer, the food recognition layer, and the application layer. In the hardware layer, the BahanbaKu app utilizes the phone camera to capture food images from the user. These images are then sent to the food recognition layer. In the food recognition layer, the image will be resized, then undergo the convolutional process using the transfer learning method with the EfficientNet-B7 model architecture. The model was initially trained on 20,000 images of 20 well-known food categories from Kaggle and Data Vision datasets. The pre-trained EfficientNet-B7 model's weights, which were trained on the ImageNet dataset, are loaded to leverage its high accuracy with fewer parameters [20]-[22]. When a new food image is received from the hardware layer, it is passed through the trained model. The model applies its learned parameters to the input image and calculates probability scores for each food category based on the image's features. The probability scores represent the likelihood of the input image belonging to each food category. Once the food probability scores are calculated, the model will return the top 5 food predictions to the application layer. Then in the application layer, we created an API so that the BahanbaKu app can use the classification model. The classification flow of this application is shown in Figure 3.

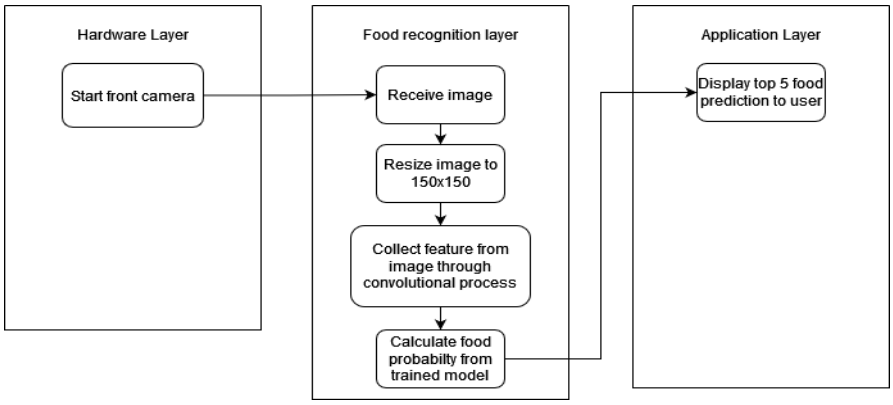

Figure 3. The process flow of the classification model

2.4. Prototype implementation

As described in IEEE standards [23], [24], validation is needed to check whether all software functionalities have satisfied the requirements. There are several features have been implemented in the proposed system. The home page will contain recommended recipes that can make it easier for users to buy ingredients directly from recipes. This page also has categories so that users can find food or inspiration according to their needs and desires. After the user has chosen one of the recipes, the app shows the detailed recipe page including the name of the food, the description of the food, the rating, and the estimated time to cook. The user can scroll down this page to see the list of detailed ingredients that are needed in the chosen menu. Figure 4 shows the screen capture of the home page and user preference menu in the detailed recipe page.

The recipe detail page provides the ingredients needed for cooking as well as the cooking steps. With this feature, users do not need to check one by one whether the ingredients purchased are complete because the application has already made a list of ingredients for purchase. The checkout page is the page where users pay for the selected ingredients. Users will be able to get the payment information, the payment methods, and the shipping destination. Users can also add the additional desired ingredients to the cart. Several payment methods are indeed provided in the proposed app to meet the user's preferences. The main feature is to snap real object food images and convert them into detailed recipes. The user interface of this feature and the feature comparison of the proposed app with existing mobile recipe apps that are available on Play Store are shown in Figure 5 and Table 2.

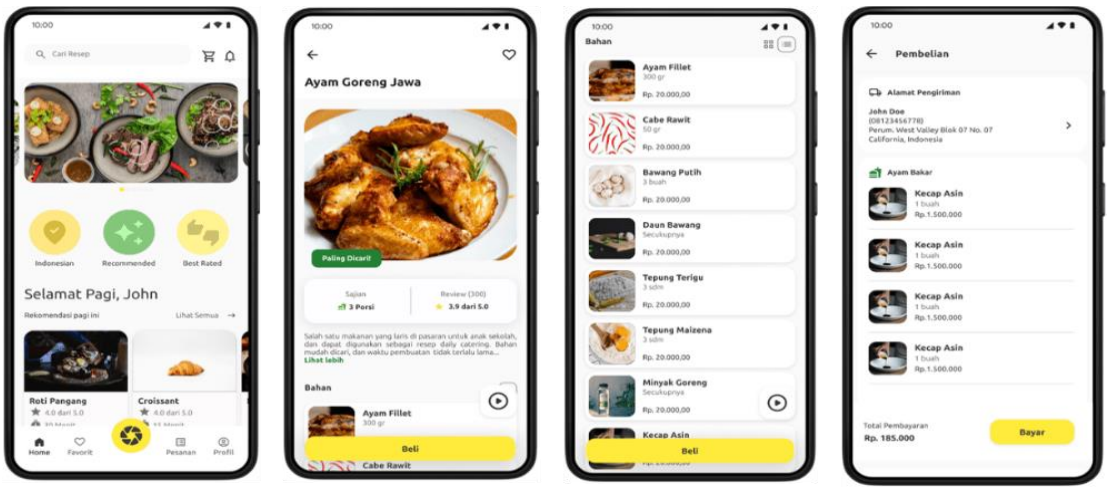

Figure 4. The screenshot of the BahanbaKu

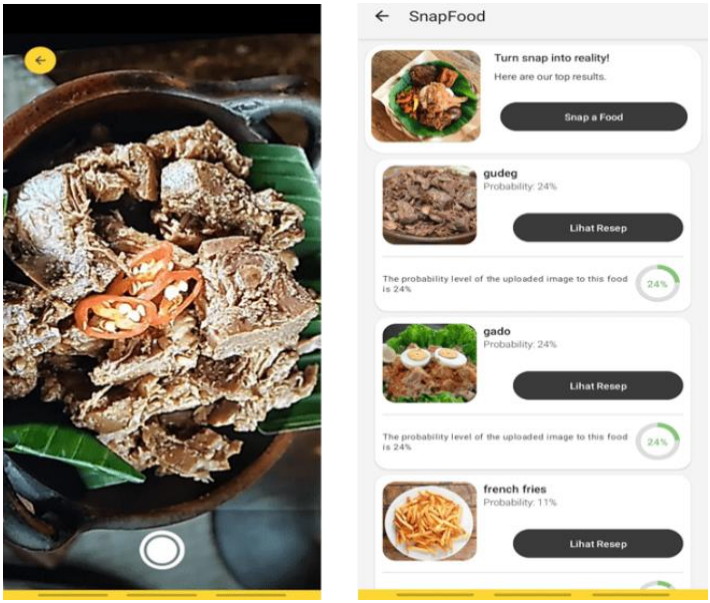

Figure 5. The screenshot of the image recognition feature

The implementation results showed that the app was effective in providing users with an intuitive interface and guiding them through the cooking process step by step. However, we also encountered several issues during the implementation phase, such as compatibility issues with certain Android devices and slow loading times. These issues were addressed through updates and improvements to the app, and we continue to refine and enhance the app based on user feedback and testing. The details of implementation results and possible issues encountered during the implementation phase will be presented in Table 2.

Table 2. The comparison feature of similar mobile app in Playstore

No	App name	Input-type	Recipe collection	Cooking instructions	Buy ingredients	Using ML recommendation
1	Cookpad [25]	Text only	V	V	X	X
2	SideChef [26]	Text only	V	V	X	X
3	Recipe Keeper [27]	Text and Image	V	V	X	V (scan hand writing)
4	BahanbaKu	Text and Image	V	V	V	V (scan food image)

An experiment came out to assess the feasibility of the proposed ML model and also the user acceptance while using the BahanbaKu app. The food classification feature in this app helps users to identify

the name of the food based on the user's camera feed and image. The ML model that is used to classify food images has been trained on 20 thousand images which divide into 18 thousand for the training set and 2 thousand for the validation set. The training is performed in about 15 epochs and the model achieved 88.5% accuracy on the training set and 73.4% accuracy on the validation set. For further experimental purposes, we perform testing for the model using 12 images that we take from Google Images. The result is good enough, Figure 6 depicts some sample predictions by the proposed model inside the BahanbaKu app. The model successfully predicts 11 images correctly out of 12. In the BahanbaKu app, to reduce misclassification produced by the model we return the top 5 predictions to users, so they are also able to choose which prediction actually matches the picture they provide.

This research also conducted a usability test for young people with the age ranging from 18 to 25 years old as well as housewives using the system usability scale (SUS). A total of 75 Participants tried all the BahanbaKu features app and then filled out the SUS questionnaire survey. SUS has 10 questions that cover efficiency, effectiveness, and satisfaction parameters. Each question has a scale of 1 to 5. Scale score 1 means strongly disagree and scale score 5 means strongly agree [28]-[31]. The SUS result shows that the usability score of the BahanbaKu app is 81.7 which was included in the excellent category.

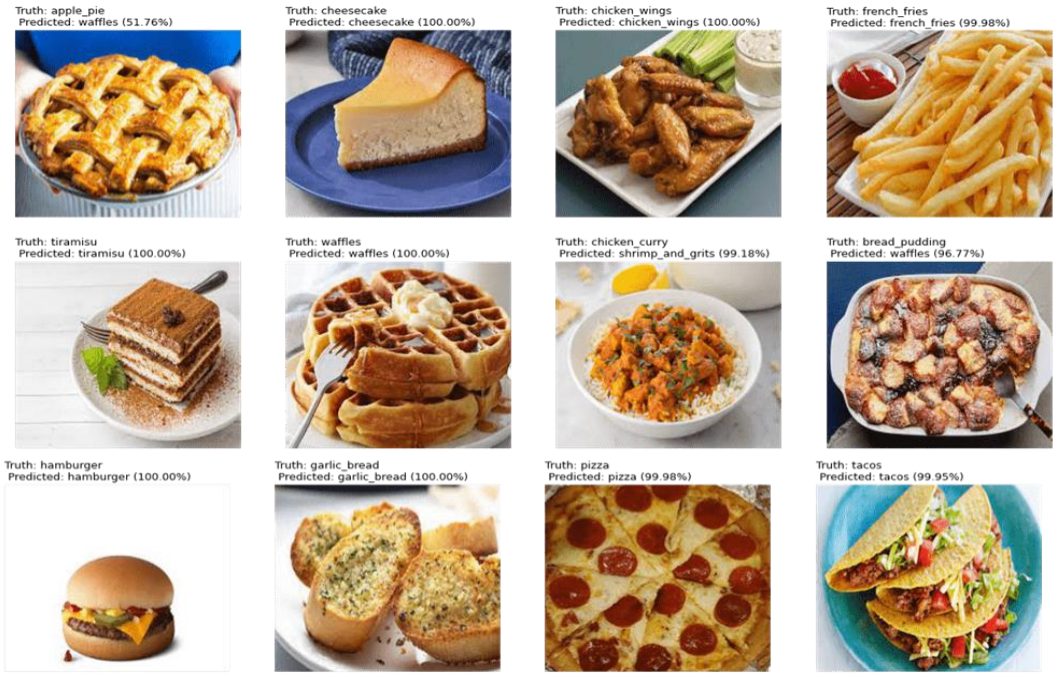

Figure 6. The accuracy testing of the ML model

3. CONCLUSION

This paper proposes an intuitive application called BahanbaKu which intuitively help customer to find and buy their preferred food recipe. A user can scan the real food or image of a particular food then get the information about the ingredients recipe and also can buy them directly from the app. In addition, the implementation of the BahanbaKu could bring impact local MSME businesses. The ML model that is used to classify food images has quite promising accuracy on the validation set. This system also has been tested in a real environment with 75 respondents. The usability results show that the proposed system is accepted by the user with an excellent usability level. The app's recipe database could be expanded by continuously adding new and diverse recipes from various cuisines, providing users with a more extensive selection of recipes to explore. Although this study is still in a preliminary phase, based on the evaluation result, we conclude that the proposed app is feasible for future implementation.

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