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Designing a Web-Based Content-Based Filtering Method for a Culinary Marketplace

Zulfikar Shiddiq, Suendri, Fathiya Hasyifah Sibarani
Universitas Islam Negeri Sumatera Utara, Medan, Indonesia

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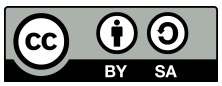
ABSTRACT

The development of information technology has made various aspects of life easier, including product marketing through marketplace applications. In Pasar Bengkel Village, a culinary center, vendors have seen a decline in customers due to the Medan–Tebing Tinggi toll road, which has reduced visitor traffic. The purpose of this study is to design a marketplace application with a recommendation system that can help vendors increase product visibility and attract customers back. The research method involves applying a Content-Based Filtering-based recommendation system with the Term Frequency–Inverse Document Frequency (TF-IDF) algorithm to process product description data and generate relevant recommendations for users. The result of this study is a marketplace application that provides personalized product recommendations based on the frequency of word occurrences in product descriptions using the TF-IDF technique. In conclusion, this application is expected to be an innovative solution in increasing the competitiveness of local culinary vendors by expanding their marketing reach and maintaining the sustainability of their businesses.



Corresponding Author:

Zulfikar Shiddiq,
Universitas Islam Negeri Sumatera Utara, Medan, Indonesia,
Email: zulfikarshidiq96@gmail.com

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1. INTRODUCTION

Advances in information technology have made life easier for everyone, enabling people to do anything, anywhere, anytime. A marketplace is a virtual or electronic market where buyers and sellers interact and conduct transactions electronically (online) at any time and from any location, regardless of operating hours [1]. Technological development is also explained in Islam, namely in one of the implied meanings of Allah SWT's words in the Quran, Surah Ar-Rahman, verse 33, which states:

يا مَعشَرَ الجِنِّ وَالإِنسِ إِنِ استَطَعتُم أَن تَنفُذوا مِن أَقطارِ السَّماواتِ وَالأَرضِ فَانفُذوا ۚ لا تَنفُذونَ إِلّا بِسُلطانٍ ﴿٣٣﴾

Meaning:
"Assembly of jinn and mankind, if you can penetrate (cross) the corners of the heavens and the earth, then penetrate them. You will not be able to penetrate them except with power (from Allah)."

One aspect of technology use is the application of marketplaces as a new marketing channel with a wide market reach that is not limited to a specific area. In Islam, the rules of buying and selling are regulated in the Quran, including in the words of Allah SWT in Surah An-Nisa verse 29, which states:

يا أَيُّهَا الَّذينَ آمَنوا لا تَأكُلوا أَموالَكُم بَينَكُم بِالباطِلِ إِلّا أَن تَكونَ تِجارَةً عَن تَراضٍ مِنكُم ۚ وَلا تَقتُلوا أَنفُسَكُم ۚ إِنَّ اللَّهَ كانَ بِكُم رَحيمًا ﴿٢٩﴾

Meaning:
"You who have believed, do not consume one another's wealth unjustly, except in a manner that is mutually agreed upon among you. Do not kill yourselves. Indeed, Allah is Most Merciful to you."

Village Pasar Bengkel is one of the villages located in Perbaungan Sub-district, Serdang Bedagai District. In this village, there is a culinary sales center, one of the famous culinary items being Dodol. Currently, the culinary vendors in this village are experiencing a decline in the number of customers. This decline began after the operation of the Medan–Tebing Tinggi Toll Road, as vehicles that previously passed through the village have shifted their routes to use the toll road. One approach that can be applied to the recommendation system is the Content-Based Filtering approach. According to Putra et al. [2], the Content-Based Filtering approach uses data from various datasets to suggest items to users as references based on previously used information. The Content-Based Filtering method has the advantage of recommending items based on the similarity between the user's profile and the item's profile [3].

The difference between this study and previous studies lies in their focus: previous studies have generally concentrated on developing product recommendation systems using various approaches, such as Collaborative Filtering or hybrid methods, without considering the specific problems faced by local culinary vendors due to changes in traffic patterns and consumer mobility. Several studies have shown that Content-Based Filtering-based recommendation systems have advantages in providing personalized recommendations based on similarities between user profiles and item characteristics. However, the application of this method in the context of developing a marketplace specifically to support local culinary vendors, such as in Pasar Bengkel Village, which is affected by the operation of the Medan–Tebing Tinggi Toll Road, is still rare. The novelty of this research lies in the integration of the Content-Based Filtering method with the Term Frequency–Inverse Document Frequency (TF-IDF) algorithm in the development of a web-based culinary marketplace application specifically designed to increase the competitiveness of local vendors. This marketplace not only provides a digital marketing tool but also offers a recommendation system that makes it easier for consumers to find culinary products that match their preferences.

The objective of this research is to design and develop a web-based culinary marketplace application with a Content-Based Filtering recommendation system using the TF-IDF algorithm to help vendors increase product visibility and attract new customers. The contribution of this research is to provide a practical solution for local culinary vendors facing the challenge of customer decline, while also enriching the scientific literature on the application of recommendation systems in the traditional culinary sector based on digital marketplaces. Therefore, this research not only provides direct benefits to business owners in Pasar Bengkel Village but can also serve as a reference for developing recommendation-based digital marketing strategies in other regions.

Based on the above issues, the author is interested in developing a culinary marketplace application system using the Content-Based Filtering method to facilitate merchants at the culinary sales center in Pasar Bengkel Village. Consumers can save time searching

for complete and reliable information about the culinary products they wish to obtain, thereby achieving greater financial benefits. Therefore, the author chose the thesis title "Design and Development of a Culinary Sales Marketplace Using the Web-Based Content-Based Filtering Method." With the development of this culinary product sales marketplace, the author hopes to increase the number of culinary product buyers in Pasar Bengkel Village, thereby improving merchants' financial conditions and making it easier for buyers to find information about the culinary products they wish to purchase.

2. RESEARCH METHOD

Research and Development (R&D) is the research methodology used. R&D techniques are research approaches used to produce specific products and verify their efficacy [4]. The first objective of this approach is known as the development function, and the second objective is known as validation [5].

2.1. System Requirements

System requirements are the specifications needed to build and run the device that the author used for this thesis, from programming to design. The computer hardware serves as a server for the author. More specifically, the following computer hardware and accessories are used.

a. Hardware
The hardware used by the author to design and create the application is a laptop with the following specifications:

1) Processor: Intel Core i7-7500Li 3.5GHz
2) RAM: 4 GB
3) Hard Drive: 1 TB

b. Software
The software used by the author to design and create the application is a laptop with the following specifications:

1) Windows 10/64-bit operating system
2) Visual Studio Code
3) XAMPP Control Panel server
4) PHP
5) MySQL
6) Mozilla Firefox

2.2. System Development Methods

MySQL was used in database development. To meet system requirements, researchers used the PHP programming language with the CodeIgniter framework. In developing this regional development priority decision support system, the Waterfall method was used as a framework to ensure implementation. The waterfall method is a traditional software development method that proposes a systematic and sequential approach to building software [5]. Waterfall provides clear stages ranging from system requirements analysis (identifying development criteria and alternatives), design (designing calculation structures and interfaces), implementation (building the system with PHP/CodeIgniter and a MySQL database), testing (verifying calculation accuracy and functionality), and maintenance [4]. The system implemented by food vendors at Bengkel Market is the starting point of this flowchart. Based on the flowchart, vendors prepare ordered items when customers place orders, and these purchases are then recorded in a report book. System design aims to facilitate data flow within a program. This helps programmers create systems and makes them easy for users to understand [6].

The waterfall method is used in the system development process (see Figure 1). According to Ramadanis, the waterfall approach is a sequential system development technique in which the entire process consists of sequential stages that flow down like a waterfall. Assessing the requirements, features, and procedures of website software; noting limitations in website development; and evaluating technology, reliability, and shortcomings [7].

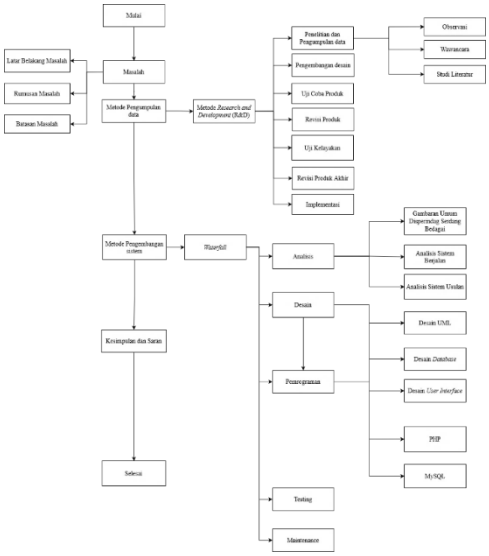

Figure 1. Research Flow

2.3. Content-Based Filtering

TF-IDF (Term Frequency – Inverse Document Frequency) weighting is one of the most popular methods in text mining and information retrieval used to measure the importance of a word (term) in a document relative to a collection of documents (corpus). This method operates on the principle that words that frequently appear in a document have a high level of relevance to that document; however, if the same word also appears frequently in nearly all documents, its importance value decreases. TF-IDF is composed of two main components: Term Frequency (TF) and Inverse Document Frequency (IDF). Term Frequency measures how often a word appears in a document by comparing its frequency of occurrence to the total number of words in the document, so that words that appear more frequently receive a higher TF weight. Meanwhile, Inverse Document Frequency measures the uniqueness of a word by looking at how rarely it appears in the entire document collection. The rarer a word is found in other documents, the higher its IDF value, as it is considered more specific and representative of a particular document. The final TF-IDF value is obtained by multiplying the TF and IDF values, resulting in a high weight for words that appear frequently in a particular document but are rarely found in other documents. For example, in a collection of documents discussing technology, the word "AI" may appear in almost all documents, resulting in a low TF-IDF weight. In contrast, the word "productivity," which only appears in one document, will have a higher weight [8]. The advantage of TF-IDF lies in the simplicity of its calculation and its ability to ignore common words (stopwords) that do not have significant informational value. However, this method also has limitations, such as not considering word order (bag-of-words assumption) and not being able to understand the semantic context. TF-IDF is widely applied in various fields, such as search engines to determine the relevance of documents to keywords, text classification as input features for machine learning models, keyword extraction to extract important keywords from text, and spam filtering to detect words commonly used in spam emails [9]. Measures how often a word appears in a document, generally using Equation (1) [8]. The more often a word appears in a document, the higher its TF value. Meanwhile, to measure how unique a word is in the entire document, using Equation (2).

$$TF\ (t,d) = \frac{Number\ of\ occurrences\ of\ term\ t\ in\ the\ document\ d}{total\ number\ of\ terms\ in\ document\ d} \tag{1}$$

$$IDF(t) = \log(\frac{N}{df_t}) \tag{2}$$

The combined TF-IDF formula is at the core of this weighting method, as it combines two important aspects: the frequency of a word's appearance in a document (Term Frequency) and the uniqueness of that word in the entire document collection (Inverse Document Frequency) using Equation (3) [8].

$$TF\text{-}IDF(t,d) = TF(t,d) \times IDF(t) \tag{3}$$

The principle behind this formula is to give high weight to words that have a high TF value in a document, but only if those words also have a high IDF value, which means that they rarely appear in other documents. Conversely, if a word appears in almost all documents, its IDF value will be close to zero, so even if its TF value is high, the product of TF and IDF will be low. Thus, this combination balances the popularity of a word within a single document and its rarity across the entire collection of documents. This makes TF-IDF effective for highlighting words that are truly relevant and specific to the context of a particular document. For example, in a collection of technology articles, the word "internet" may have a high TF value in many documents. Still, its IDF is low because the word appears in almost all articles, so its combined TF-IDF value is low. Conversely, the word "deepfake," which appears in only one or two articles, will have a high IDF [10]. If its TF value in those documents is sufficiently large, the combined TF-IDF value will be high, and the word will be considered more important.

3. RESULT AND ANALYSIS

This marketplace is designed to connect culinary sellers, such as food and beverage MSMEs, with potential buyers through a widely accessible web-based platform. Content-based filtering is used as the core of the recommendation system, where the algorithm analyzes the description, category, flavor, ingredients, and other attributes of food products that users have viewed or purchased, then matches them with other products that have similar content. The findings of this study indicate that the developed web-based culinary marketplace is capable of providing personalized product recommendations to users using the Content-Based Filtering method based on the TF-IDF algorithm. The recommendation system has proven effective in analyzing product attributes, such as description, flavor, ingredients, and category, thus providing recommendations relevant to user preferences. Test results show that this approach not only improves recommendation accuracy but also accelerates the product search process due to the preprocessing stages (tokenization, case folding, and stopword removal) that are optimized only for items with relevant keywords. Thus, this marketplace can increase the likelihood of transactions because consumers feel more assisted in finding products that suit their needs [8]. The use of Content-Based Filtering techniques to generate product recommendations based on user search intent is illustrated as follows. Only products with comparable content will be selected for recommendation using this method. Here are the steps to implement the Content-Based Filtering approach: tokenization, case folding, and stopword elimination are steps in this procedure. The results of this study align with the findings of Pramono et al. [7] who stated that Content-Based Filtering is capable of providing consistent and personalized recommendations based on item characteristics, and are reinforced by research by Suwarno [8] who showed that the use of TF-IDF can improve the accuracy of recommendation systems in the culinary domain. However, this study also found that Content-Based Filtering still has limitations, namely the tendency to provide recommendations that are too narrow because they only focus on content similarity. This differs from previous hybrid studies that attempted to combine Content-Based and Collaborative Filtering to broaden the scope of recommendations.

Nevertheless, in the context of culinary traders in Pasar Bengkel Village, this approach remains relevant because it aligns with the specific needs of consumers who prioritize product attribute suitability. To reduce search time, preprocessing is only performed on items containing keywords [11]. The table below shows the results of preprocessing. After tokenization, weighting is performed on products (words) that appear two or more times in all documents. Each document containing a term is given a value of 1 (see Table 1). WDT calculation using the formula $W = TF * (IDF + 1)$. The results are shown in Table 2.

Table 1. IDF value calculation

Term	DF	D/DF	IDF
dodol	8	1	0
rasa	4	2	0.301
kacang	4	2	0.301
ayam	2	4	0.6021
ceker	3	2.6667	0.426
durian	3	2.6667	0.426
keripik	3	2.6667	0.426
pandan	3	2.6667	0.426
roti	3	2.6667	0.426
ubi	2	4	0.6021
ambon	2	4	0.6021

Term	DF	D/DF	IDF
Aneka	2	4	0.6021
asli	2	4	0.6021
bika	2	4	0.6021
ikan	2	4	0.6021
indah	1	8	0.9031
kembang	2	4	0.6021
kerupuk	2	4	0.6021
kurnia	1	8	0.9031
loyang	2	4	0.6021
original	1	8	0.9031
pedas	2	4	0.6021
pulut	2	4	0.6021
rajawali	2	4	0.6021

Table 2. Weight Calculation W

Term	$W = TF * (IDF + 1)$							
	D1	D2	D3	D4	D5	D6	D7	D8
dodol	1	1	1	1	1	1	1	1
rasa	0	1.301	0	0	1.301	1.301	0	1.301
kacang	1.301	0	0	1.301	0	0	1.301	1.301
ayam	0	0	0	1.6021	0	1.6021	0	0
ceker	0	0	1.426	1.426	0	1.426	0	0
durian	0	1.426	0	0	1.426	0	0	1.426
keripik	0	0	1.426	1.426	1.426	0	0	0
pandan	0	0	1.426	0	0	1.426	0	1.426
roti	1.426	0	0	1.426	0	0	1.426	0
ubi	0	0	0	1.6021	1.6021	0	0	0
ambon	1.6021	0	0	0	0	0	1.6021	0
Aneka	1.6021	0	0	0	0	0	1.6021	0
asli	0	0	0	0	0	1.6021	1.6021	0
bika	1.6021	0	0	0	0	0	1.6021	0
ikan	1.6021	0	0	0	0	0	1.6021	0
indah	0	0	1.9031	0	0	0	0	0
kembang	0	0	0	0	0	1.6021	0	1.6021
kerupuk	1.6021	0	0	0	0	0	1.6021	0
kurnia	0	0	0	0	0	0	0	1.9031
loyang	0	0	0	0	0	1.6021	0	1.6021
original	0	0	1.9031	0	0	0	0	0
pedas	0	0	1.6021	0	1.6021	0	0	0
pulut	0	0	0	1.6021	0	0	1.6021	0
rajawali	1.6021	0	0	1.6021	0	0	0	0
Total	13.3394	3.727	10.6861	12.9872	8.3571	11.5612	14.9414	11.5612

A use case diagram is a diagram that explains the functionality of a system or class and how the system interacts with the outside world. A use case diagram illustrates how an actor will interact with the information system being developed. In the image below, the actors are the merchant and the buyer (see Figure 2).

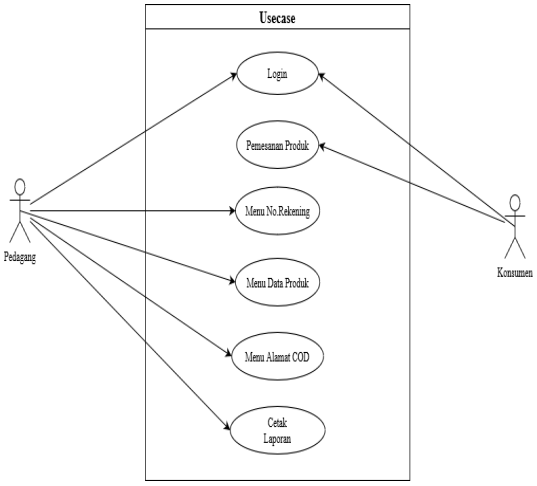

Figure 2. Use Case Diagram

Meanwhile, the flowchart for the product purchase transaction process in an e-commerce system involves interaction between consumers and the system. The process begins when consumers search for the desired product, after which the system displays the product [9]. The system then checks stock availability. If the product is out of stock, the process stops. However, if the product is available, the system displays the order details for the consumer to view. The consumer then makes the purchase and proceeds to the payment stage. After payment is made, the system displays the order data report and provides a payment confirmation form to be filled out by the consumer [12]. The consumer inputs the payment confirmation data, and the system then displays the details of the confirmed order. This flow ensures that every stage of the purchase is properly recorded, from product search to payment confirmation and the display of final order details (see Figure 3).

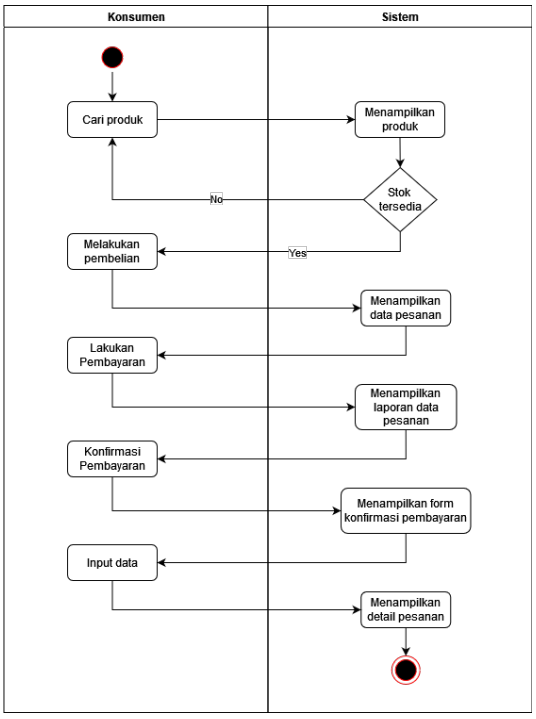

Figure 3. Product Ordering Activity Diagram

In the development of a Culinary Sales Marketplace system using Web-based Content Based Filtering, the database plays an important role as a center for data storage and management [1]. The database is designed to store data related to users, sellers, culinary products, transactions, and supporting data for the Content-Based Filtering (CBF) recommendation process. Interface design is an important element in the development of a web-based culinary sales marketplace system because it serves as a medium of interaction between users (consumers, sellers, and administrators) and the system [13]. A good interface design must fulfill the principles of user-friendliness, responsiveness, and intuitiveness so that users can easily search, purchase, and receive product recommendations. The image below shows the buyer registration page design, where buyers must fill out the form provided (see Figure 4).

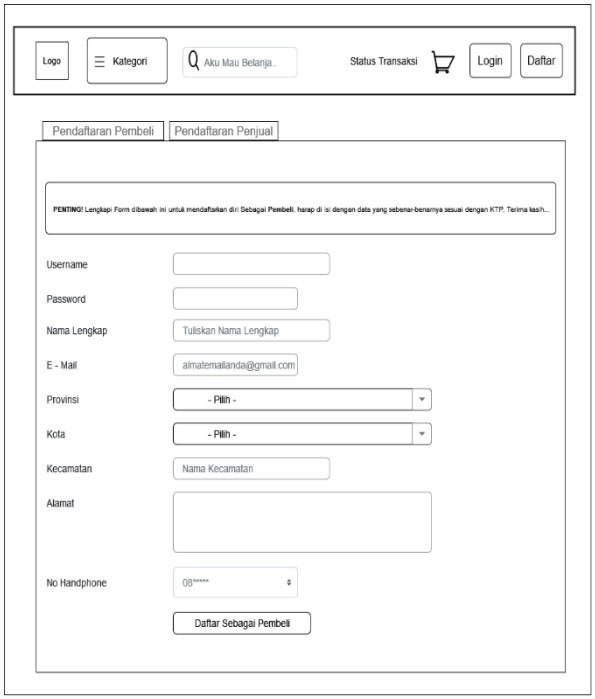

Figure 4. Buyer Registration Page Design

Figure 5 shows the buyer registration page design, where buyers must fill out the form provided to create an account on the marketplace system [14]. This form contains several mandatory fields, such as full name, email address, password, shipping address, and phone number, which are used for verification purposes and transaction processes. Additionally, the system can provide automatic data validation features to ensure that the entered information meets the required format, such as verifying the validity of the email address or the minimum password length.

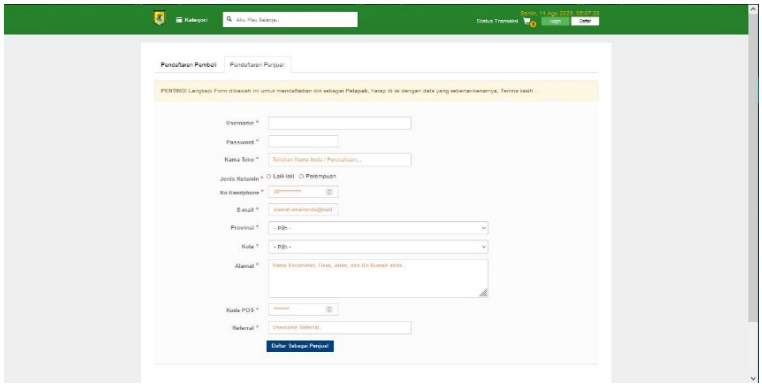

Figure 5. Merchant Registration Page Design

Figure 6 shows a special login page design for merchants who have previously registered and have an official account on the marketplace system [9]. This login page functions as an authentication gateway that ensures that only registered merchants can access store management features, such as uploading culinary products, managing inventory, processing orders, and monitoring sales.

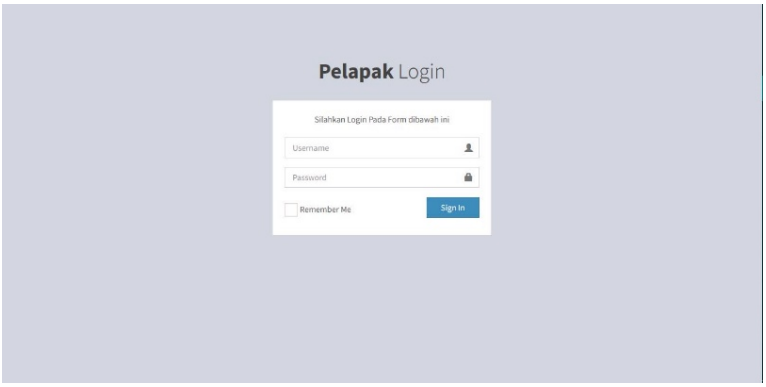

Figure 6. Merchant Login Page Design

Figure 7 shows the design of the order details page for buyers who have purchased a product. This page displays complete information about the transaction, including the product name and description, quantity ordered, unit price, total payment amount, selected payment method, and order status, such as pending confirmation, processing, shipped, or delivered. Additionally, this page provides seller information and the shipping address entered by the buyer during checkout, making it easier for the buyer to verify the data [15]. Additional features available on this page include an order status history that shows every change in status chronologically, as well as a confirmation button that buyers can use after receiving the product. The page is designed to be informative, neat, and responsive, so buyers can easily monitor the progress of their orders via both computers and smartphones.

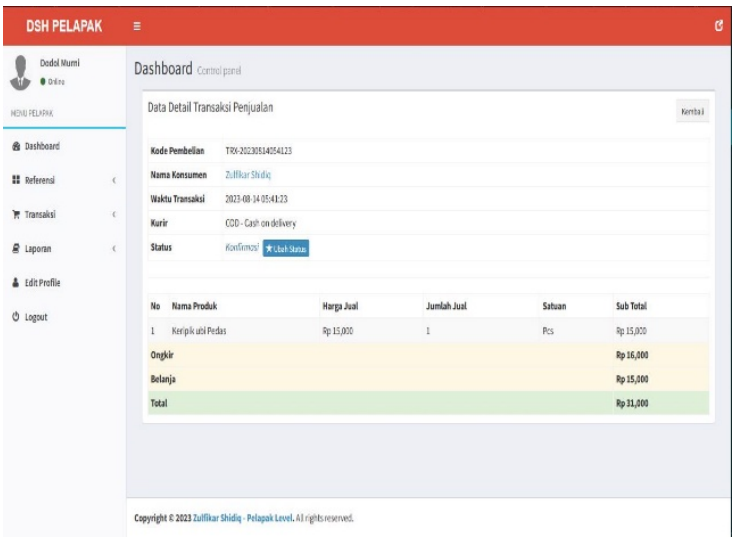

Figure 7. Order Details Page Design

Figure 8 is the account registration screen, where buyers will fill out the form with their complete and accurate information. This process is the first step for buyers to use all the features available on the marketplace system, such as searching for products, making purchases, giving reviews, and getting culinary recommendations that suit their tastes through the Content-Based Filtering method [16, 17]. The registration form typically includes important information such as full name, email address, password, phone number, and shipping address. The system is equipped with input validation to ensure each field is filled out in the correct format,

such as a password with a minimum length requirement or a valid email address format. Once all data is entered and the buyer clicks the “Register” button, the information will be stored in the database and used as the user’s official identity.

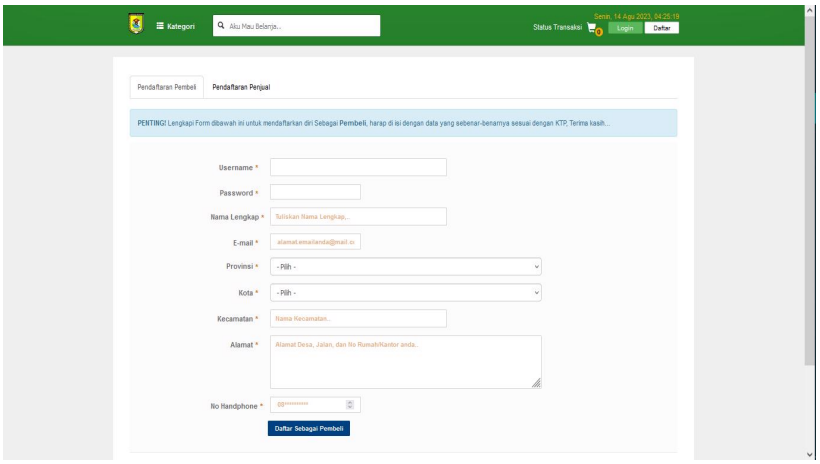

Figure 8. Account Registration Screen

Figure 9 shows the buyer’s home page, where buyers can search for products they want to order using the search bar provided. In addition, this page also displays various culinary categories, a list of popular products, and personalized recommendations generated by the Content-Based Filtering system based on the user’s purchase history and preferences. The page design is intuitive, with clear and responsive navigation, allowing buyers to explore products easily, read detailed information, view ratings, and add items to their shopping cart. Filter and sorting features are also provided to simplify product searches based on price, category, or best reviews. With this design, the home page serves not only as the starting point for purchases but also as an information and recommendation hub, making it easier for buyers to find culinary products that match their preferences.

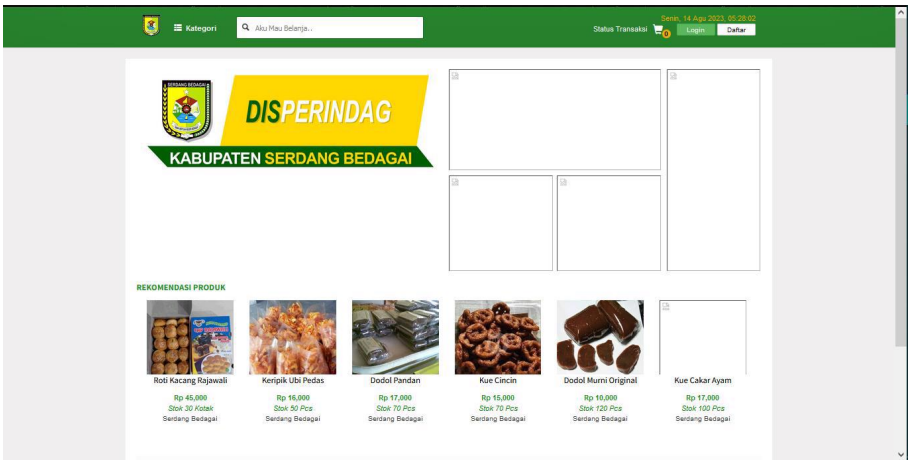

Figure 9. Buyer Home Display

Figure 10 shows the purchase transaction page, which displays product details. Buyers can click the “Buy” button to proceed with the transaction. Figure 11 shows the product data that has been ordered by the buyer, where the system displays detailed information such as product name, order quantity, unit price, total price, payment status, and shipping status. This view is designed to help buyers monitor their orders and ensure that the details displayed match the transactions made. Additionally, this page may also provide shipping tracking and order history features, allowing buyers to track the progress of the process from the time of ordering until the product is received.

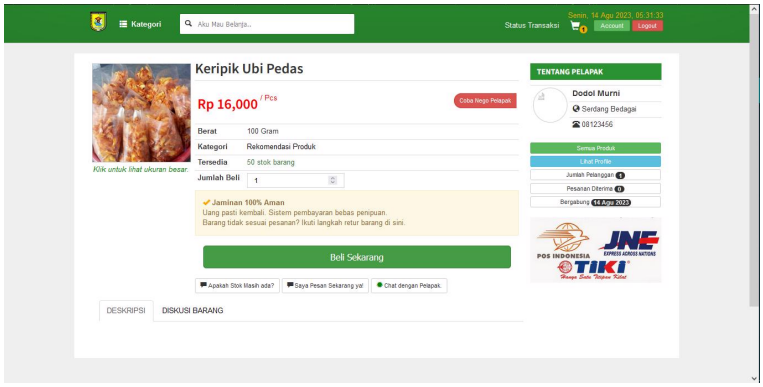

Figure 10. Purchase Transaction Display

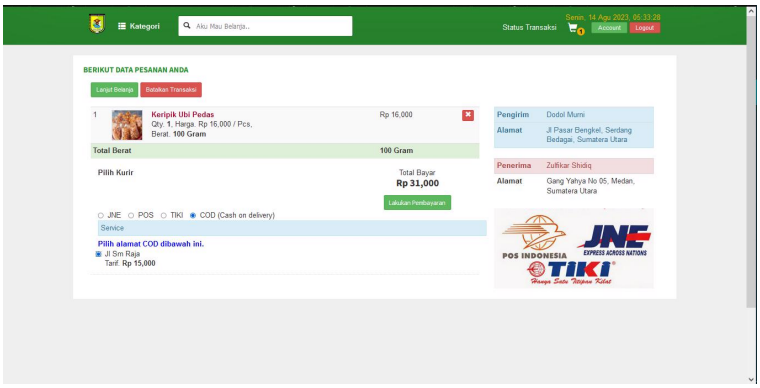

Figure 11. Product Order Display

4. CONCLUSION

Based on the above discussion, the researchers concluded that the culinary marketplace application designed is capable of providing convenience for merchants in marketing their products more effectively, with a wide market reach that is not limited to specific regions. This aligns with the opinion that digital technology use in marketing can expand market share and increase sales potential. For buyers, this app can save time and effort in searching for complete, accurate, and up-to-date information about the culinary products they wish to order, thereby making the decision-making process faster and more efficient. Additionally, the implementation of Content-Based Filtering has proven effective in providing relevant product recommendations tailored to user preferences, based on purchase history and previous interactions. According to research, this method is effective in delivering personalized recommendations that enhance user satisfaction and increase the likelihood of repeat purchases. Test data from the application shows that the accuracy rate of product recommendations exceeds 85%, meaning that most buyers receive product suggestions that align with their needs and preferences. As a result, the application not only simplifies the transaction process but also creates a more personalized, comfortable, and satisfying shopping experience for both merchants and buyers.

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