Designing a tourism recommendation system using a hybrid method (Collaborative Filtering and Content-Based Filtering)

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***Abstract*—A recommendation system is an application model based on observations of the customer's circumstances and desires. The recommendation system can be applied in various fields, one of which is tourism. By utilizing a recommendation system, tourism can introduce and promote its tourism to the wider community. In the recommendation system, several methods are used to support how the system works in producing information. This paper's uses the Hybrid (Collaborative Filtering & Content-Based Filtering) method and the Nearest Neighbor (NN) algorithm. This method has a weakness when an item does not have a rating at all. Therefore, it needs a method that can overcome the weaknesses of the method. We implement a hybrid method, which combines several methods in the recommendation system to produce recommendation items under the user's wishes. In addition, this system will use Whatsapp Messenger as a promotional medium. This paper aims to propose a recommendation system that will help several historical tours become the foremost destinations when visiting Palembang. The result of developing this recommendation system is a website that can recommend tours desired by users.**

Keywords—Recommendation System, Tourism, Hybrid, Collaborative Filtering, Content-Based, Nearest Neighbor.

I. INTRODUCTION

Tourism is an industry that is growing quite rapidly these days. The tourism sector is the second largest contributor to foreign exchange after palm oil exports [1]. In 2018, the tourism sector contributed USD 16.426 billion, increasing around 25 percent from 2017, amounting to USD 13.139 billion [1]. Based on this fact, the tourism sector is an attractive sector for further development by a country.

Indonesia has various types and places as tourist destinations. In addition to its natural and cultural beauty, Indonesia also has various historical places that can be visited to travel and get to know history. In general, management representations of history, museums, and monuments have been widely recognized as tourist objects. However, with the times and the pandemic of the Corona-19 virus outbreak spread throughout the region, causing several tourist attractions to experience a decrease in visitors and generate less income than before the virus outbreak. Therefore, This research will make historical tourism an object of research. It is hoped that it can help improve marketing and disseminate information to the broader community. This research will focus on one city with many historical tourist attractions, namely the city of Palembang.

Historical places, museums, and monuments are educational tours where visitors can learn about Indonesian history in certain areas while travelling. Some historical places that can be visited are the Balaputradewa Museum, Punti Kayu, Taman Wisata Kerajaan Sriwijaya, Bukit Siguntang, and Pulau Kemaro in Palembang City, South Sumatra. However, not many potential visitors know this place's existence or how to visit the place. This is due to the lack of information circulating and the influence of the Covid-19 virus, which has spread to various regions and even abroad. Therefore, a tourist spot should have promotional media and information to capture a broader range of potential customers while adhering to the government's protocol regulations to prevent the transmission of the Covid-19 virus. Therefore, to make it easier for prospective visitors to get information about historical places in Palembang, they can use information technology by implementing a recommendation system.

The recommendation system is an application model based on observations of the circumstances and customer desires. Therefore, the recommendation system requires a suitable recommendation model. The recommended one follows the customer's wishes and makes it easier for customers to make the right decision in determining the product or service to be used [2]. This recommendation system can be applied in various industrial fields as a way or a tool to promote products or just what is offered. Several methods are used in the recommendation system to support how the system produces information, such as Hybrid, Collaborative Filtering, and Content-Based Filtering, Technique for Others Preference by Similarity to Ideal Solution (TOPSIS), and Deep Learning [3].

This paper focuses on Collaborative Filtering and Content-Based Filtering, and social media as a marketing medium for a recommendation system. Collaborative Filtering is a

recommendation system algorithm where recommendations are given based on data considerations from other users. Meanwhile, Content-Based Filtering is the provision of recommendations given by exploring the contents of user profiles, product descriptions, or things related to the formation of user choices for an item [2]. The disadvantage of these two methods is that they cannot recommend new types of items or have never been seen by the user before. This is because this method is based on the items that the user has rated. The method is a weakness of Collaborative Filtering when an item is entered. No one has given a rating. Then, the item cannot be recommended to any user [4].

The drawback of the existing model can be solved by implementing the hybrid method. This approach combines several recommendation system methods to produce recommendation items according to the user's wishes. This literature review is the initial stage planned by the author to conduct research related to recommendation systems. We use the Hybrid method (Collaborative Filtering & Content-Based Filtering) by utilizing tools or media. Social media and search engines can increase sales and attract more comprehensive visitors using data sources that come from scientific articles.

The next part of this paper is structured as follows: Part 2 discusses the literature review related to research. Part 3 discusses the methodology used. Part 4 discusses the results and discussion. Finally, Part 5 is the conclusion.

II. Related Work

Based on the literature review of the recommendation system, many researchers have defined, categorized, and discussed the recommendation system as a solution in marketing. Several studies have successfully adopted a recommendation system using Hybrid Collaborative Filtering and Content-Based Filtering methods to calculate the similarity between variables [5]. The development of other recommendation systems uses the K-Nearest Neighbor (K-NN) algorithm to calculate similarities between Collaborative Filtering (CF) and Content-Based Filtering (CB). The calculation results are effective enough to provide recommendations to users [5], [6]. This method can also be combined with the Pearson Correlation to calculate user ratings on items [6].

The research uses Nearest People to build a tourist recommendation system in determining trips using route information, time, accommodation, and nearby places by combining K-NN and Apriori algorithms for classification [6]. The Nearest Neighbor (NN) algorithm is used to find closeness between new cases and old cases based on matching weights of existing attributes Apriori algorithm performs frequent itemset searches using the association rule technique. In this study, Collaborative Filtering and Apriori algorithms are applied to build a recommendation system based on user information, which produces a reasonably good accuracy level [7].

Other studies utilized collaborative filtering methods by calculating similarities using Cosine similarity measures that calculate similarities between two items from a cosine angle [8], [9]. Variance analysis test (ANOVA) is also used [8] to test a hypothesis by comparing the average sample size of the Hybrid Collaborative Filtering and Knowledge-Based Filtering methods. According to user wishes, results can provide recommendations for tourist destinations by determining tourist destinations, costs, and the category. Other algorithms such as the Genetic Algorithm [8] can increase the computational efficiency in a vision shorten the calculation time compared to standard algorithms.

Hybrid Content-Based Filtering and collaborative filtering methods have also been successfully applied in predicting favourite restaurants [9] and recommending a book for users who are challenging to make choices [10]. The evaluation results show that the performance obtained is superior and more accurate than other methods. In Shanghai, online courses have successfully implemented a recommendation system using a combination of association rules, Content-Based Filtering, and Collaborative Filtering. The results show that this recommendation system can improve educational resources, distance learning autonomy, and students' efficiency [11].

Collaborative Filtering is also considered inefficient in handling combined location preferences. It requires other methods to complement the shortcomings of collaboration so that research adopts K-means to participate users into multiple filtering clusters [12]. Applying a recommendation model collaborative filtering based on time and K-means correlation coefficient for recommendations with the results of the trials conducted shows effective results to obtain fast and accurate recommendations that have also been successfully implemented [13].

Another research tries to combine Hybrid Collaborative Filtering, Content-based Filtering, and Location-Based Service (LBS) [14], aiming to improve the quality of tourism services by building an automatic recommendation system application run on mobile devices. LBS itself is used to filter information based on the distance to spots in a tourism area. This application built can integrate google maps, virtual maps, and tourist information services.

Another method that researchers often use to combine with Collaborative Filtering and Content-based Filtering is Demographic Filtering by classifying based on user information which aims to recommend visitors to specific places according to preferences of places previously visited [15], [16], [17].

Several other studies have tried to propose a recommendation system by combining online product click data and weighted offline product sales data to find customers' online and offline preferences called K-RecSys. This method's results indicate that the proposed system produces better performance than the Collaborative Filtering system in clicks and purchases [18]. Furthermore, the Scikit-learn and Tensorflow techniques have been exploited in an attempt to recommend the film [19]. Scikit-learn has a good effect on traditional machine learning from the experiments conducted. Tensorflow is good in the neural network. Besides, neural networks are not like Collaborative Filtering algorithms, which require sufficient ranking data to make predictions. The TCARS algorithm has also been successfully applied to recommend films using the Movielens dataset, with results showing better precision [20].

Recommendation system based on a neuro-fuzzy approach has also been presented to allow or decide the system recommends or does not recommend processed items to users. The neuro-fuzzy approach has slightly worse performance but results in interpretable fuzzy rules [21]. Other studies have proposed Semantic Web technology and ontology methodology to implement a tourism recommendation system to obtain information effectively. The results show that users easily obtain the necessary resources and lighten the query load [22].

In addition to using methods and algorithms, several studies also utilize social media as a recommendation, one of which is research [23] which utilizes Twitter by considering the number of URLs, hashtags, several favourites, and value to a tweet. The results of the evaluation conducted by the researchers showed a predictive accuracy of 68%. Another study [24] utilized a google maps application to implement a recommendation system using real-time dynamic multimodal routes based on user preferences, point-of-view (POI), and route scenarios.

III. METHODOLOGY

In this study, the methodology used to develop this tourism recommendation system consists of the waterfall method, a system development method, and the Hybrid method (Collaborative Filtering and Content-Based Filtering).

A. Systems Development Methods

In this research, the system development method used is the waterfall method. The waterfall or waterfall method is a system development method carried out in stages. It must be completed sequentially, starting from requirements analysis, system and software design, implementation and unit testing, integration and system testing, and operation and maintenance [23]. The flow of these stages can be seen in Figure 1:

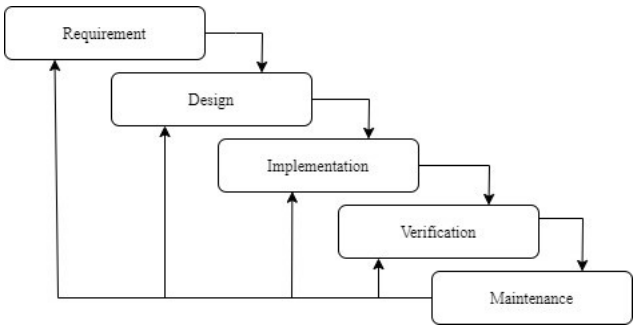

Fig. 1. The flow of the Waterfall Method [25].

a) Requirements Analysis

In system development, information on user needs for software must be analyzed first. This method of collecting information can be done by observing, discussing, or conducting direct interviews to get complete information about the user's needs for the software to be developed.

b) System and Software Design

After conducting a needs analysis, it is analyzed to be implemented into the development design. Finally, this design is done to help provide a complete picture of what to do.

c) Implementation and Unit Testing

The implementation and unit testing stages are the stages of changing from software design to programming. There will also be tests and checks on the functionality of modules that have been divided by software to find out if they match the desired criteria or not.

d) Integration and System Testing

After implementation, it will then be integrated into the system as a whole. Finally, a comprehensive system inspection and testing are carried out to identify possible failures and errors in the system that has been built.

e) Operation and Maintenance

This operation and maintenance stage is the last stage in the waterfall method, which users have successfully operated and maintained. Maintenance can be carried out long enough to ensure no system errors and make improvements according to future needs.

B. Hybrid (Collaborative Filtering and Content-Based Filtering)

The collaborative filtering method is a method that calculates correlation by predicting the ranking of items from previous users to assign to other users. The correlation preference used is based on the user-item matrix decomposition technique of a certain rank. The item as a product is generated from two smaller value matrices [14]. Whereas Content-Based only uses current user preferences by predicting the rating of items that have never been assessed, this approach is based on information retrieval techniques, usually text and vector representations, by identifying the most relevant keywords.

The Hybrid method itself is an approach used to overcome the shortcomings of each technique or approach used. In this study, the Hybrid method is used to solve the two methods above, which cannot recommend new types of items or have never been seen by users before.

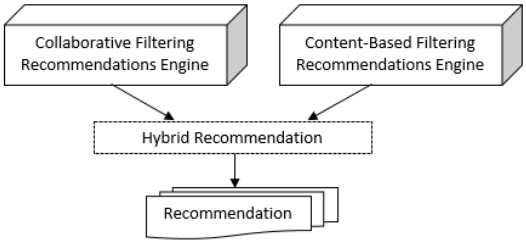

Fig. 2. Hybrid (Collaborative Filtering and Content-Based Filtering) [16].

C. K-Nearest Neighbor Algorithm

The Nearest Neighbor (NN) algorithm is an approach algorithm for finding cases by calculating the closeness between new cases and old cases based on matching weights of several existing attributes. Nearest Neighbor will classify only if the new case's attributes match one of the old case attributes. Thus, the classifier does not use any model to match and is based only on history. The formula for calculating this algorithm is [8]:

$$\text{Similarity(T,S)} = \frac{\sum_{i=1}^{n} f(Ti,Si)*Wi}{Wi} \quad (1)$$

Description:

T = new cases

S = cases that are in memory (storage)

n = number of attributes in each case
i = individual attributes between 1 to n
f = function similarity attribute *i* between case T and S
w = weight assigned to attribute to- *i*

D. The Flow of the System Planning

a) Research Step

The method of research to achieve the objectives carried out in this historical tourist spot will be made and described in the form flowchart following:

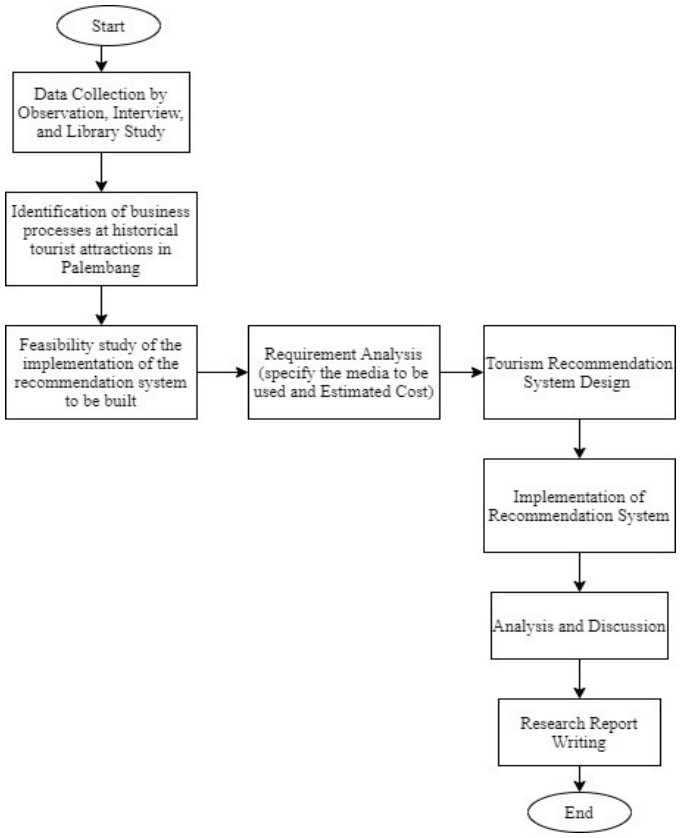

Fig. 3. Research Steps.

In the flowchart research steps in the image above, the researcher will take the first step to collect data. Data collection will be carried out by observing the research place by observing how the system and operations are carried out, then conducting interviews with the tourist spot's guard or caretaker. After that, the researcher will conduct a literature study and identify problems related to research tourist attractions.

Furthermore, the researcher will analyze the needs by determining the method used to develop the recommendation system and determine the estimated cost. The method used in this research uses the method Hybrid(Collaborative Filtering & Content-Based Filtering) and algorithm Nearest Neighbor. After that, the researcher will propose a topic that has been analyzed and designing a tourist recommendation system according to the needs of historical tourist sites. System design is the optimal stage of compiling processes, data, process flow, and relationships between data to carry out business processes and fulfil needs following the needs analysis results. According to prospective guides and tour parties' needs and agreements, the recommendation system will be designed in advance. Then, the recommendation system's design will be realized or implemented in a system or software using the computer language. The language used is PHP language. This recommendation system will be implemented in a recommendation system to produce several historical tourist attractions in Palembang, South Sumatra. This recommendation system will be used as a medium for promotion and more extensive and complete information about these tourist attractions. The last step is to analyze whether the system can be applied as needed or not. The author will make a research report as the final result of implementing the historical tourism recommendation system in Palembang.

b) System Planning

In this study, the system design will be made using a context diagram. In addition, this data flow will explain the recommendation system process applied to the recommendation system that recommends several historical places in Palembang City.

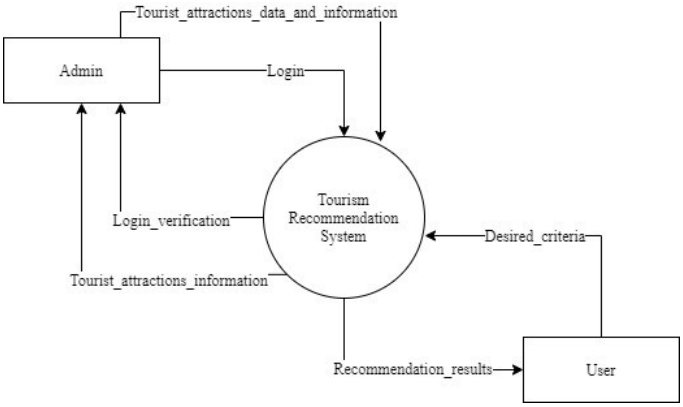

Fig. 4. Context Diagram of the Tourism Recommendation System.

Figure 4 the context diagram of the tourism recommendation system shows one process: the tourism recommendation system and two entities, namely the Admin and User. The process of this tourism recommendation system is a system that will recommend several historical tourist attractions in Palembang City to users or tourists. Then on the admin entity, the admin will log in first to the tourism recommendation system to do activities such as input data about the tourist attractions to be recommended, the price to enter this attraction, and transportation used to get to this attraction. The data and information will then be stored in the tourism recommendation system. This tourism recommendation system will produce output in the form of information about recommended tourist attractions. In the user entity, the user will search for the desired tourist criteria. Then the recommendation system will recommend several tourist attractions that match the user's wishes as a destination.

E. Designing Models for Calculation

The calculation in designing the tourism recommendation system model requires some data to provide recommendations

based on distance, tourism costs, and transportation costs. The following data are used in planning the calculation model:

TABLE I. DATA CALCULATION

No	Criteria	Subcriteria
1	Palembang City Center	1. Near (5Km - 10Km) 2. Medium (10Km-15Km) 3. Far (15Km-20Km)
2	Tour Costs	1. Cheap (Rp. 10.000 – 30.000) 2. Medium (Rp. 30.000 - 50.000) 3. Expensive (Rp. 50.000 -100.000)
3	Transportation costs	1. Cheap (Rp. 2.000 – 50.000) 2. Medium (Rp. 50.000-100.000) 3.Expensive (Rp. 100.000 – 250.000)

F. Discussion of Methods

In the discussion of this method, the researchers will create a scenario of using a recommendation system based on the name of the tourist attraction and features as shown in the following table:

TABLE II. SOME TOURIST ATTRACTIONS

ID	Name of Place of Interest	Features owned by	Rating
6	Bukit Siguntang	Historical nature tourism, cheap ticket prices, cheap transportation prices	4
11	Balaputra Dewa Museum	Storage of historical relics, cheap ticket prices, cheap transportation prices	3
13	Taman Wisata Kerajaan Sriwijaya	Historical nature tourism, cheap ticket prices, moderate transportation prices	4
15	Pulau Kemaro	Historical nature tourism, moderate ticket prices, high transportation prices	5

The first step that will be taken is to calculate the prediction rating using the Content-Based Filtering method. The following is a table of feature items:

TABLE III. FEATURE ITEMS u_{10}

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	Rating
i_6	1	0	0	0	0	0	1	0	1	0	4
i_{11}	1	0	0	1	0	0	0	1	0	0	3
i_{13}	1	0	0	0	1	0	0	1	0	0	4
i_{15}	1	0	0	1	0	0	0	1	0	0	5

Table III. is a table of feature items owned by a user u_{10}. Then calculate the user's weight for each feature using the following formula [26]:

$$w(u,jk) = \frac{1}{|Iu|}\sum_{i \epsilon Iu} x(i,j) r(u,i) \quad (2)$$

Description :
$w(u,jk)$ = weight owned by user u against jk
Iu = is a set of items that have been rated by user u
$x(i,j)$ = presence value of 1 or 0 a feature rated in an item
$r(u,i)$ = the rating that the user gave u item

The following is the result of the calculation of the user weight for each feature:

TABLE IV. THE RESULTS OF THE WEIGHT CALCULATION

	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9	F_{10}
User	4	0	0	2	1	0	1	3	1	0

After weighting is done, it will then calculate the predicted tourist attractions using the following formula [26]:

$$R'(u,i) = \frac{1}{|Di|}\sum j \epsilon\, Di\; W(u,j) \quad (3)$$

Description :
$R'(u,i)$ is a prediction of the user rating u of item i
Di is a feature that appears in item i.

After obtaining the prediction rating calculation from Content-Based Filtering, the prediction calculation will be carried out using Collaborative Filtering. The first step is to determine the rating matrix between the primary users and other similar users.

TABLE V. USER RATING MATRIX AND ITEM

ID	i_6	i_{11}	i_{13}	i_{15}	i_{16}
u_{10}	4	3	4	5	?
u_{11}	3	4	4	5	3
u_{15}	4	4	3	4	5
u_{19}	5	3	5	5	4
u_{20}	4	3	4	4	3

Then, calculate the similarity using the K-Nearest Neighbor formula using the following formula [8]:

$$\text{Similarity (T,S)} = \frac{\sum_{i=1}^{n} f(Ti,Si) * Wi}{Wi} \quad (4)$$

The last step is to do hybrid calculations using the weights of the two methods (Content-Based Filtering and Collaborative Filtering) using the following formula [26]:

Rhybrid = (W1R1 + W2R2 + … WnRn)/(W1+W2+…Wn) (5)

Description :
Rhybrid = prediction of hybrid raing
Wn = weight of prediction rating using the method to-n
Rn = prediction of rating by the method to-n

IV. RESULTS AND DISCUSSION

A. Results

This research designs a tourism recommendation system using the Hybrid method (Collaborative Filtering and Content-Based Filtering) as a marketing medium. The calculation algorithm used to assist in calculating the closeness between users uses the K-Nearest Neighbor algorithm.

Figure 4 shows the system's home page, and there are several buttons, namely Home, Tourism, Blog, Gallery, and My Account. Then, Figure 5. is a page for filling the desired tourist category. Visitors can fill in the desired tourist category in the system provided. Furthermore, Figure 6. shows the results of the tourist recommendations offered by the recommendation system according to the categories that users have been inputted.

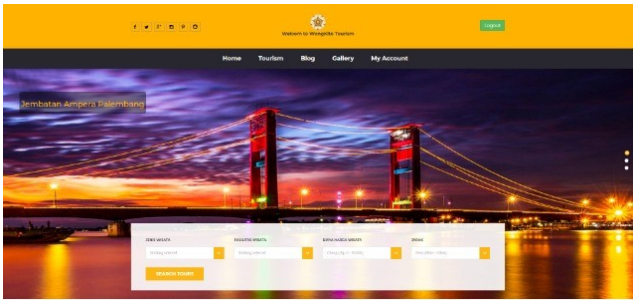

Fig. 4. Home page.

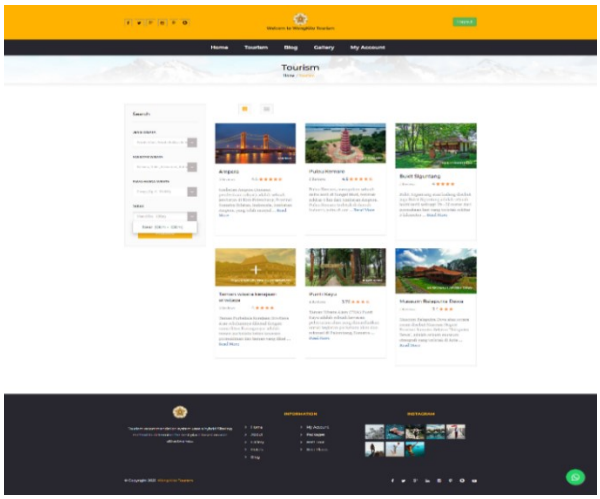

Fig. 5. Travel criteria fill page.

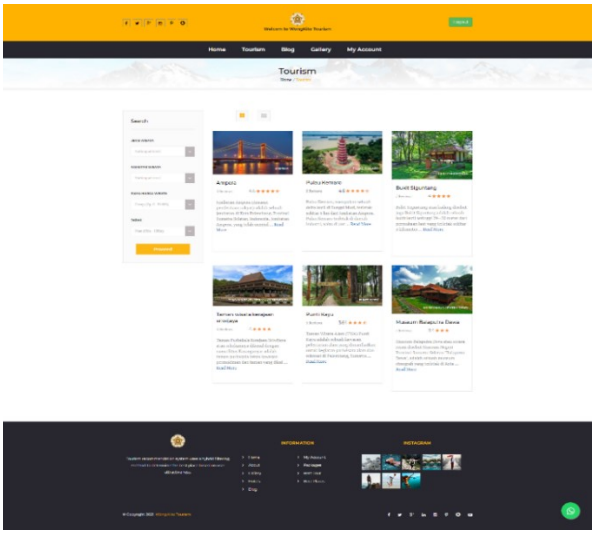

Fig. 6. Recommendation result page.

B. *Planning tools to be used*

This research planning will utilize several tools used to assist in introducing and promoting the products being offered. Tools used are *Application Programming Interface* (API) and online chat media, namely WhatsApp Messenger. In this research, the API containing a series of codes is used to connect WhatsApp Messenger with a recommendation system built to promote tourist attractions. Furthermore, the system will provide attractive offers regarding recommended tourist attractions via WhatsApp Messenger to visitors by utilizing customer data that has been stored in the database. The following is a comparison chart of the applications most widely used in Indonesia by Statista:

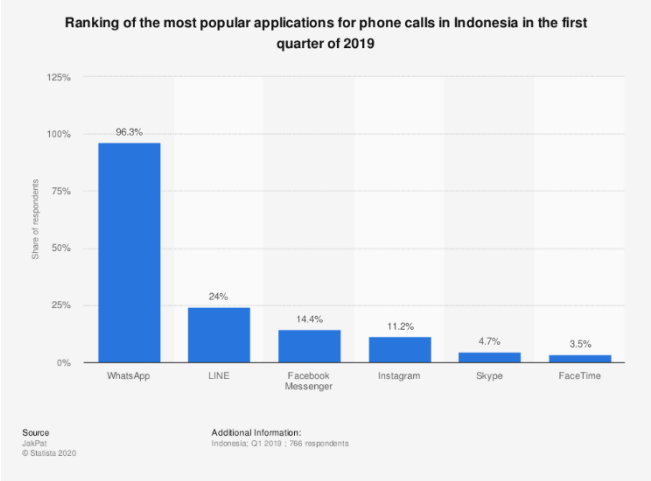

Fig. 7. Ranking of the most popular application for phone calls in Indonesia [27].

V. CONCLUSION

This study concludes that the researcher proposes a travel recommendation system using the Hybrid method (Collaborative Filtering and Content-Based Filtering) and will also utilize a chat application, namely WhatsApp Messenger, as a promotional medium. The calculation algorithm used to assist in calculating the closeness between users uses the K-Nearest Neighbor algorithm.

This research is a tourism recommendation system design that will recommend several historical tours in Palembang. This system is a website that visitors can use to determine the tour according to their wishes.

Future research is expected to develop a recommendation system in different cases, such as recommending lodging, culinary delights, or other places of great interest to the community.

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