

Performance of Multi-Criteria Recommender System Using Cosine-Based Similarity for Selecting Halal Tourism

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Abstract—Tourism is an activity where people or groups travel voluntarily for relaxation, seeking entertainment, or enjoy cultural diversity both within the city, outside the city, or even abroad. For traveling, information about halal tourism is essential that tourists must know. Tourists can contact a tour guide to find information and recommendations for halal tourism. However, it will cost quite a bit and need for a recommendation system to obtain recommendations and make it easier for tourists to determine which halal tourism to visit. This study aims to obtain the Multi-Criteria Recommender System's (MCRS) performance using cosine-based similarity to select halal tourism in Batu City. MCRS extends the traditional approach by using more than one scoring criteria to generate recommendations. The implementation of MCRS using cosine-based similarity succeeded in producing the five highest recommendations for halal tourist attractions, which were implemented in a game-based system. Through recommendation accuracy testing on two items, three items, four items, and five tourist attractions items, we obtained an average accuracy is 77,95%.

Index Terms—Cosine-based Similarity, Halal Tourism, Recommendation, MCRS.

I. INTRODUCTION

Tourism is an activity where people or groups travel voluntarily for relaxation, seeking entertainment, or enjoy cultural diversity both within the city, outside the city, or even abroad. A tourist destination or place is an area or area in which there is a tourist attraction that can be visited by residents or tourists from various regions and outside the country [1]. The definition of tourism in Islam has a comprehensive meaning.

The meaning of the tour is more to make a journey by interpreting all the majesty of the Creator. Islam strongly recommends taking a trip or tour as stated in the QS. Al Ankabut verse 20. The verse explains that Allah SWT. Encourage his people to travel to places while admiring all the power of Allah SWT. Halal tourism itself is to travel following what was ordered by Allah while still paying attention to the sharia aspects of Islam.

One of the areas that have become tourist destinations, namely Batu, Batu is one of the cities located in East Java. The name Batu City is undoubtedly familiar to many tourists. According to the data, there are 60 tourist attractions in Batu [2]. In 2021, the number of tourists who came to Batu was 2.478.764 [3]. This number shows an increase in the number of tourists from previous years [4]. Based on data from the Batu BPS mentioned earlier, the increasing number of tourists who visit has made the Batu government continue to improve services in many sectors, including improving services for halal tourism [5]. The Batu tourism office is improving services for halal tourism by implementing halal tourism systems and conducting socialization and direction to parties related to Batu tourism [5]. Tourists can hire a tour guide to find out this information and get recommendations for tourist attractions, but it can cost quite a bit [6]. To reduce spending, tourists must determine their own desired tourist destinations, starting with searching for information on each tourist spot. A halal tourism recommendation system is needed to make it easier for tourists to determine which halal tourism to visit [7]. In addition, to make it easier for tourists to get information about recommendations for tourist attractions, a media is needed. The media can also be a place for the government to promote tourist attractions in Batu. Promoting the tourism sector has great benefits for economic, social, and environmental activities around tourist attractions [8]. The recommender system proposal in this study allows it to be applied in various media, for example, games, web, and mobile. Games can promote tourist attractions, and the costs incurred will be more efficient than promotions using posters or advertisements [9]. Tourists can use the game to get recommendations for halal tourist attractions and visualize the desired tourist attractions.

A game must receive additional support from the

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recommendation system to offer its players knowledge advantages [10]. Through the use of a recommendation system, tourists can quickly choose, compare, and make decisions, tourists can quickly select, compare and make decisions [11]. The main objective is to create recommendations for potential tourists to choose halal tourism attractions. The selection of travel destinations is essential knowledge for prospective tourists to prepare for their trip [12]. Therefore, in this study, the researchers developed a recommendation system to obtain the Multi-Criteria Recommender System (MCRS) performance using cosine-based similarity and implemented it into a game-based system that visualizes tourist attractions.

II. RELATED WORK

Arif et al. explained that to reduce expenses in determining the place needed a system that can recommend tourist attractions. The research was conducted on a blockchain-based which can handle the wide circulation of multi-criteria rating data nodes required by MCRS as a reference in producing tourist destination recommendations for tourists. The fastest time in transmitting node data based on various criteria from the user to the server is 15.4 ms [7].

Arif et al. also designed the selection of game scenarios based on several characteristics of tourism destinations using the TOPSIS method. Of all the scenarios designed, the system reduces it to several scenarios that are influenced by the recommendations of Top N tourism destinations. In its testing, ASC succeeded in producing a choice of scenarios in tourist destinations for players with an accuracy value of 0.78 [9].

Battour and Ismail explain the increasing interest in halal tourism at this time. His research discussed the opportunities and challenges in developing and marketing halal tourism in the industrial realm. This research aims to help marketers and policymakers choose appropriate halal alternatives and increase their knowledge about the concepts and components of halal tourism. The most crucial thing in marketing halal tourism is the existence of halal food. Muslim-friendly hotels must also be available and do not provide alcoholic beverages, pork, and other haram foods. The Moslem-friendly airport is a starting point that can be used as a promotional tool to market Muslim-friendly destinations [13].

Samori et al. argue the importance of halal tourism with a concept based on the Qur'an and Hadith as the primary source. When going on a journey, there are rules and regulations in Islam that every Muslim must follow [14].

A. Multi-Criteria Recommender System (MCRS)

A recommendation system or Recommender System (RS) is a decision support system that suggests items to users that may be relevant to their choice. RS can also be defined as software that helps users get valuable and exciting items from an extensive collection of items in a personalized way. RS developed as a separate research area in the mid-1990s when people in the research community began to pay attention to recommendations that depended solely on assessment patterns [15]. The multi-criteria recommendation technique or the Multi-Criteria Recommender System (MCRS) extends the traditional approach by increasing the number of ratings to

cover various item attributes and combining their ratings to increase the accuracy of RS prediction [16]. Criteria are various item attributes that can be put together to describe the item's quality. The recommendation system based on multi-criteria can create a user utility model for specific items with an overall rating of R_0 and user ratings of R_1, \dots, R_k for each criterion c ($c = 1, \dots, k$). Some systems can choose not to use overall ratings and only focus on assessing individual criteria.

B. Halal Tourism

Tourism is all types of tourism activities that facilities and services support the government, community, people in business, and local governments. The United Nations World Tourism Organization (UNWTO) defines tourism as a social, cultural, and economic phenomenon that requires a trip from a person or group for individual or business purposes. Tourism, according to Islam, is a form of tourism activity that puts the values of Islamic law as the foundation. So all activities related to tourism must be based on Islamic law in terms of tradition, environment, clothing, attitudes, and dietary habits [17].

The legal basis for tourism can be found in the Qur'an in Surah Al-Mulk, verse 15. In the contents of the Surah, Allah commands His servants to take a vacation to gain wisdom from every trip taken. Allah has created the earth for humans to travel on His earth and enjoy the sustenance given by God to His servants, which they realize only to Allah people will return. A tour is said to be halal tourism based on several parameters or criteria that have been determined in this study based on Cape Town Tourism and Crescent Rating.

III. RESEARCH METHOD

A. Research Data

The data used in the study were obtained through direct surveys of tourists by filling out a questionnaire on Google Form. The filling is required for tourists of different ages, occupations, and regional origins. The total data obtained from filling out the questionnaire amounted to 120 data. The data obtained is then selected based on the variation in the rating of the items of tourist attractions and obtained as many as 100 valid questionnaire data that will be used in testing the system. The valid data is then divided into reference and test data [18]. The reference data consists of 90 data, and the test data consists of 10 data. The data obtained through the questionnaire, reference data, and test data contains the personal data of respondents and rating data given by respondents to tourist attractions based on predetermined criteria. Where the rating given starts on a scale of 0 to 10.

B. System Design

In this study, we implement the recommender system in game-based applications. The application is designed and created to help tourists make choices or decisions about halal tourist attractions to be visited in Batu. Through the game, tourists can find out the criteria, such as the halal services and facilities provided, and tourists can visualize halal tourist attractions based on the recommendations generated by the game system. The visualization of this game adds to the tourist experience in exploring the halal tourist spots they want to visit.

The calculation of the recommendation system in the

application uses the Multi-Criteria Recommender System (MCRS) or a multi-criteria recommendation system with a rating that the user already knows. In this case, the user has visited or knows about the tourist attractions that will be given a rating. When running the game, the user first gives a rating of at least two tourist attractions out of 14 tourist attractions with various criteria shown in table 1 for a list of halal tourism criteria and table 2 for 14 tourist attractions. The rating is given on several criteria in each tourist attraction. The criteria for halal tourism that must be given a rating are eight criteria, including the overall rating [19]. After the user gives the rating, the system will calculate and provide recommendations and can play tourist games that the system has generated. The user inputs the rating value on the form provided in the application. The rating value that has been inputted is stored in the script table object in Unity3D. The data stored in the script table object is then processed using MCRS calculations. The calculation results will be displayed to the user in the application as an output recommendation for halal tourist attractions. In this section, figure 1 shows the system's input process, while figure 2 shows the output process.

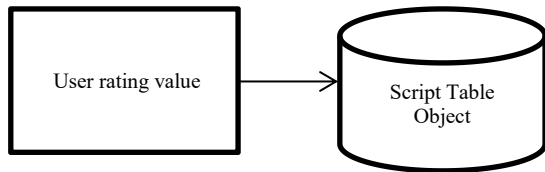


Fig. 1. Input Process

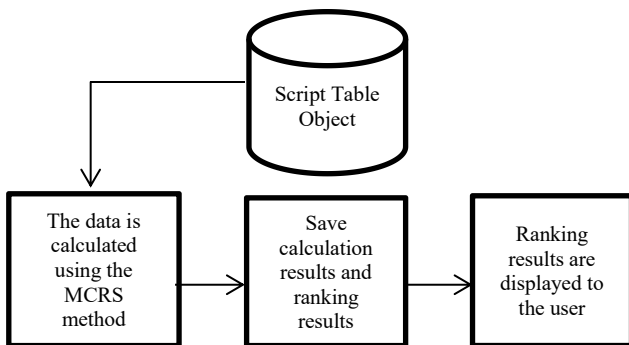


Fig. 2. Output Process

Table 1
Halal Tourism Criteria

Criteria Code	Description
C1	There are lodgings or hotels with halal facilities and services
C2	Availability of halal restaurants or food outlets
C3	Separation of places of worship between men and women
C4	Separate male and female toilets
C5	The state of the toilet and the water in the toilet is clean and holy
C6	Availability of halal shopping places
C7	The existence of supporting information on tourist attractions such as maps or directions to the mosque, halal outlet information, Qibla directions, and others

Table 2
Tourist Attractions Item Data

Item Code	Description
I1	Jawa Timur Park 1
I2	Jawa Timur Park 2
I3	Jawa Timur Park 3
I4	Museum Angkut
I5	Selecta
I6	Batu Night Spectacular (BNS)
I7	Eco Green Park
I8	Alun-alun Kota Batu
I9	Kusuma Agrowisata
I10	Cangar
I11	Coban Talun
I12	Pemandian Songgoriti
I13	Coban Rais
I14	Predator Fun Park

This study uses a heuristic-based Multi-Criteria Recommender System (MCRS) to generate the halal tourism destinations recommendations. The heuristic-based approach is also called neighborhood-based collaborative filtering. This approach has steps in determining the criteria desired by Un. The first step is to calculate the similarity rating on each criterion of user u (user on test data) and user u' (user on reference data). The calculation uses the cosine-based similarity contained in equation (1). $I(u, u')$ is the item i rated by users u and u' and $R(u, i)$ is the user rating for the item.

$$sim(u, u') = \frac{\sum_{i \in I(u, u')} R(u, i)R(u', i)}{\sqrt{\sum_{i \in I(u, u')} R(u, i)^2} \sqrt{\sum_{i \in I(u, u')} R(u', i)^2}} \quad (1)$$

After knowing the results of the similarity between users in each criterion c , the second step in the heuristic-based approach is to calculate the individual similarity values of $k + 1$ where k is the total criteria [20]. This process uses average similarity sim_{avg} between users u and u' in equation (2). This step can then find out the highest R0 value to generate recommendations.

$$sim_{avg}(u, u') = \frac{1}{k+1} \sum_{c=0}^k sim_c(u, u') \quad (2)$$

Testing the recommended system is carried out by comparing the results of system calculations and accurate data, calculated for accuracy using the formula in the confusion matrix shown in table 3. Table 3 shows the confusion matrix used to calculate the accuracy of the recommendations generated by the system.

Table 3.
Confusion Matrix

		Prediction Data Class	
		TRUE	FALSE
Actual Data Class	TRUE	TP (True Positive)	FP (False Positive)
	FALSE	FN (False Negative)	TN (True Negative)

To calculate the classification accuracy, use the accuracy formula based on the confusion matrix shown by (3) [21].

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \tag{3}$$

IV. RESULT

A. Recommendation for Halal Tourism

The system used cosine-based similarity to generate top-N recommendations for halal tourist attractions through MCRS calculations. Top-N tourist attractions produced as many as five places. The recommendations of the five tourist attractions are the highest results from the calculations that the system has carried out. The five places recommended by the results are shown in Table 4.

Table 4.
Results of Recommendations for Halal Tourist Attractions

Top-N	Halal Tourism Name
1	Selecta
2	Jawa Timur Park 1
3	Predator Fun Park
4	Jawa Timur Park 3
5	Jawa Timur Park 2

B. Accuracy Test Results

System accuracy testing is carried out in several conditions, where the user provides recommendation values for two items, three items, four items, and five items. In each case, accuracy is calculated on the highest result from the order of 1 to 5 halal tourist attractions recommendations. Table 5 shows the matrix results of the tests carried out on ten users. Based on the previous explanation, testing has been carried out on several conditions and calculation results for top-1 to top-5.

Table 5.
The Result Matrix of the Test

		2 ITEMS				
		TP	FP	FN	TN	
Top-N	1	8	2	3	69	
	2	12	8	6	69	
	3	18	13	12	69	
	4	23	17	16	69	
	5	29	21	21	69	
		3 ITEMS				
		TP	FP	FN	TN	
Top-N	1	6	4	0	66	
	2	13	7	2	66	
	3	18	12	12	66	
	4	23	17	16	66	
	5	28	22	22	66	
		4 ITEMS				
		TP	FP	FN	TN	
Top-N	1	6	4	1	61	
	2	10	10	5	61	
	3	14	16	13	61	
	4	15	25	21	61	
	5	21	29	29	61	
		5 ITEMS				
		TP	FP	FN	TN	
Top-N	1	8	2	4	64	
	2	12	8	6	64	
	3	16	14	12	64	
	4	22	18	17	64	
	5	24	26	26	64	

Table 6.
Accuracy Percentage

		2 ITEMS	
Top-N	Accuracy Percentage		
1	93,9%		
2	85,26%		
3	77,48%		
4	73,6%		
5	70%		
		3 ITEMS	
Top-N	Accuracy Percentage		
1	94,74%		
2	89,77%		
3	81,55%		
4	72,46%		
5	65,71%		
		4 ITEMS	
Top-N	Accuracy Percentage		
1	93,06%		
2	82,56%		
3	72,12%		
4	62,3%		
5	58,57%		
		5 ITEMS	
Top-N	Accuracy Percentage		
1	92,31%		
2	84,44%		
3	75,47%		
4	71,07%		
5	62,86%		

Table 6 shows the overall accuracy percentage in each situation, namely on two items, three items, four items, and five items. The accuracy percentage is calculated based on the recommendations generated by the system on top-1 to top-5. Accuracy results are based on recommendations from 10 users

who have given the tourist attractions ratings that have been determined.

We obtain the overall accuracy result from the average percentage of accuracy calculated in each test state. The test conditions in question are tests carried out on two items, three items, four items, and five, each calculated from top-1 to top-5. The average percentage of overall accuracy obtained is 77,95%.

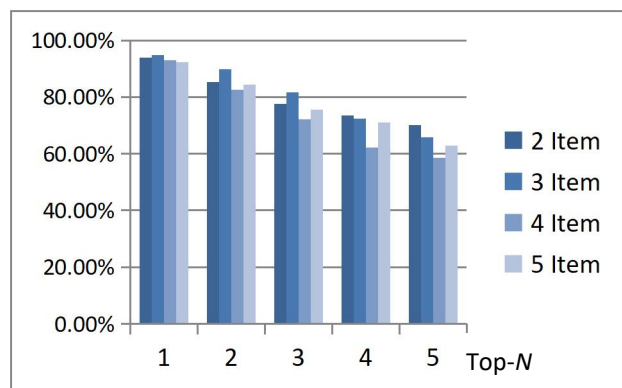


Fig. 3. Percentage of Testing Accuracy of Each condition

Results from Fig. 3 show that the highest accuracy value is in the test of 3 items with the first highest accuracy or top-1. The calculated highest accuracy is 94.73%.

Conditions	Average Percentage Accuracy
Two items	80,04%
Three items	80,82%
Four items	73,71%
Five items	77,23%

Table 7 shows the average percentage of the overall accuracy N-1 to N-5 of the various test conditions. Various test conditions begin with a two items test condition because cosine-based similarity cannot be used only on 1 item. Cosine-based similarity requires the comparison of items in the calculation process. The results of the highest average accuracy from the comparison of the existing test conditions in table 7 are in the three items test of 80.82%, where the input combination of tourist attractions used is Jatim Park 1, Jatim Park 2, and Jatim Park 3. Other test conditions use different combinations of inputs. The test conditions for two items used a combination of inputs for Jatim Park 1 and Jatim Park 2 with an accuracy of 80.04%. For the four items test condition, the combination of tourist attractions used is Jatim Park 1, Jatim Park 2, Jatim Park 3, and Museum Angkut, with an accuracy of 73.71%. As for testing the condition of 5 items, the input combination of tourist attractions used is Jatim Park 1, Jatim Park 2, Jatim Park 3, Museum Angkut, and Selecta, with 77.23%. From the average accuracy of overall test conditions,

the average accuracy for determining recommendations for halal tourist attractions is 77,95%.

Table 8. Comparison Related Works for Recommender System

Reference	Method	Application	Object	Accuracy Result
[12]	Destination Rating-Based MCRS	Game	Halal tourist attractions	60%
[11]	SVM and MLP	Not mentioned	Chiang Mai destination dataset	69,28%
[22]	Common MCRS	General application	Movielens dataset	Not mentioned
Ours	Cosine-Based Similarity MCRS	Game and other application	Batu halal tourist attraction	77,95%

Based on table 8, which compares related work, paper [22] uses almost the same method as our research, MCRS. The difference is in the object used. In paper [22], the object used is the Movielens dataset, while in our paper, we use tourist attractions in Batu. However, the authors in this paper did not include the magnitude of the resulting accuracy, so the use of MCRS could not be compared more deeply for further study. Other references have also been mentioned in table 8. Paper [11] made a recommendation system using a different method from our paper, namely SVM and MLP, with accuracy is 69.28%. Meanwhile, paper [12] uses a method similar to ours, namely MCRS, with accuracy is 60%. From the two papers, [11] and [12], the accuracy results are smaller than our paper's accuracy using the cosine-based similarity method, which is 77.95%.

V. CONCLUSION

The study was conducted using a heuristic-based Multi-Criteria Recommender System (MCRS). Recommendations for halal tourist attractions are obtained from the rating by the user of at least two tourist attractions that have been visited or know these tourist attractions. The rating is given to 7 types of halal tourism criteria determined and the overall rating (R0). The system succeeded in producing five recommendations for halal tourist attractions. The trial of recommendations for halal tourist attractions was carried out by comparing the system calculations and accurate data on 90 reference data and 10 test data, obtaining an overall average accuracy of 77.95%.

Other MCRS methods to produce recommendations for halal tourist attractions, such as the model-based method, can be used in further research to compare the best methods in producing recommendations for halal tourist attractions. In addition, the amount of data used in this research, which only 90 reference data and 10 test data, was deemed insufficient. Future research is expected to increase the amount of data and add more varied criteria and respondent data to produce more

accurate recommendations.

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