The framework accommodation of systems recommendation via social media

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Abstract. Tourists can plan trips using social media and other information sources found on the internet. However, to get information takes more time and efficient less. Recommendation systems have been developed to solve this problem. This research proposes the two-way relationship framework for the accommodation of systems recommendation using the hybrid method. To implementing the two-way relationship framework, this research is divided into two main architectural frameworks, the text processing architecture and the component system recommendation architecture. Focus this research for the framework component recommendations, where the decision-making process within the framework of two-way relationships using the hybrid method. The two-way relationship framework is probably to provide impression for the accommodation of system recommendation that can be developed and implemented in future research.

1. Introduction
Social media has users that are continually growing from year to year. As revealed in the statistical data from APJII (Association of Indonesian Internet Service Providers), the number of social media users in Indonesia reaches approximately 129.2 million [1]. This phenomenon shows that social media overall has an enormous potential as the source of data and information that can provide quality and competitive services to support a business process.

In tourism sector, social media has recently been used by tourists as a media in accessing information about tourism sites along with its services. Such utilization includes the possibility of tourists to plan their tour after reading the comments, testimonies, or posts as seen from social media. Data and information on social media are used by the community since the information is updated every time; however, the problem commonly faced by tourists is that they must search for, compare and choose so much information in accordance to their wish. This is certainly time-consuming and inefficient. To overcome this problem, Recommendation System has been developed then.

Research on recommendation system has been widely developed and implemented in various platforms to support the process of selecting tourism service [2]. The recommendation system carried out by Husnul, et al. [3] has developed a recommendation system by using the recommendation combination technique from various social media and extracting them into knowledge about the tourist sites by developing a space vector model. Mittal, et al. [4] proposed a recommendation system that could be personalized with the Time-Bound Activity technique, a technique using some activities surrounding including various factors such as location, mood, transportation and duration of availability. Nevertheless, most of the systems that have been developed are still in one-way, meaning
that the system design developed has not been able to reflect the tourists’ needs that can be totally captured, represented and appropriately processed.

For this reason, there is a need to design a system framework that can build a two-way relationship between tourism service providers and tourists. The two-way relationship referred to here is the participation of tourists and society, fellow tourists, government and employers in supporting the tourism activities aimed to meet the needs and to realize the tourists’ satisfaction that later can bring a positive impact on the economy and culture in a tourism area. This relationship can be realized with an assistance of Information and Communication of Technology (ICT) to automate the communication flow between government and citizens.

Thus, to be able to realize this two-way relationship, this study attempted to develop an accommodation recommendation system framework through social media. The framework to be developed has a two-way relationship technique between tourists and tourism service providers. This relationship occurs by grouping various types of hotel in accordance with comments, testimonies or posts coming from social media. The results of service processing will recommend a hotel service based upon the interest, hobbies and tourist characters.

In developing this recommendation system framework, the system has been divided into two major architectural frameworks: text processing and recommendation system components. In text processing architecture, the process occurred is the process of being able to read various kinds of post and comment and identify text related to what the users (traveler) want. Whereas in the component architecture, the recommendation system refers to a process to provide recommendation to tourists in accordance with their desire.

The focus of the discussion in this study is in the framework of the recommendation system component architecture, i.e. how to design a system framework that can accept any requests from users (tourists) and provide recommendations for the users based upon data and information coming from comments, posts, rating from social media and on the site of travel service providers.

This research also proposed a hybrid method in processing its recommendations. This method is a combination of various techniques in the recommendation system, i.e. a combination of collaborative filtering (CF) and content based filtering (CBF) [5]. The hybrid method has been chosen in this study as this method combines various different recommendation techniques to have a better system optimization to overcome any limitation problems and various problems frequently occurred in recommendation system such as cold start, scalability, and scarcity.

2. Literature Review

Research on recommendation system has been carried out by Husnul, et al. [3]. It was developed using a technique that could compile the combined recommendations from various social media and extracted them into knowledge about the tourist sites by developing a vector space model. In this method the researcher assumed that items that might be preferred by the friends of the users would also directly influence the user's choice. This assumption is known as "advice seeking" by utilizing connections between users on social networks making it possible to complete the process from assumptions. This advice seeking-based recommendation has some advantages compared to the existing recommendations in which it can overcome the usual sparsity problems in a conventional recommendation.

Mittal, et al. [4] proposed a recommendation system that could be personalized by utilizing the Time-Bound Activity. This recommendation system considered a number of activities surrounding including several factors such as the location of the user, mood (artsy, hungry/thirsty, outdoorsy, shopaholic, or touristy), user transportation modes (driving, walking, cycling or public transit) and the duration of user availability. The solution proposed in this paper can be used as a basis for solving problems in making road-trip where this solution will work as an aggregated model to map the preference of a user group occurred in road trip.

Kesorn, et al. [5] conducted a research to develop a personalized tourism information service (PTIS) framework. This framework analyzed the user interest and made attraction recommendation that could be personalized using the check-in information taken from Facebook service. The approach in this study can also overcome the cold start problem by gathering information from individual users and friends on Facebook. This identification was based on three factors: affinity score, edge weight and time decay. The proposed system can therefore dynamically study the user behavior and adaptively
provide the right recommendation. This paper demonstrated the usefulness of data on Facebook through the example of studies involving attraction recommendation, coping with the cold-start problems and adjusting the user models to improve the recommendations quality in the tourism domain.

Mark, et al. [6] proposed a machine learning approach in the recommendation system via twitter. The researcher in this research proposed an ontology based upon a machine learning approach to extract the name of the diseases and revealed a description of the diseases from tweets that might be used as the part of a system that has a large purpose to automasise the disease occurrence monitoring. This machine learning approach is highly useful on media such as twitter where it is possible to deeply reveal the disease condition to find a disease that has been previously unknown.

Based on a review of several papers above, there is a research gap, that is, they have not involved community participation in the implementation of a recommendation system in terms of data preparation that can be made as a sustainable recommendation. With the gap of these studies, the researcher proposed a two-way relationship framework design for accommodation recommendation by utilizing the community participation from social media.

3. Theoretical Base
   a. Two-Way Relationship
      The term of meaningful in Meaningful Two-Way Relationship means to correctly understand what is needed by society. The aim is to invite the existence of a state/government to the community by providing services accurately matching the community needs [7].

      The two-way relationship here also refers to a relationship between government and community enabling collaboration, transparency and participation of both in order to improve the decision making quality [8].

   b. Recommender System
      Recommender System (RSs) is a software and technique that provides a number of suggestions for the most attractive items to a particular user, suggestions related to various "Decision Making" processes such as what items should be purchased, what music should be listened to or what online news can be read. The essence of the recommendation technique is to be used to produce some customized recommendations to provide a useful and effective advice for certain types of item [9].

   c. Recommendation Technique
      To implement the main function and identify items useful to the user, a recommendation system must be capable of predicting an appropriate item to be recommended or compared to several items and then recommended based upon the comparison. There are various types of technique or approach in the recommendation system such as Content Based Filtering, Collaborative Filtering, Demographic, Knowledge-Based, and Hybrid Recommender System [9].

   d. Content Based Filtering and Collaborative Filtering
      The content based filtering method is a method to recommend a number of items that are similar to those that users liked in the past. The similarity of items is calculated based upon the features related to the item being compared. For example, if a user gives a positive value to a film included as comedy, the system can recommend other films from this genre [9].

      The content based filtering method has several techniques, including the use of TF-IDF weight calculation. The formula is written as follows:

      \[
      IDF = \frac{D}{DF}
      \]

      \[
      W = TF \times (IDF+1) \quad (1)
      \]

      Information:
      \[
      W : \text{weight of each document}
      \]
      \[
      TF : \text{number of occurrences of words or terms in the document}
      \]
      \[
      D : \text{number of all documents}
      \]
      \[
      DF : \text{number of documents containing terms}
      \]
      \[
      IDF : \text{inverse document frequenc}
      \]
Collaborative Filtering method is a method that recommends to active users based upon some items that other users liked with the similar taste in the past. Similarity in the taste of two users is calculated based on the similarity in the history of user rating. This is the reason why collaborative filtering method is often called "people-to-people correlation." Collaborative filtering method is the most popular technique and widely implemented in recommendations system [9].

Collaborative Filtering method in its calculation has several algorithms, including by means of Adjusted-cossine similarity. The formula of this algorithm is written as follows:

\[
sim(i, j) = \frac{\sum_{u \in \mathcal{U}}(R_{ui} - \bar{R}_u)(R_{uj} - \bar{R}_u)}{\sqrt{\sum_{u \in \mathcal{U}}(R_{ui} - \bar{R}_u)^2} \sqrt{\sum_{u \in \mathcal{U}}(R_{uj} - \bar{R}_u)^2}}
\]

Information:
- \(sim(i, j)\): Similarity value between item i and item j.
- \(u \in \mathcal{U}\): The set of users u rating the item i and item j.
- \(R_{ui}\): User u on item i.
- \(R_{uj}\): User rating u for item j.
- \(\bar{R}_u\): Average rating of user u

This method also has a formula for calculating the weighted sum prediction, i.e.

\[
p(u, j) = \frac{\sum_{i \in \mathcal{I}_j}(R_{ui} \cdot s_{ij})}{\sum_{i \in \mathcal{I}_j} s_{ij}}
\]

Hybrid Technique

Hybrid technique is to combine some different recommendation techniques to get a better system optimization to overcome any limitation problems and various problems frequently occurred in recommendation system. There are several hybrid techniques including weighted, switching, mixed, combination feature, augmentation feature, cascade and meta-level [9]. This method has several advantages such as if there is the rare data, it will be resolved by combining two methods of recommendation algorithms: collaborative filtering (CF) and content based filtering (CBF). This hybrid method uses the advantages of collaborative methods to correct the weaknesses of content-based method or vice versa.

4. Two Relationship Framework

A. Designing a two-way relationship framework

The design proposed and implemented in the recommendation system framework through social media has a main function, to ensure that inputs from the community (tourists) are able to reflect their needs that are really captured, represented, and properly processed so that the recommendation system to be developed can help in automating the communication flow between various parties such as tourism service providers, tourists and public. In this study, the design of a two-way relationship framework is illustrated in Figure 1 below:
In development of this recommendation system framework, the system was divided into two major architectural frameworks: text processing and recommendation system component. In the text processing architecture there were some collective inputs from citizen inputs related to events occur or will occur in the future and are the indirect signal input in the vague form that needs to be identified using text mining/text classifier such as extracting the meaning of the comments, posts and so on coming from social media. Whereas, in the component architecture, the recommendation system is a process to provide an advice to tourists in accordance with their wish.

The focus of this study is in the framework of the system recommendation component architecture on how to design a system framework that will recommend user recommendations based upon data and information from comments, posts, ratings from social media and on the sites of tourism service providers. The results of processed services will then provide information for the users about the hotel classification in accordance with the users’ wish based upon their interest, hobbies and characteristics.

There are several main plots to produce recommendation accommodation (hotel) through social media based upon the framework as shown in Figure 1. The research flow in a diagram in Figure 2 is illustrated below:

1. **Input user**: the users input the hotel classification in accordance to their wish based upon the interest, hobbies and characteristics of the users themselves.
2. **Recommendation System**: The system reads the input from the users. Input is then processed by the system.
3. The system will do the text processing by retrieving data and information such as comments, testimonies, or posts, coming from social media.

4. In the data analysis phase in the text processing form, the system will do text reading and text classifier. In this phase, there is a reading process to read various types of posts and comments by identifying the texts related to user input (cluster).

5. This two-way relationship occurs by grouping various types of hotel based upon comments, testimonies, and posts, from social media and the system will then make a decision (decision making) in the form of output (recommendation results). The results of processed services will recommend a hotel service based on interest, hobbies and characteristics of the tourists themselves.

**5 Discussion**

Given the design of this recommendation system framework that has been developed, then to support the recommendation system is by using the hybrid method a combination of collaborative filtering (CF) and content based filtering (CBF). This research attempted some sample data for this framework in its recommendation process. For example there was a new user needing the following characteristics of a hotel:

1. Classic, vintage
2. Facilities: Wifi, AC, swimming pool
3. Location: mountains
4. Room: clean, comfortable, affordable
5. Staff: friendly
6. Food: typical Javanese

From these characteristics, it would then be processed by a system based upon a database taken from social media. The document data in the database can be seen as follows:

**Table 1. Document data in the database system**

| Hotel      | Specification          |
|------------|------------------------|
| Narita (d1)| Classic |Wifi, AC,TV | Mountainous, University, Amusement Park | Clean | Comfortable | Friendly | Javanese typical | Single, Double | Affordable |
| Indoluxe (d2)| Modern |Wifi, AC, TV, Swimming Pool | Amusement park | Clean | Comfortable | Friendly | Western Style | Single, Double | Expensive |
| Emerlad (d3)| Modern |Wifi, AC, TV, Swimming Pool | Plaza Mall | Clean | Comfortable | Javanese typical | Single, Double | Relatively Expensive |
| Rose (d4) | Vintage |Wifi, AC, TV, Swimming Pool | National Park, Mountainous | Clean | Comfortable | Javanese, Chinese Typical | Single, Double | Affordable |
| Samudra (d5)| Modern | Wifi, AC, TV, | | | | | | |
Based on user1 input, it was then processed using the hybrid method. This study has designed a mixed hybrid technique. This technique is a recommendation technique from various methods by displaying them simultaneously.

User1 is a new user; thus, the system would recommend using the content based filtering (CBF) technique; while by using collaborative filtering technique, it would not be able to be processed for no rating (new user) found. Using the weight calculation of TF-IDF, the results can be shown as follows:

| Hotel     | Weight Calculation of TF-IDF |
|-----------|------------------------------|
| Narita    | 11.55                        |
| Indolu lux| 7.176                        |
| Emerlad   | 8.477                        |
| Rose      | 13.03                        |
| Samudra   | 7.176                        |
| Lestari   | 8.778                        |

It is found from the results of the weight calculation above that the highest weight value was found in Rose Hotel.

For hotel recommendation it used the collaborative filtering method if the user was a non-new user that has given a rating to a hotel as shown in the following hotel rating (1-5) data in the system:

| User | Rating |
|------|--------|
| User1| 4      |
| User2| 3      |
| User3| 2      |
| User4| 3      |
| User5| 3      |
| User6| 2      |

By using the adjusted cosine similarity algorithm, the calculation of similarity value was carried out if there were 2 or more ratings from other users of the two items, for example, for the similarity between Narita Hotel and Rose Hotel. From the calculation, the similarity value was found -1. Here are the similarities of various Hotels:

| Hotel  | Similarity Value |
|--------|------------------|
| Narita | Rose             | -1    |
| Indolu lux | Emerlad       | -0.24256 |
| Indolu lux | Rose           | -0.93201 |
After calculating the similarity of each hotel, it was then to calculate the prediction weight using the weighted sum algorithm. This algorithm was used to find the prediction value of hotels to be recommended to user1.

As seen in table 4, each predictive value will be searched and compared to whether the similarity value have met the calculation requirements. The calculation requirement is the one close to number 1. The similarity value of Emerlad Hotel and Samudra Hotel was 1 and Indoluxe Hotel and Lestari Hotel were 0.08304. So, the ones needed to search for their prediction were Samudra Hotel and Lestari Hotel. Table below presents the results of calculating the prediction for user1.

Table 5. Results of calculating the prediction for user1

| User | Hotel  | Prediction Result |
|------|--------|-------------------|
| User1| Samudra| 3                 |
|      | Lestari| 4                 |

Thus, in this accommodation recommendation system framework, the function of the hybrid method was to use the advantages of the collaborative method to correct the weaknesses of the content based method and vice versa.

6 Conclusion

Many studies on recommendation system have been developed and applied on various platforms, such as desktop application, web application and mobile application to support the process of selecting a number of tourism services such as accommodation. However, most of the systems that have been developed are still in the one-way form or have not involved community participation in implementation. Therefore, there is a need to design a system framework that can build a two-way relationship between hotel service providers and tourists or public.

The framework proposed is a two-way relationship framework for accommodation recommendation system through social media with a main function to ensure that the inputs from the community can reflect their need that is truly captured, represented, and properly processed. Thus, the recommendation system to be developed can help in automating the communication flow between various parties such as tourism service providers, tourists and public.

In this framework, the vague input needs to be identified by using text mining/text classifier, such as extracting the meaning of comments, posts and so on coming from social media. Then the system would recommend the recommendation user based on data and information from comments, posts, rating from social media or on the site of tourist service providers. The results of service processing would then provide information for users about the hotel classification in accordance with the wishes of the users based on their interests, hobbies and characteristics.

The method used in this recommendation system framework is a hybrid method, a joint method between collaborative and content-based method. It is expected that the results of the design of the recommendation system framework can be developed and implemented in further studies, which can answer the challenges of the accommodation recommendation system that can recommend a hotel service based on interest, hobby and the characters of the tourists themselves.

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