iTour2.0: A Smart Tourism Application for Independent Mobility of Tourists

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***Abstract*—iTour2.0 is a concept based on the IoT framework which claims to provide a smart, dependable, and secure tool to enhance Smart Tourism, by creating an information-based platform. Based on the idea of Smart Cities, iTour is a smart concept to boost tourism experience by providing information, resources and knowledge for independent mobility and security. This article proposes the new application iTour2.0, a user-friendly navigation and information system which also reduces battery usage and internet data usage of the user device while traveling, along with customer-oriented services.**

***Index Terms*—Smart City, Smart Tourism, Independent Mobility, Smart Map, Personal Safety.**

I. Introduction

Tourism plays an important role in the economy of a city and impacts the lives of different stake holders. In tourism people usually visit places which are less familiar and requires lot of knowledge and assistance to go around. Data provided by Google shows that more than 70 % of travelers used their mobile phones for travel related searches and bookings. From this information it is seen that mobile phones are not just a medium for tourism related smart applications but a necessity. iTour2.0 is an application that can help plan and execute a tour with minimum effort and maximum security and comfort. When it comes to personal safety of the tourist availability of emergency medical help is important as the tourists will be in an alien place with minimum information about medical services. This issue is also addressed by the IoT based Smart technologies that aid tourist safety [1]. The aim here is to make tourism easy for people and beneficial for the stakeholders.

Some of the issues that tourists face are trust in the services, support from private bodies, trust in the travel agencies and personal safety [2]. iTour2.0 provides a solution to these related issues and other concerns such as internet data usage, mobile battery consumption, fraudulent transactions, emergency help and safe mobility as shown in Figure 1.

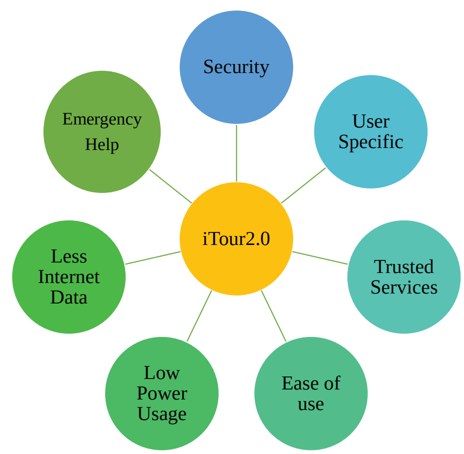

Fig. 1: Overview of the Features of iTour2.0.

The smart map will display services like hospitals, hotels, restaurants, police stations, etc. along with the regular tourist information and real-time services. The stake holders will have the advantage of ease of business with a scope for better marketing and advertising that will improve the business and hence the economy. Some of the advantages of the iTour2.0 are shown in Figure 2.

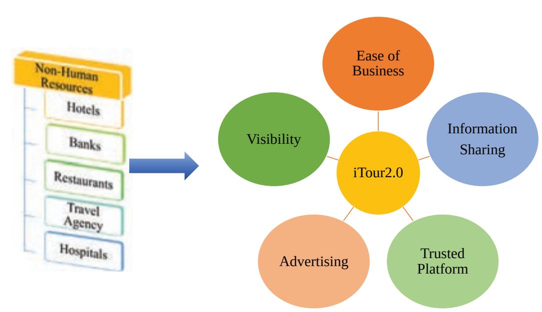

Fig. 2: Stake Holder Advantages of iTour2.0.

The rest of the paper is organized as follows: Section II presents an overview of related prior research. Section III highlights the novelty of this work. In Section IV an overview of the system is presented with implementation details given in Sections V and VI. The paper is concluded in Section VII.

II. Related Prior Research

An architecture for a Web-based-Tourism Information System (WTIS) is proposed in [3]. An infrastructure is presented that supports tourism enterprise cooperation between the involved organizations and resources, providing a platform for value added services. One application that uses a Context Aware Recommendation System (CARS) to recommended services to the user based on the user preferences, and which adopts to contexts other than just the Location to make more personalized recommendations, is given in [4]

The introduction of decentralized mechanisms for service based industry such as tourism address major concerns like trust, security, transparency and credibility. One such proposal is the BloHosT (Blockchain Enabled Smart Tourism and Hospitality Management). In this system a registered tourist (user) on the application will have cryptocurrency token in their wallets which can be exchanged over the server, stake holders can register using the tokens, and all actions are governed by smart contracts [5].

The recommendation systems that many applications use are based on different approaches. One such approach is the collaborative filtering based hybrid recommendation system that uses Fuzzy C-Means clustering algorithm [6]. This system integrates the user profiles, history of social networking and Point-of-Interest(POI) data.

One work that implemented a Collaborative Filtering Recommender System that addresses the data sparsity issue by adding new data which is obtained from the co-rated values computed from effective neighbors to the rating matrix is [7]. The 100K ratings dataset used for the research is from the popular movie recommendation website MovieLens. This process is proved to significantly increase the performance of the SVD method in making accurate predictions, qualifying it as a better option for recommendations system .

Table I shows some of the state-of-the art research implementations which use a variety of data, different algorithms and contexts to develop a recommendation system.

TABLE I: Comaparative Table for State-of-the-Art Literature.

Research	Algorithm	Dataset	Context
Jia et al. [8]	SVD++	Tmall Data	User, User actions
Fenza et al. [6]	FCM	Users and POI	Location, User, User profile
Zao et al. [9]	Item-Based Recommender	Video Website	User, Movies, ratings
Barathy et al. [7]	SVD	MovieLens	Users, ratings
iTour2.0 (Current Paper)	SVD	Hotel Ratings	User,hotels, ratings

III. Novel Contributions of the Current Paper

iTour2.0 provides an efficient solution for the benefit of both users and stake holders by the following novel approaches:

1) LBS (Location based Services) is the widely used technology for toursim applications. Along with LBS this paper proposes the use of Geofencing for improving the user experience and business-centric approach.
2) The application proposes a Collaborative Filtering based recommender system through user feedback, where the user response is taken from the reviews, ratings and social media posts.
3) iTour2.0 works on reducing Internet data usage by displaying all the relevant information on the user console based on their location and choices, so the user do not have to browse through many web pages.
4) The reduction in browsing time also reduces the cell phone battery usage.
5) Real-Time travel assistance, emergency services and volunteer services are available to the user to help them in case of any emergency.

IV. Proposed iTour 2.0 Framework - A Broad Overview

The development of a framework for iTour2.0 begins with identification of the resources involved. The resources are grouped as Human Resources and Non-Human Resources as shown in Figure 3.

A. Cloud Based Application Server

The databases are dynamically created using PostgreSQL. Data of new users and resources can be updated manually to the database or the data in the form of flat files can be loaded with suitable permissions and connections.

B. Notification Server

The notification system works on the geofences using the Google Location API and the beacons of the Smart Phones using Bluetooth technology [10]. Whenever user enters/exits a geofence perimeter, an event is generated. Inside geofence the notification server sends push notifications to the user.

C. Geofencing for Enhanced Tourist Experience

Geofencing is a technology that employs the Geofencing API to identify the location of the user and create a perimeter around the user and deliver relevant information to the user based on the user preferences. The location aware notification system is triggered when the user enters a certain area, as shown in Figure 5. A GPS based smart map or mobile application along with Geofencing can greatly enhance the user experience during their travel to new places. Once the user enters the perimeter they will receive push notifications on their cellphones about the deals or other advertisements in their surrounding. The stake holders can decide on the size of the area they want to capture in order to attract the required amount of visitors [11].

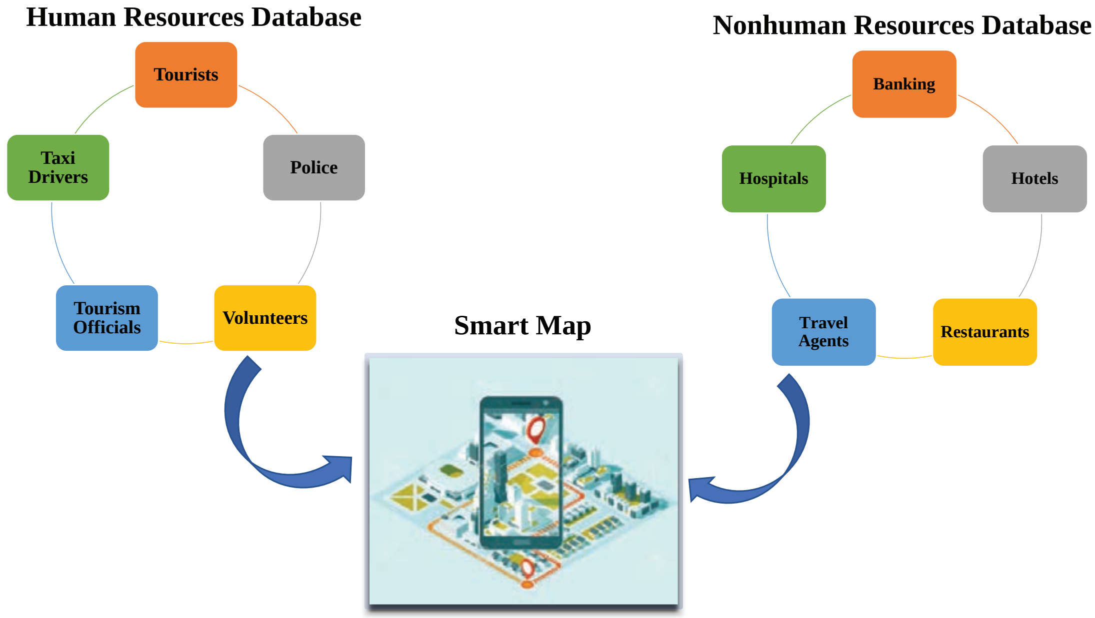

Fig. 3: iTour2.0 Resource Database Overview.

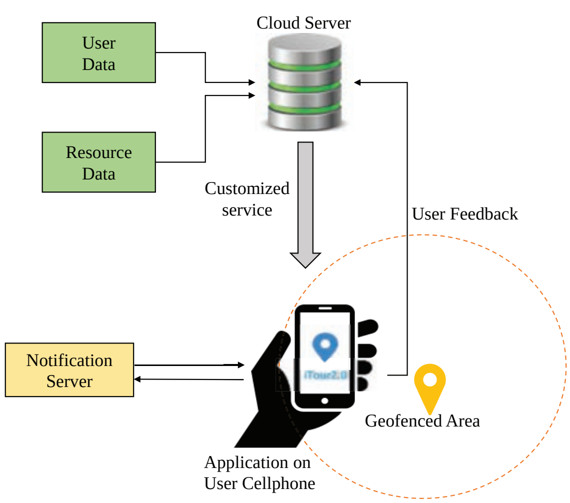

Fig. 4: Proposed iTour 2.0 Framework.

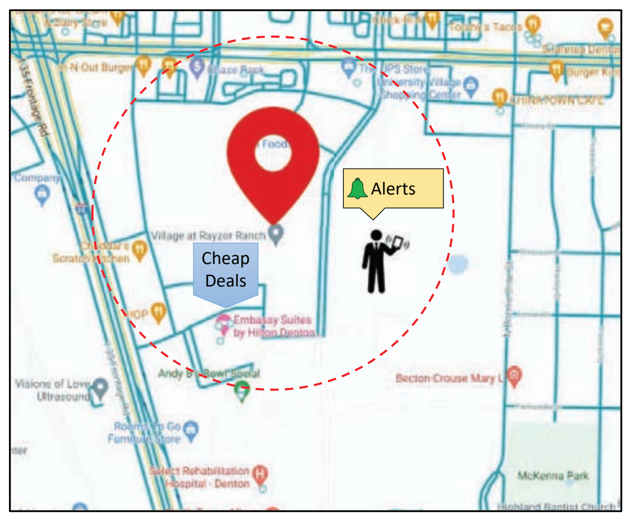

Fig. 5: Geofencing to Enhance Tourism Experience.

D. Recommender System

Recommender systems in tourism are classified as LARS (Location Aware Recommendation System), CARS (Context Aware Recommendation System) and CBRS (Critique Based Recommender System) [12]. Recommendations are based on contextual data, to make an information more user specific a recommender system considers many aspects called context like user context, environmental context or social context. The more contexts are considered, the more customized and relevant the information will be [13]. For an application like iTour2.0 which is designed for user experience needs to look at the context that can improve the recommendations. In tourism different users are moving through different environments at different time periods and using many services, in such a scenario the only context that looks valuable is the user feedback. In the year 2021 it is estimated that there are more than 3 billion users of the social networking sites, people on these sites share their reviews, ratings, opions and experiences. Some of the popular social networking sites are Facebook and Twitter, which are text based, Instagram which is picture based and Youtube which is Video based [14]. The user feedback considered in this application is the reviews/ratings/recommendations/Geotags/Hashtags/Texts that the user posts on the social media. The listed contexts fall under the interaction media context Type among the four types on contexts considered for application development. The other three contexts are Physical context, Social Context and Modal

Context [15]. Collaborative Filtering (CF) is one of the most successful recommendation techniques which has been widely studied and applied. The CF method makes recommendations for the current user based on the historical data of ratings by other users.Based on the field of application we can choose old or latest data as needed.

V. Implementation of SVD based Recommendation System

To tackle the issues of Big Data many Machine Learning and data mining techniques are being employed. Some of them are Singular Value Decomposition (SVD), Probability Matrix Factorization (PMF), Non-Negative Matrix Factorization (NMF), etc. These methods improve the performance of the recommendation system. SVD in particular manages the scalability issue by reducing the dimensionality of the Recommender system and it can be used for prediction tasks. To implement a recommender system for hotels in a given user location we have consider the user location, hotel reviews and ratings. Based on the user location the SVD algorithm comes up with an estimated value for best probable context considered here as the threshold value. The application used is SurPRISE (Simple Python Recommendation Sytem Engine), which is a python package for building and analyzing recommender systems.To train the algorithm we have used data from 50 different users for 10 different hotels with a total of 500 ratings with preference rating rate 1-5 and 0 for no preference or rating for the place. Table II shows the RMSE (Root Mean Squared error) and MAE (Mean Absolute Error) values obtained for a 5-fold Cross-Validation of the test data generated by splitting the data into test set and training set.For an ideal model the RSME and MAE must be close to 0. From Table 1 it is seen that RSME and MAE values are less than 1 and close enough to 0.

TABLE II: Table of RMSE and MAE Values.

	Fold 1	Fold 2	Fold 3	Fold 4	Fold 5	Mean
RMSE (test)	0.9862	0.8274	0.9171	1.0721	0.9564	0.952
MAE (test)	0.7892	0.6689	0.7369	0.8025	0.7203	0.744
Fit Time	0.04	0.05	0.03	0.04	0.03	0.04
Test Time	0.00	0.00	0.00	0.00	0.00	0.00

The recommender system is written in python using the surPRISE packages and modules. The threshold for recommending is set using the prediction estimation. The result of one sample is shown in Figure 6.

```
1142
[{'id': 5, 'hotel_name': 'Hilton', 'average_rating': 5}]
3.455982208351275
[{'id': 6, 'hotel_name': 'Paradise', 'average_rating': 4}]
```

Fig. 6: Recommended Hotels with Best Average Rating.

To test the prediction accuracy for a large set of data, we used a 10K dataset and ran the SVD algorithm without adding additional contexts and increasing the unknown neighbors of the matrix. The algorithm was run for 5-Fold cross validation with 10 epochs. The RMSE decreased with each run of the epoch as shown in Table III with no added context or just using the most valuable context only.

TABLE III: Table of RMSE and MAE Values for 10K Data.

	Fold 1	Fold 2	Fold 3	Fold 4	Fold 5	Mean
RMSE (test)	0.64	0.60	0.63	0.60	0.57	0.61
MAE (test)	0.30	0.28	0.28	0.27	0.28	0.28
Fit time	0.25	0.25	0.26	0.26	0.30	0.26
Test time	0.01	0.01	0.01	0.01	0.01	0

Table IV shows the performance of 10 recommender algorithms. This data will be used as a reference to build a recommender system.

TABLE IV: Comparison Table of Various Algorithms.

Algorithm	RMSE	MAE	Time
SVD	0.946	0.733	0:00:00
SVD++	0.963	0.751	0:00:00
NMF	1.104	0.862	0:00:00
Slope One	1.104	0.862	0:00:00
k-NN	1.104	0.862	0:00:00
Centered k-NN	1.104	0.862	0:00:00
k_NN Baseline	0.956	0.743	0:00:00
Co-Clustering	1.104	0.862	0:00:00
Baseline	0.956	0.743	0:00:00
Random	1.623	1.341	0:00:00

From the above comparison table we can see that the closest values to 0 of the RMSE and MAE are from the SVD algorithm. Finally, we look at the results of various state-of-the-art Literature and their algorithms to understand the effect of context in the recommendation systems, as in Table V.

TABLE V: Comparative Table of State-of-the-Art Literature RMSE Values.

Research	Algorithm	No of Records	RMSE
Jia et al. [8]	SVD++	100,000	0.9116
Fenza et al. [6]	FCM	1000	0.811
Zao et al. [9]	Item-Based Recommender	800	1.057
Barathy et al. [7]	SVD	100,000	0.939
iTour2.0 (Current Paper)	SVD	10,000	0.6375

VI. Implementation of overall iTour2.0 Framework

The data required for implementation is created in various files and loaded into the PostgreSQL database as different data tables. For this implementation the database is local, but we can also connect to the cloud databases and retrieve data for further testing and implementation.

1) iTour2.0 Application: The iTour2.0 application is built on the Linux operating system using python and leaflet. PostgreSQl is used to create the relational databases to hold the data about the resources. PostGIS is used to add the geospatial objects to the location data in the database. The leaftlet API and GeoJSON is used for creating the interactive smart map along with pandas for manipulating the data for analysis. The interactive smart map homepage is shown in Figure 7.

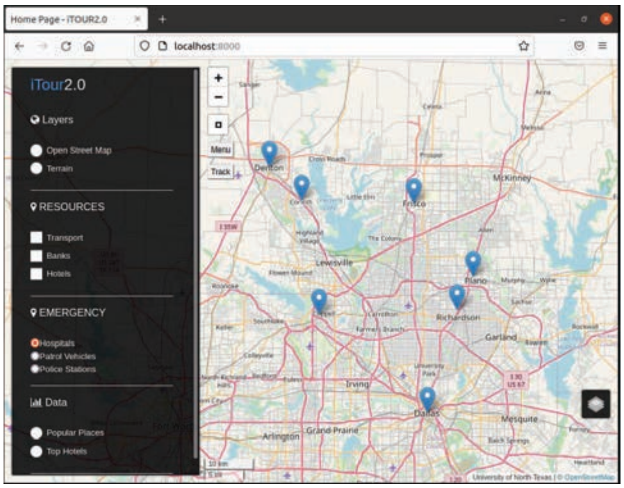

Fig. 7: iTour2.0 Application Homepage.

2) Resource Database: The services and stakeholders involved in the tourism application are grouped into two separate databases. The databases are created in Oracle DB under two schemas: HR-DB for Human Resources and NHR-DB for Non-Human Resources. The tables in the databases contain sample data used for this implementation. The data is tested by running SQL queries to retrieve the useful information.

3) Services Menu: The services menu displays all the available services, such as Banks, Hotels, Hospitals and emergency services. When the user makes a choice, the display changes to that particular page where all the services around the user location are displayed on the google maps and the interactive map will show pop up information when the user touches the marker of interest. The pop ups can be telephone numbers in case of hospitals/Police/Volunteers and in case of other services the pop up will be a link to the website or just an image, depending on the site.

4) Interactive Smart Map: The smart map is generated using the Folium visualization tool which uses leaflet.js libraries and many other Markers and styling functions to create an interactive map through python. For testing the functionality of the map, data from the Oracle databases are imported into a *.xlsx file where the location coordinates are manually entered. A python code will retrieve the data from the sample *.xlsx file and create an html file based on the location which shows the areas of interest around that location.

The html file can be opened in the desired web browser. A sample html file opened in the google chrome browser is shown in Figure 8.

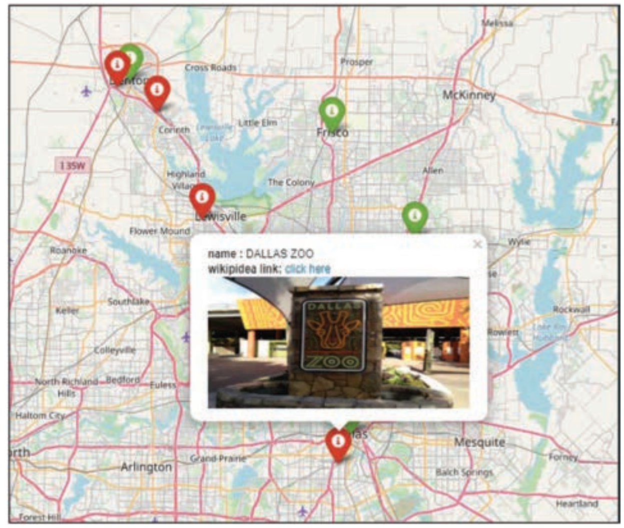

Fig. 8: Map Generated from Html File.

Performance testing is done on the web application to test the performance of the application. In this paper, we have done the load testing to determine whether the web application can handle high load requirements or not. Load testing is done by simulating multiple user access to the web services concurrently. Load Test set up:

- Number of users = 100
- Ramp-Up Period = 100s
- Loop Count = 10

With a loop count of 10, 1000 samples are generated with delay of 1s between each user request. The statics of the load test and the throughput of the test are shown in Table VI and Table VII, respectively.

TABLE VI: Statistics Table of Load Test

Requests	Executions			Response Times(ms)
Label	Samples	Fail	Error %	Average
Total	3000	0	0.00%	18.52
HTTP Request	1000	0	0.00%	27.84
HTTP Request-0	1000	0	0.00%	16.28
HTTP Request-1	1000	0	0.00%	11.43

TABLE VII: Throughput and Network Statistics.

Requests	Throughput	Network(KB/sec)	
Label	Transactions/s	Received	Sent
Total	30.26	38.92	5.18
HTTP Request	10.09	19.46	2.59
HTTP Request-0	10.09	2.56	1.29
HTTP Request-1	10.09	16.91	1.3

For the second instance of load testing we increased the number of users to 1000 and maintained the same ramp-up time and loop count. The results of the load test shows an improved throughput with error rate 0.03%. The error rate is negligible and all the transactions were successful. The network usage and throughput are shown in Table VIII where RT is Response Times.

TABLE VIII: Throughput of 1000 Users.

Requests	Throughput	RT(ms)	Network(KB/sec)	
Label	Transactions/s	Average	Received	Sent
Total	30000	1712.13	285.3	37.97
HTTP Request	10000	2568.22	73.92	18.99
HTTP Request-0	10000	696.22	73.93	9.46
HTTP Request-1	10000	1871.93	73.95	9.53

The performance graph of the latency for the number of requests is shown in Figure 9.

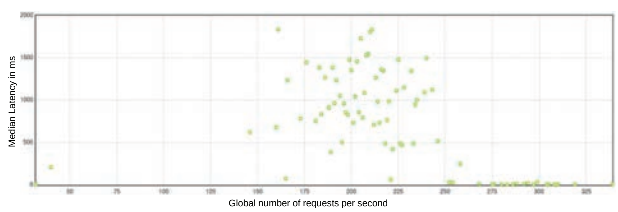

Fig. 9: Latency Vs Request.

The response Time for the HTTP Requests is shown in the graph in Figure 10.

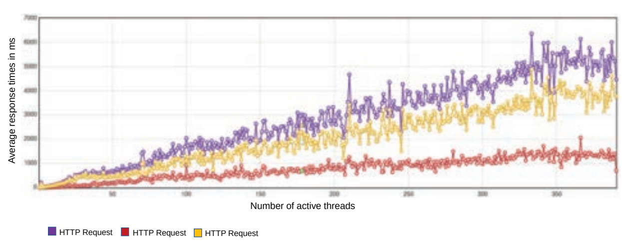

Fig. 10: Time Vs Request Threads.

From the load test results it is seen that the web application can handle 1000 users without any failures.

VII. Conclusions

Tourism is an essential part of the economy. The driving technologies of smart cities like ICT and IoT help to design better solutions for tourism based applications that help in safe and comfortable mobility of tourists to new places. Mobile applications within the IoT framework, like iTour2.0, are an essential tool to aid the improvement in the way people travel and experience the social, cultural, recreational and commercial environments of a given place. Adding Geofencing to the tourism application open avenues for better marketing of local business and gives more exposure to the tourists about the commercial opportunities/deals available around them. The use of a feedback based recommender system helps tourists make choices that are economic, fair priced and improve quality of experience. The addition of contextual data to the user preferences gives room for better personalization of the information. The application can further be developed to provide data privacy and security through enabling technologies like the blockchain. By considering more observable contexts regarding a destination Location/City, like the current social/political/climate conditions the recommender system will be able to provide more information for tourism planning.

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