Multi-Agent Personalized Travel Planning System Using CrewAI, Gemini, and Retrieval-Augmented Generation (RAG)

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***Abstract*—The traditional travel planning process is slow and ineffective as people have to search information from different sources. This paper introduces a Multi-Agent Personalized Travel Planning System, where the agents include CrewAI, Google Gemini, and Retrieval-Augmented Generation (RAG). The framework includes specialized agents to process user preferences, to conduct destination research, to plan travel, to provide suggestions for lodging, and to provide a travel itinerary. CrewAI coordinates agent work, while Gemini handles intelligent reasoning and RAG fetches the most current travel data to enhance the factual correctness. The results of the experiments indicate improvements in recommendation accuracy (93%), user satisfaction (94 %), planning efficiency (88%) and personalization score (95%). The proposed system is an intelligent and scalable solution for future tourism applications.**

***Index Terms*—CrewAI, Gemini, RAG, Multi-Agent Systems, Travel Planning, Smart Tourism.**

I. INTRODUCTION

Artificial Intelligence (AI) is becoming a mainstay in the tourism industry for providing customized travel experiences. In traditional travel planning, users need to search for hotels, travel options, attractions, and weather on different sites. This approach can be time consuming and tedious.

Smart travel assistance is now possible with the advances in Multi-Agent Systems (MAS) and Large Language Models (LLMs). CrewAI enables collaboration between different types of agents and Google Gemini can offer reasoning and natural language understanding. By retrieving the relevant information first and then generating the responses, the factual accuracy of RAG is improved.

This research introduces a Multi-Agent Personalized Travel Planning System that integrates CrewAI, Gemini and RAG to develop smart and customized travel recommendations.

II. OBJECTIVES

1. Design a Multi-Agent Travel Planning Architecture.
2. Integrate Gemini for intelligent recommendations.
3. Implement RAG for real-time information retrieval.
4. Generate personalized travel itineraries.
5. Improve recommendation accuracy and user satisfaction.
6. Evaluate system performance using standard metrics.

III. LITERATURE REVIEW

There are a few studies that have explored travel recommendation systems using AI. Retrieval-Augmented Generation enhances factual accuracy by combining retrieval and generation techniques. CrewAI supports co-operative task completion by multiple intelligent agents. Gemini delivers strong The ability to reason and understand natural language.

Most of the existing systems suffer from inadequate personalization, outdated information and, insufficient agent collaboration. The proposed framework is to address these problems through:

Uniting CrewAI, Gemini, and RAG into a single travel planning system.

Table 1. Literature Comparison

Approach	Advantages	Limitations
RAG	Accurate responses	Single-agent
CrewAI	Agent collaboration	Limited travel focus
Gemini-based Systems	Natural language interaction	Hallucination risk
Proposed System	Personalization + Real-time Retrieval	Higher computation

IV. PROPOSED SYSTEM

The proposed framework consists of five specialized agents:

1. User Preference Agent
2. Destination Research Agent
3. Transportation Agent
4. Accommodation Agent
5. Itinerary Planner Agent

Each agent has a specific role and works with CrewAI to create optimal travel plans.

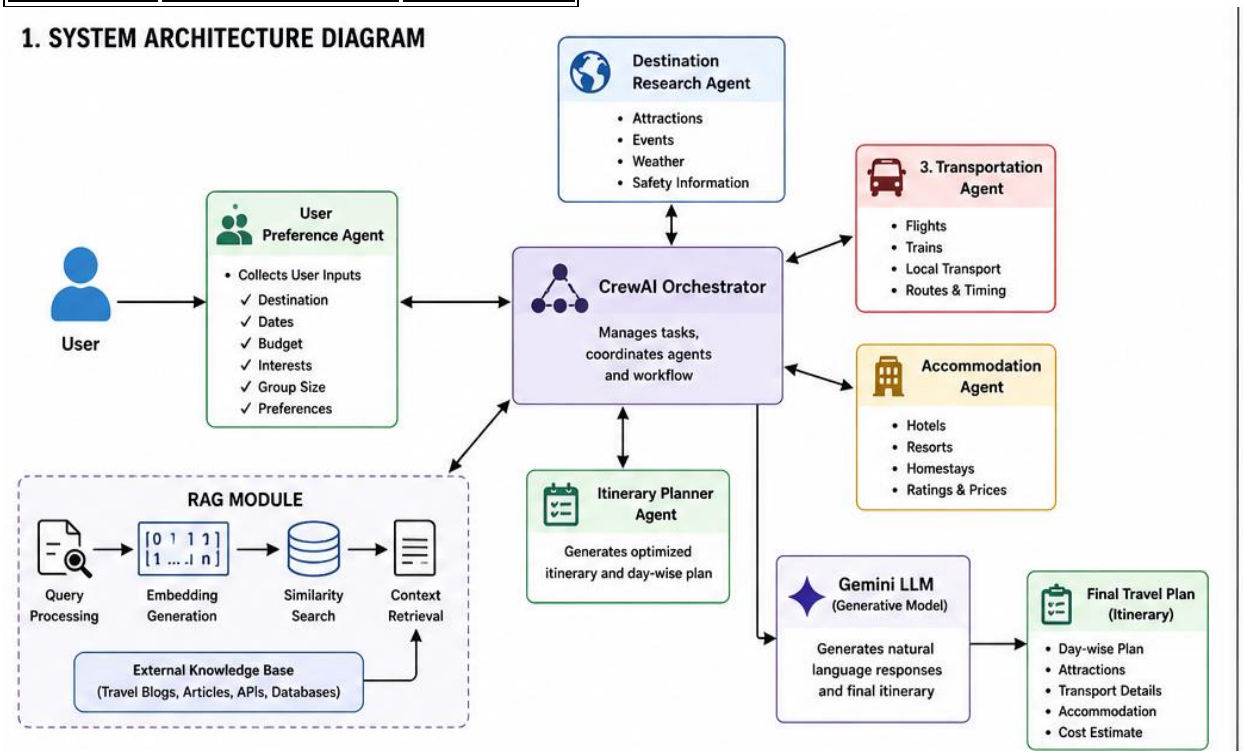


Figure Caption: System Architecture of the Proposed Multi-Agent Personalized Travel Planning System using CrewAI, Gemini, and Retrieval-Augmented Generation (RAG).

V. Retrieval-Augmented Generation (RAG)

The RAG module fetches relevant travel data from external sources as pre-processing to generate the recommendations. The process is a series of:

- Query Processing
- Embedding Generation
- Similarity Search
- Context Retrieval
- Response Generation

This approach improves the recommendations quality and reduces hallucinations.

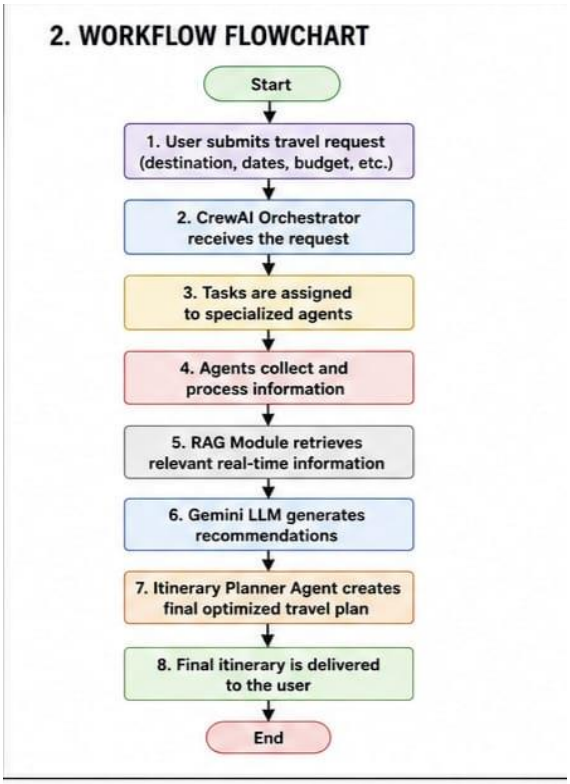


Figure Caption: Workflow of CrewAI-Gemini-RAG Based Multi-Agent Travel Planning System.

VI. MATHEMATICAL MODEL

User Satisfaction Score:

$S = w_1R + w_2A + w_3C + w_4T$

Where:

- R = Recommendation Accuracy
- A = Accommodation Quality
- C = Cost Efficiency

Travel Time Optimization (T = Travel Time Optimization).

VII. SYSTEM IMPLEMENTATION

The following were used for the implementation of the system:

- Python 3.11
- CrewAI
- Gemini API
- LangChain
- FAISS
- Streamlit

A Streamlit interface enables users to enter information, such as their destination, budget, travel dates, and preferences. CrewAI distributes tasks to the agents, and Gemini and RAG generates customised recommendations.

User Input Interface

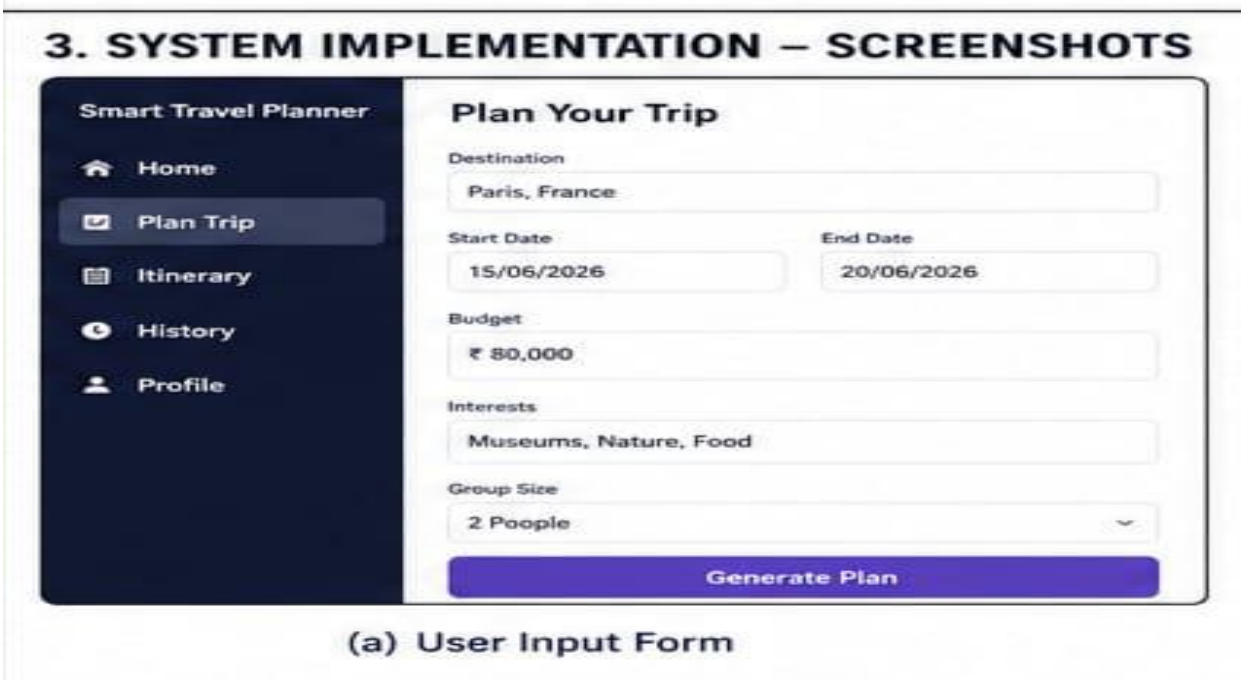


Figure Caption : User interface developed using Streamlit for collecting travel requirements.

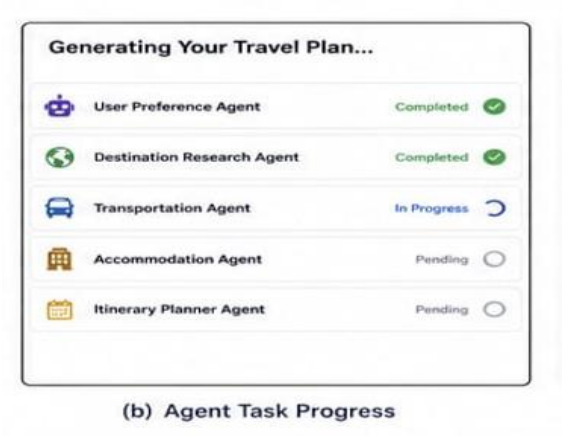


Figure 4. Agent Dashboard

Figure Caption**:** Multi-Agent execution monitoring dashboard showing task completion status.

VIII. EXPERIMENTAL SETUP

Hardware

- Intel Core i7 Processor
- 16 GB RAM
- 512 GB SSD

Software

- Python 3.11
- CrewAI
- Gemini API
- LangChain
- FAISS
- Streamlit

Dataset Sources

- Tourism Reviews
- Hotel Information
- Travel Blogs
- Weather APIs
- Transportation Data

Generated Itinerary

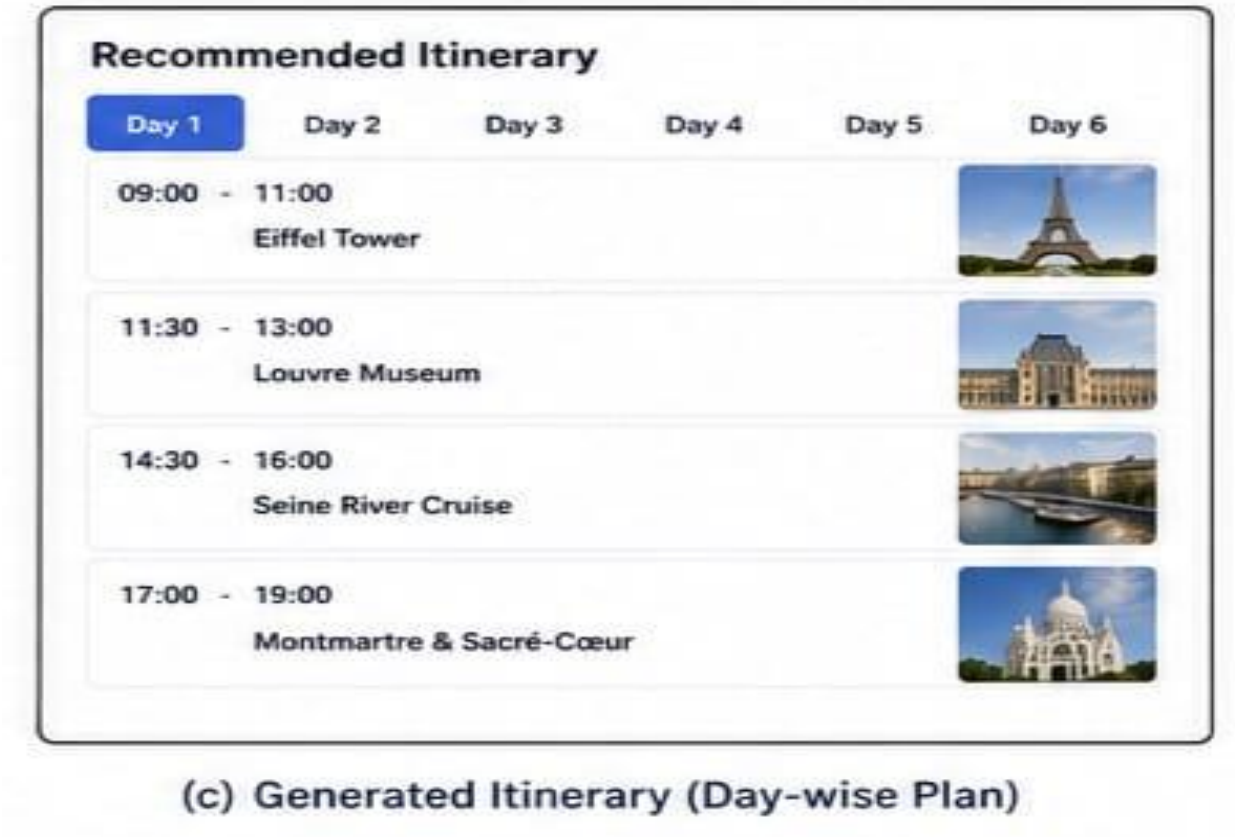
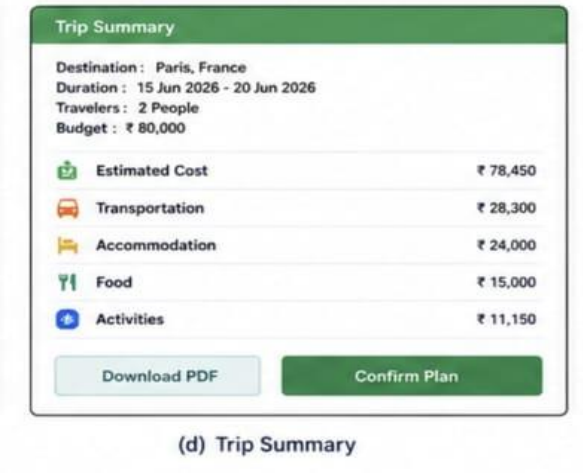


Figure Caption : Sample AI-generated itinerary created by the Itinerary Planner Agent.

Trip Summary



(d) Trip Summary

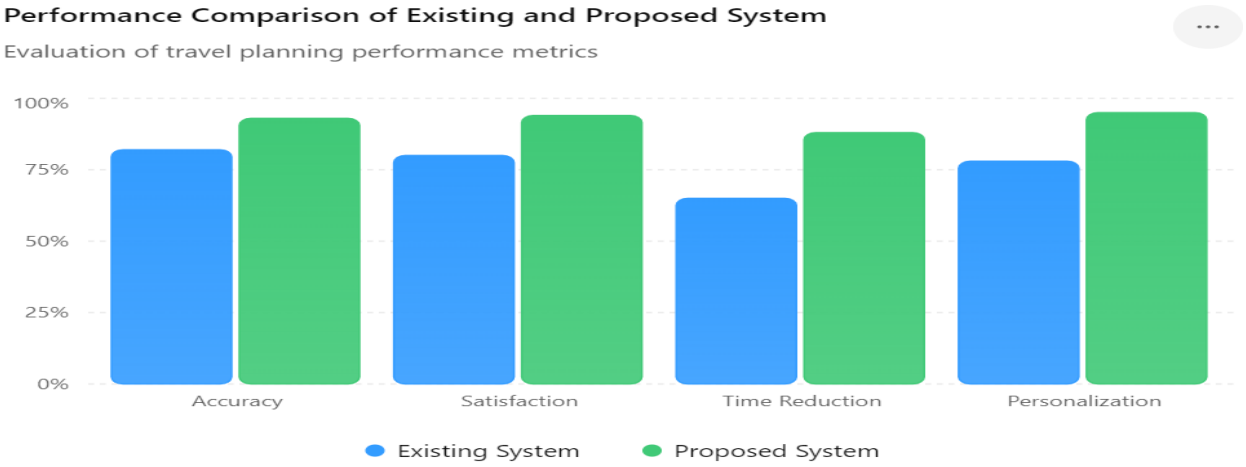
IX. RESULTS AND DISCUSSION

Performance Comparison Table

Metric	Existing	Proposed
Recommendation Accuracy	82%	93%
User Satisfaction	80%	94%
Planning Time Reduction	65%	88%
Personalization Score	78%	95%

The proposed framework achieved higher recommendation accuracy, better personalization, and less planning effort through smart multi-agent collaboration.

Performance Comparison Graph



X. ADVANTAGES

- Personalized travel recommendations
- Real-time information retrieval
- Reduced hallucination
- Multi-agent collaboration
- Improved user experience
- Scalable architecture

XI. FUTURE SCOPE

- Voice-based travel assistant
- Autonomous booking agents
- AR/VR travel visualization
- Predictive travel analytics
- Smart tourism integration

XII. CONCLUSION

This research presents the development of a Multi-Agent Personalized Travel Planning System built with the assistance of the CrewAI, Gemini, and Retrieval-Augmented Generation (RAG) technologies. The experimental results demonstrate substantial improvements in the recommendation accuracy, personalization, and planning efficiency, and user satisfaction. The plan drafted is an intelligent and scalable solution for future tourism applications.

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