1. Introduction

Tourism is a vital component of the global economy, with the sector contributing an estimated USD 3.5 trillion to the world's gross domestic product in 2019 according to the United Nations World Tourism Organization (UNTWO) (1). Indonesia, known for its diverse landscapes and cultural attractions, is one of many countries that rely on tourism to drive economic growth. In fact, tourism is the second-largest contributor of foreign exchange to Indonesia's GDP (2).

Due to the high tourism demand, many travel agents have been emerging, offering various travel plans. However, relying on a travel agent to plan a trip can be expensive, and the plans may not always align with the tourist's preferences. Therefore, to satisfy the tourist experience and maximize the economic benefits of tourism, researchers have developed personalized tourism route recommender systems. To address these issues, these systems aim to provide tourists with personalized itineraries that meet their needs and preferences without needing a costly travel agent.

A tourism route recommender system optimizes a tourist's traveling route by covering their desired attractions and needs. The problem can be modelled as a Traveling Salesman Problem (TSP) with multiple constraints solved using optimization methods. These methods, which include swarm-based approaches such as the Ant Colony Optimization (3), the Simulated Annealing (4), Genetic Algorithm (5), and the Firefly Algorithm (6), can effectively plan out a tourist's route to cover their desired attractions optimally. There have been several previous studies on generating travel route recommendations using heuristic methods. For example, Uwaisy et al. (7) used tabu search to generate recommendations for N-days travel routes. However, their research was limited to generating recommendations for a maximum of three days and only considered a small number of nodes.

Nonetheless, the complexity of these heuristics algorithms increases with the scale of the problem, limiting their scalability for large-scale applications (8). Likewise, the use of machine learning and deep learning in route recommendation (9; 10; 11) has gained popularity in recent years due to their ability to handle large datasets and make more accurate predictions. In a study using real-world datasets, machine learning approaches were shown to outperform heuristic methods in terms of route recommendation accuracy (12)

This paper proposes a method for optimizing N-days travel plans to maximize the number of destinations visited following user preferences. This is a challenging problem, as the itinerary must consider multiple criteria, including the number of destinations to be visited, the popularity of a destination, and the cost of visiting a destination. To generate a tour that satisfies the given criteria, we propose a method using a reinforcement learning (RL) approach that incorporates Q-learning and the Multi-Attribute Utility Theory (MAUT) as the reward scheme. RL is a subfield of machine learning in which agents learn to navigate their environment by taking a series of actions in pursuit of maximizing cumulative rewards (13).

Our dataset for this study consists of tourist attractions and hotels in the Special Region of Yogyakarta, Indonesia, sourced from Google Maps. In addition, information on traffic patterns, operating hours, and entry fees for each tourist attraction was also obtained from Google Maps.

The remainder of the paper is organized as follows: Section 2. discusses related work on tourism route recommendation systems, and Section 3. presents our proposed approach in detail. In Section IV, we present the results of our experiments. Finally, in Section VI, we provide conclusions and future work.