Recommendation for Scheduling Tourist Routes Using Particle Swarm Optimization (Case Study of Yogyakarta)

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I. INTRODUCTION (*HEADING 1*)

Tourism is a global industry that involves the dissemination of vast volumes of information [1]. In another word, in the global economy and our daily lives, tourism is a significant industry [2]. Until the end of 2019, with about 1.47 billion international travelers earning $1.7 trillion in international tourism profits [3].

Known for its diversity and diverse landscapes, Indonesia has a wide range of tribes, civilizations, races, religions, and natural beauty. Furthermore, Indonesia offers a diverse set of industries that can help the country's foreign exchange. One of them is the tourism industry, which is the largest foreign exchange for the country. Additionally, research has shown that the Indonesian tourism industry is likely to grow from 2020 to 2024 as a result of increased international travel and foreign exchange [4]. It is clear that the tourism industry in Indonesia will expand substantially in the future.

Many tourists, both domestic and international, are interested in taking a few days to explore new destinations. In this situation, travel agencies will be offering their services to new tourists who have never been to destination before. However, travel agencies may provide less effective or unpleasing services due to the fact that tourists are unable to select their destination. According to a study by Uwaisy et al [5] tourists who have never visited find it difficult to choose tourist attractions without the assistance of travel agencies. When tourists travel without relying on travel agencies, several factors must be considered, including the distance from where they will stay, the projected distance between tourist locations, and operating hours. Therefore, the goal of this research is to create a system that provides personalized tourist route recommendations to enable tourists to travel independently without relying upon travel agencies.

Earlier studies have shown that the Traveling Salesman Problem (TSP) contributes to some of the problems tourists encounter. A personalized tourist route recommender system provides the solution by finding optimal travel routes for tourists without addressing a number of important considerations. Several swarm intelligence approaches are widely used and have been taken to solve TSP problems are Firefly Algorithm [6], Ant Colony Algorithm [7], Artificial Bee Colony [8] and Particle Swarm Optimization [9].

Particle swarm optimization (PSO) is one of the most often used evolutionary methodologies for optimization problems. PSO is based on the notion of swarm intelligence, in which a number of individuals collaborate to discover the optimum solution [10]. PSO has been effectively employed in numerous optimization situations in recent years [11], including function optimization [12], image processing [13], and automated control [14]. The conventional PSO algorithm is not suitable for directly solving the TSP, as it is a discrete optimization problem rather than a continuous optimization problem. PSO was initially proposed as a method for solving the TSP by Clerc [15] in 2004. Various modified variants of the PSO method have been presented over time, especially for handling discrete optimization problems such as the TSP. For instance, a hybrid algorithm for solving the TSP was proposed that combined the swap sequence-based PSO method with ant colony optimization (ACO) and the K-opt operation [16].

Discovering an appropriate tourist route that fits user preferences and constraints has been a focus of research in the demanding field of tourism recommendation systems. Various optimization solutions have been proposed in the literature, such as Baizal et al [17] method for developing a travel route itinerary with multiple constraints such as daily travel time limits, opening/closing hours, and the average duration of stay for each tourist attraction in a few days. In terms of running time, the authors demonstrated that the Simulated Annealing Algorithm beat the Ant Colony Algorithm.

In this paper, we propose to use the PSO algorithm to solve an optimization problem in the field of tourism. Specifically, we aim to develop an optimal route recommendation mechanism for tourism itineraries using the PSO method to find the optimal N-Day travel plans that satisfy user preferences.

To achieve this goal, we integrate the PSO algorithm with the Multi-Attribute Utility Theory (MAUT) concept. MAUT is a decision-making method that considers multiple interconnected factors or criteria in order to reach the optimal results [18]. By doing so, we can take into account multiple factors that affect the tourists' decisions when planning their trips, such as the number of destinations to visit, the duration of stay at each destination, the distance between destinations, and the preferences of the tourists. The PSO algorithm then

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searches for the optimal travel plan that maximizes the number of destinations visited while satisfying the tourists' preferences.

Therefore, our proposed method for optimizing N-Day travel plans is a combination of the PSO algorithm and the MAUT concept, which provides a powerful and flexible tool for designing optimal tourism itineraries.

In this research, we employed Google Maps as a data source to collect information about tourist attractions and hotels situated in the Special Area of Yogyakarta, Indonesia. Google Maps furnished us with valuable data pertaining to traffic conditions, operational timings, and entrance fees associated with each tourist destination.

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