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Web-Based Internship Scheduling System for Imelda Medan Vocational High School of Tourism Students Using the Ant Colony Optimization (ACO) Method

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A R T I C L E I N F O

Keywords:

Field Work Practice (PKL), Scheduling System, Web-Based Application, Ant Colony Optimization (ACO), Vocational High School.

ABSTRACT

Field Work Practice (PKL) is an important component of vocational education that provides students with real workplace experience. However, scheduling PKL activities often encounters problems such as overlapping schedules, mismatched student quotas, and inefficient time management. At Imelda Medan Vocational High School of Tourism, the scheduling process is still done manually, which often leads to errors and delays. This study proposes a web-based PKL scheduling system using the Ant Colony Optimization (ACO) method to generate optimal and efficient schedules. The ACO algorithm imitates the behavior of ants in finding the shortest path, making it suitable for solving complex scheduling problems. The system is expected to minimize schedule conflicts, balance student placement, and simplify data management for schools, students, and partner industries.

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INTRODUCTION

Field Work Practice (PKL) is one of the essential activities in the vocational education curriculum that aims to provide students with real work experience. Through this activity, students can apply the knowledge they have learned in school to actual workplace situations. However, in practice, the PKL scheduling process often faces various challenges, particularly in the distribution of placements, time allocation, and the number of students that must match the capacity of partner industries.

At Imelda Medan Vocational High School of Tourism, the PKL scheduling system is still carried out manually using spreadsheets or written records. This manual process often causes problems such as schedule conflicts among students, mismatches between the number of students and industry quotas, and errors in setting the implementation period. As a result, the efficiency of PKL implementation decreases, and it often takes a long time to produce an optimal schedule[1]

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To overcome these problems, a web-based system is needed to assist the school in performing scheduling automatically, quickly, and accurately. With such a system, all student data, internship locations, and schedules can be managed centrally and accessed easily[2]

In this study, the researcher applies the Ant Colony Optimization (ACO) method to optimize the scheduling process. The ACO method imitates the behavior of ants in finding the shortest path to a food source, which can mathematically be used to find optimal solutions in complex problems such as scheduling. By implementing this method, the system is expected to produce efficient PKL schedules, minimize schedule conflicts, and balance the distribution of students across internship locations[3]

Thus, the design of a web-based PKL scheduling system using the ACO method is expected to improve the effectiveness of schedule management, reduce the administrative workload of supervising teachers, and provide convenience for students and industry partners in obtaining real-time PKL schedule information[5]

METHODS

The stages of this research are carried out systematically to design and implement a web-based internship scheduling system using the Ant Colony Optimization (ACO) method. The steps are as follows:

1. Problem Identification
   The initial step involves identifying the problems faced by Imelda Medan Vocational High School of Tourism in scheduling Field Work Practice (PKL). Observations and interviews were conducted to understand the difficulties in manual scheduling, such as overlapping schedules, limited placement quotas, and inefficient time allocation.
2. Goal Setting
   The main objective of this research is to develop an automated scheduling system that can optimize the placement of students in internship locations based on capacity, time, and fairness criteria using the ACO method.
3. Literature Review
   To support this study, relevant literature, journals, and previous research related to scheduling systems, optimization algorithms, and specifically the Ant Colony Optimization (ACO) method were reviewed. The review serves as a theoretical foundation for the system design and algorithm implementation.
4. Data Collection
   Data were collected from the school, including student data, internship site information, and available time periods. Interviews with teachers and industry partners were also conducted to determine the constraints and requirements needed in the scheduling process.
5. System Design and ACO Implementation
   The system is designed using web-based technology, allowing administrators to input and manage student and internship data easily. The ACO algorithm is then applied to generate optimal scheduling results. The algorithm works by simulating the behavior of ants in finding the shortest and most efficient path, which in this context represents the best distribution of students to internship locations while minimizing schedule conflicts.
6. Testing and Evaluation

The developed system is tested using real data from the school to evaluate its accuracy and performance. The testing phase includes comparing manual scheduling results with ACO-based scheduling to measure improvements in efficiency, time reduction, and fairness of student placement. Feedback from teachers and administrators is also collected to assess system usability and reliability.

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Ant Colony Optimization (ACO) Method

Ant Colony Optimization (ACO) is a metaheuristic algorithm inspired by the foraging behavior of ants in finding the shortest path between their nest and a food source. In this research, ACO is used to find the optimal arrangement of students, internship places, and schedules. Each "ant" represents a potential scheduling solution, and pheromone trails are used to reinforce good solutions over iterations. The algorithm evaluates each solution based on constraints such as student preferences, company capacity, and time availability until the most optimal schedule is obtained.

Web-Based System Design

The proposed system is developed using web technologies such as PHP**,** MySQL, and Bootstrap for the interface. The system allows for centralized data management and automatic generation of schedules. Key features include data input for students and internship sites, automatic optimization using ACO, and real-time display of schedules. The system also provides reports for administrators, teachers, and students.

The Ant Colony Optimization (ACO) method is applied in this study to generate optimal solutions for scheduling student internships efficiently. ACO is a metaheuristic algorithm inspired by the behavior of real ants in finding the shortest path between their nest and a food source. The ants communicate indirectly through pheromone trails, which strengthen over time along favorable paths.

In this research, the ACO algorithm is used to determine the best combination of student placements, internship locations, and time schedules while minimizing conflicts and balancing distribution. Each ant represents a possible scheduling solution, and through multiple iterations, pheromone updates guide the search toward the most optimal arrangement.

Mathematically, ACO is effective for solving combinatorial optimization problems such as scheduling, routing, and resource allocation. The formal theory behind ACO is based on the concept of positive feedback, distributed computation, and probabilistic solution construction, which makes it well-suited for complex, dynamic systems like internship scheduling.

By implementing the ACO method, the developed web-based system can automatically produce schedules that meet constraints such as company capacity, available time slots, and fairness among students. This approach enhances efficiency, reduces human error, and improves overall management of internship activities at Imelda Medan Vocational High School of Tourism.

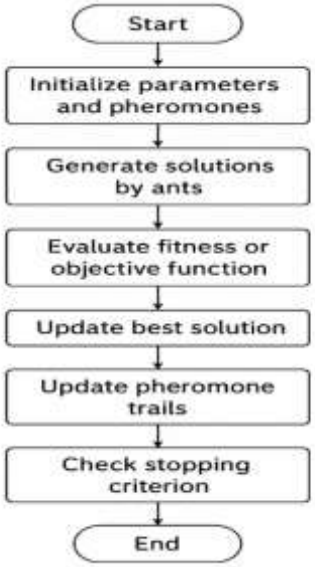

Figure 1. Process Ant Colony Optimization Method

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RESULTS AND DISCUSSION

The results of the Ant Colony Optimization (ACO) process in the web-based internship scheduling system, after importing the student internship data into the system, have been analyzed using the path construction, pheromone updating, and probability evaluation stages. The generated optimized scheduling results are displayed in the following figure:

Figure 2. Process Login

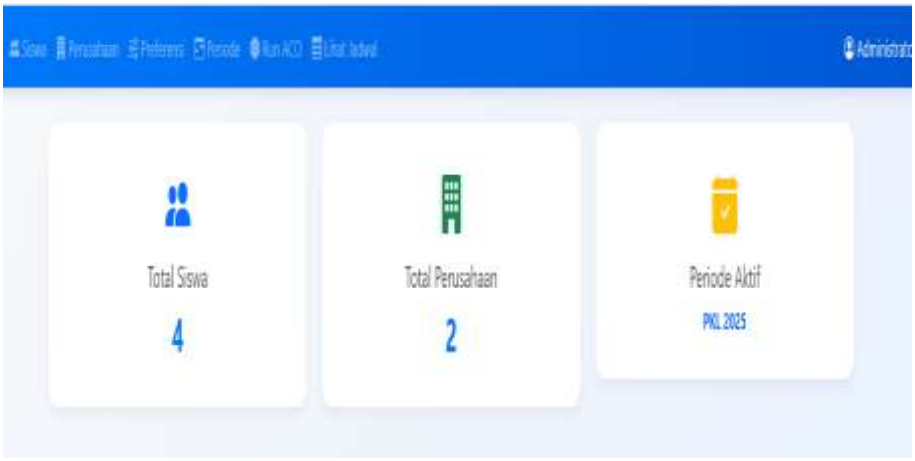

Figure 3. Process Dashboard

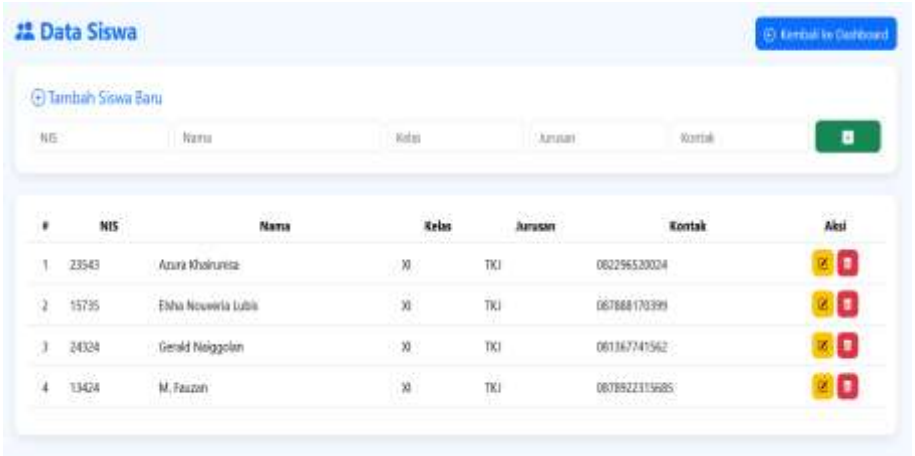

Figure 4. Process Siswa

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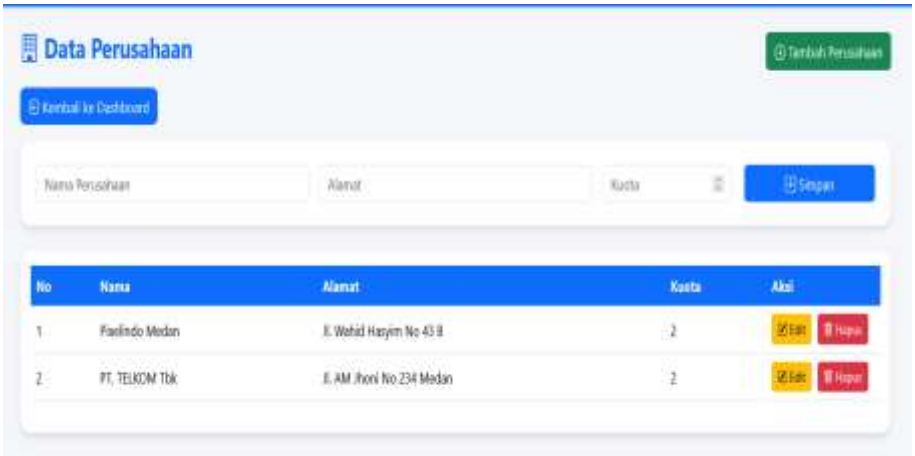

Figure 5. Process Siswa

Figure 6. Process Periode

Figure 7. Process Algoritma ACO

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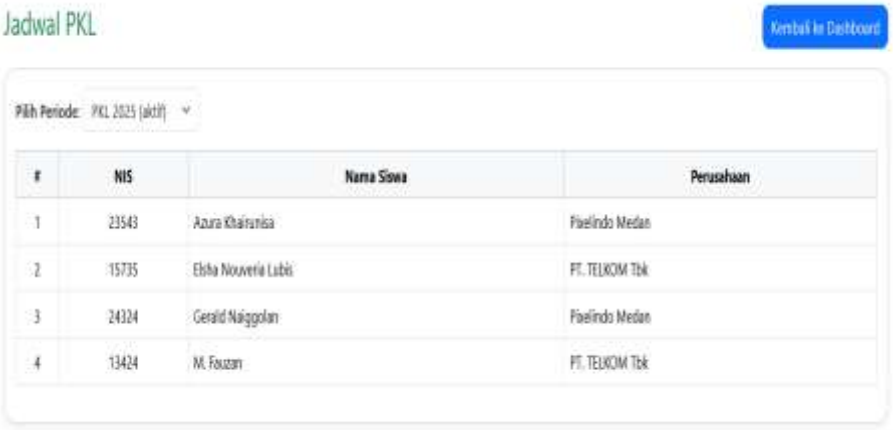

Figure 6. Process Algoritma ACO

CONCLUSION

This study successfully developed a web-based internship scheduling system for students of Imelda Medan Vocational High School of Tourism **using the** Ant Colony Optimization (ACO) method. The implementation of ACO proved effective in optimizing the scheduling process by minimizing conflicts, balancing the distribution of internship placements, and reducing manual workload for school administrators. Through this system, internship schedules can be generated automatically and more efficiently based on predefined constraints such as student preferences, partner availability, and time allocation. The results demonstrate that ACO can serve as a reliable optimization approach for complex scheduling problems in educational environments.

Future development of this system could include integrating real-time monitoring features, adaptive pheromone updates, and a broader range of constraint parameters to further enhance scheduling accuracy and flexibility.

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