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Development of Adaptive Lecture Scheduling System using Genetic Algorithm Case Study: Ahmad Dahlan Institute of Technology and Business

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ABSTRACT

Optimal course scheduling is a crucial aspect in supporting the efficiency of the teaching and learning process in higher education. In many institutions, lecture scheduling is still done manually or with static methods that are not adaptive to changing needs and limited resources. This research aims to develop an adaptive lecture scheduling system using genetic algorithms, with a case study at ITB Ahmad Dahlan. Genetic algorithms were chosen because of their ability to solve complex optimization problems with high efficiency, such as managing dynamic variables such as lecturer availability, rooms, and lecture time preferences. In this research, data related to courses, lecturers, time, classroom availability, and curriculum requirements are integrated into the designed system to generate an optimal course schedule. The development process involved several key stages, including requirements analysis, system design, algorithm implementation, and performance evaluation. Genetic algorithm implementation is done by simulating various scheduling scenarios to find the most optimal solution. The results show that the developed system is able to produce a more efficient and clash-free course schedule compared to traditional scheduling methods. In addition, the system also allows higher flexibility in adjusting the schedule to changes that may occur, such as the addition or reduction of classes. Thus, this research makes a significant contribution in improving the quality of educational services at ITB Ahmad Dahlan as well as offering solutions that can be adopted by other educational institutions facing similar challenges.

Keywords: *Adaptive Scheduling System, Genetic Algorithm, Lecture Scheduling, Scheduling Optimization*

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INTRODUCTION

The lecture scheduling process is one of the most important things in a study program in higher education. Good lecture scheduling will certainly improve the quality and service of education, because it can optimize resources such as the number of teaching lecturers and existing classrooms, so that students can carry out lecture activities optimally (Abed-alguni, 2022). Inefficient and inappropriate scheduling can cause student dissatisfaction, schedule clashes, or even hinder the smooth teaching and learning process (Baringo, 2019).

Currently, several universities still use manual methods in scheduling lectures including Ahmad Dahlan Institute of Technology and Business (ITB). This lecture scheduling system consumes excessive time and effort from study program coordinators and academic staff (Cao, 2021). In addition, static scheduling systems tend to be less responsive to dynamic changes in student preferences and resource availability. As a result, making a schedule takes a long time and raises the level of clash of lecture schedules with each other, so that the lecture schedule is not optimal (Gholami, 2019).

As a solution to overcome these problems, this research aims to develop an adaptive lecture scheduling system using a genetic algorithm approach. Genetic algorithm uses the principle of evolutionary theory, making it one of the most effective optimization algorithms and can be used in various case studies (Bassen, 2020).

This research will focus on the development of a genetic algorithm-based adaptive lecture scheduling system by considering various constraints and preferences relevant to ITB Ahmad Dahlan. It is hoped that the results of this research can have a positive impact on the development of scheduling systems in the academic environment and be an effective solution for improving the quality of educational services at ITB Ahmad Dahlan.

Based on some of the following research, the genetic algorithm is the method used. Research conducted by (Handayani dkk., 2020) by comparing various algorithms used for the course scheduling process, the final result found that the Genetic Algorithm has the advantage of the most optimal results with the fastest time compared to the Greedy Algorithm and Simulated Annealing Algorithm.

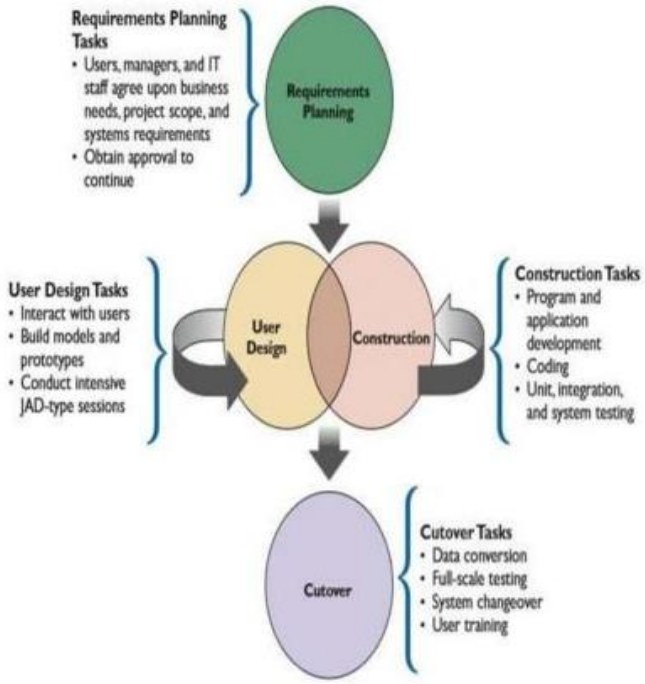
Research conducted by (Pambudi dkk., 2021) genetic algorithms were successfully used to optimize the lecture scheduling process, achieving the fastest duration of 00:12:17 with a population value of 10, a mutation probability of 0.4, and a crossover probability of 0.7. Meanwhile, the adaptive scheduling system to be developed, with similar parameters, is able to complete the scheduling process in less than 1-5 seconds. This shows a significant improvement in time efficiency, which is crucial in situations with frequently changing scheduling needs (Li, 2021).

RESEARCH METHODOLOGY

SYSTEM DEVELOPMENT METHOD

In this study, the authors used the Rapid Application Development (RAD) Model as a system development method. The RAD model is a system development life cycle designed to speed up the development process, while producing higher quality products compared to traditional method (Casalino, 2021).

Figure 1. RAD Stages



Requirement Planning

At this stage, all stakeholders come together to discuss the system requirements and project scope. The focus is on identifying and documenting business needs and constraints to ensure the system meets user expectations.

User Design

This stage involves close collaboration between developers and users to design the system interface. The design is done iteratively through prototypes and continuous feedback, ensuring an intuitive and user-friendly interface before going into the development phase.

Construction

The system development process is carried out based on the design that has been created. Developers build, test and refine system modules in short cycles with user involvement, ensuring the system meets specifications and needs.

Cutover

This stage is the full implementation of the system, including final testing, user training, and data migration. The system is rolled out and evaluated to ensure it functions properly, with a support and maintenance plan for the long term.

GENETIC ALGORITHM METHOD

According to (Lahoz-Beltra & Rodriguez, 2020) the steps in the Genetic Algorithm work process are:

Population Initialization

The process begins by creating an initial population of possible solutions. These solutions are usually represented in the form of chromosomes (often as binary strings or arrays). The initial population is generated randomly or based on some specific rules.

Chromosome Evaluation

Each chromosome in the population is evaluated using a fitness function, which measures how well the solution solves the problem. The fitness value indicates the quality of each chromosome. The formula for finding the fitness value is as follows:

$$fitness = \frac{1}{1 + f(x)}$$

Selection

Chromosomes with high fitness values are selected to become the parents that will produce the next generation. The roulette wheel selection method is the most commonly used, then there is tournament selection, and ranking selection.

Crossover

Pairs of parent chromosomes undergo a crossover process to produce offspring. This process involves exchanging segments of the parents' chromosomes to create new offspring chromosomes. There are several crossover techniques such as one-point crossover, two-point crossover, and uniform crossover.

Mutation

To maintain genetic diversity in the population, some genes in the daughter chromosomes undergo mutation with a certain probability. Mutation usually involves randomly changing the value of a gene.

Formation of a New Generation

The child chromosomes resulting from the selection, crossover, and mutation process form the new generation. This process repeats from chromosome evaluation to the formation of a new generation, iteration by iteration.

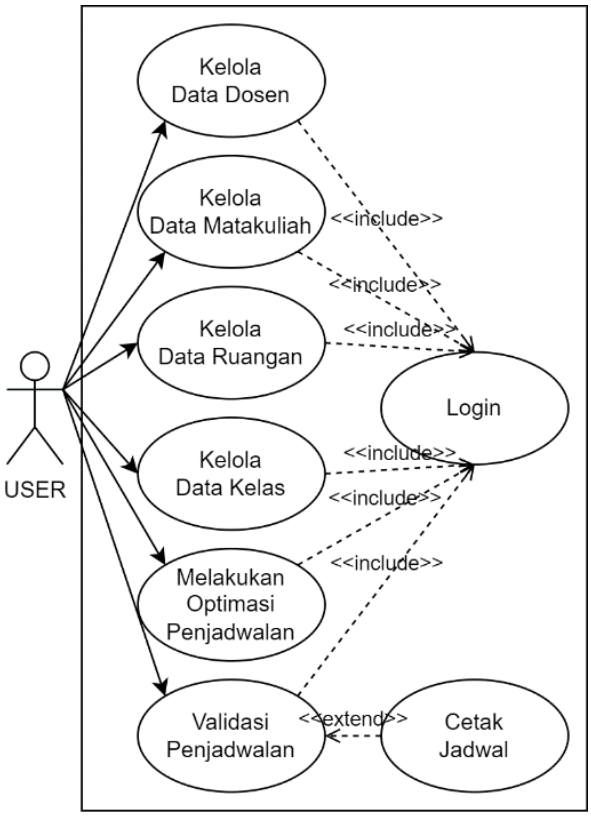
Termination

The genetic algorithm will stop when certain criteria are met, such as the number of generations that have reached the maximum limit, or when the optimal solution is found.

RESULT AND DISCUSSION

Use Case Diagram of Lecture Scheduling SystemUse Case Diagram

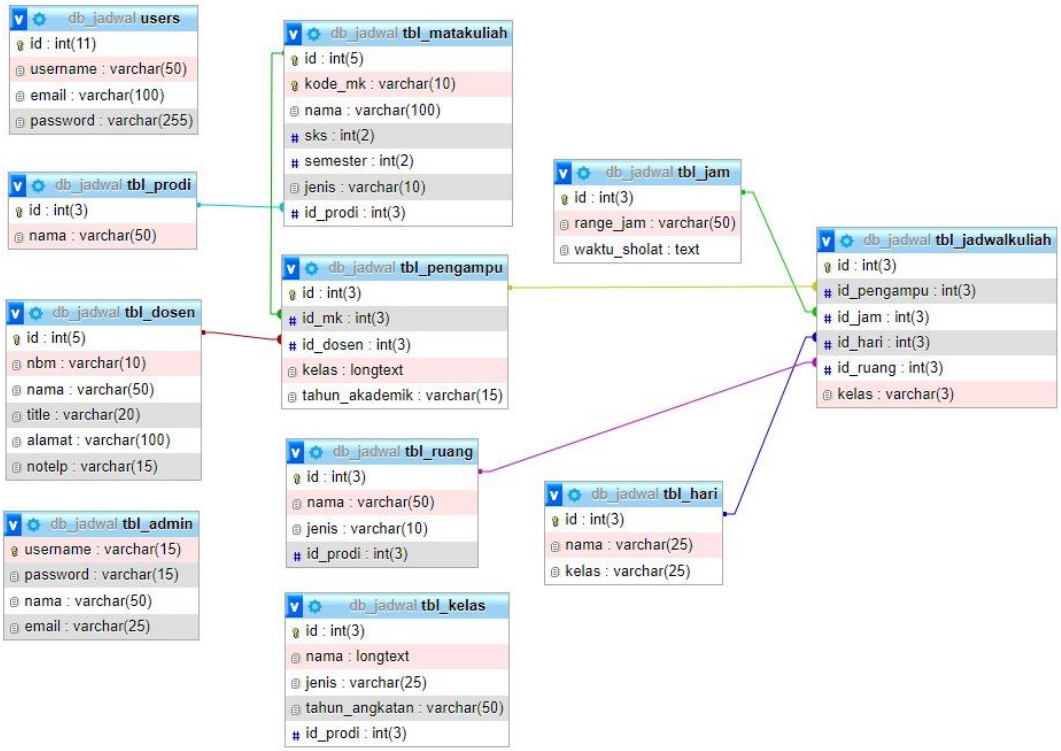
Figure 2. Use Case Diagram of Lecture Scheduling System



Use Case Diagram shows how the interactions that occur in the lecture scheduling system relate to each other. The use case function is an introduction to the initial stage of the scheduling system process being designed. This diagram plays a role in explaining the sequence of system processes clearly, and becomes a link between system developers and admins as system users.

Entity Relation Diagram (ERD) of Lecture Scheduling System

Figure 3. ERD of Lecture Scheduling System



To understand the relationship between tables, an ERD is used. ERD is a graphical notation that describes a data model or network that explains the data stored in the system in an abstract way.

System Output

In Figure 4-13 is a system display for the supporting data page of the lecture scheduling information system using genetic algorithms.

Figure 4. System Login Page Display

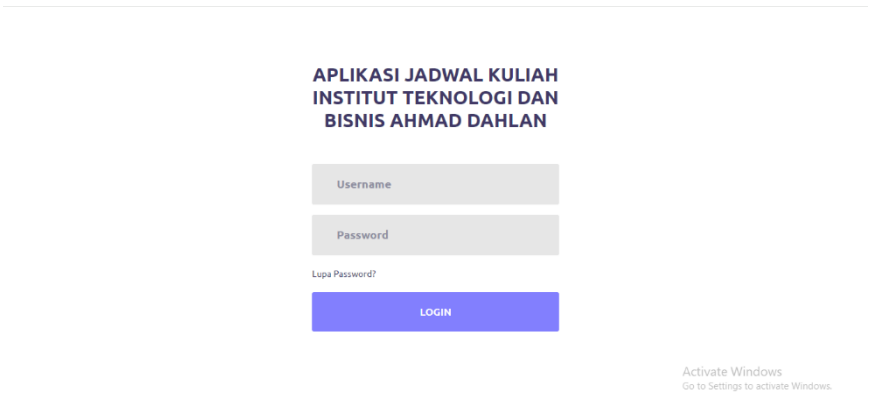


Figure 5. Home Page Display

Figure 6. Course Page Display

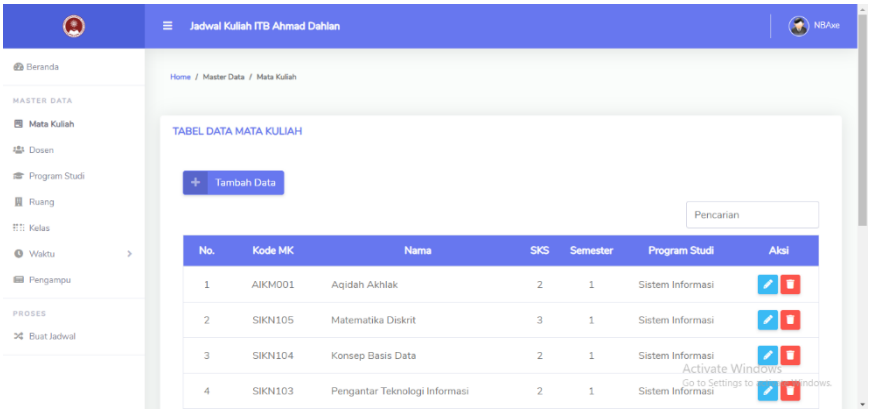


Figure 7. Lecturer Page Display

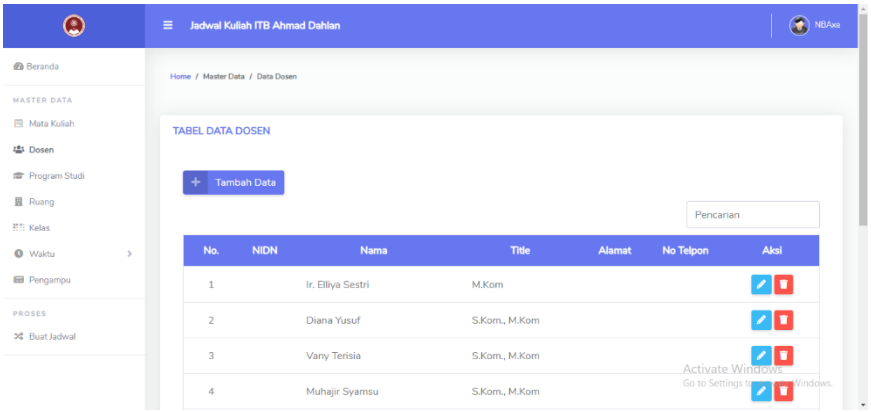


Figure 8. Study Program Page Display

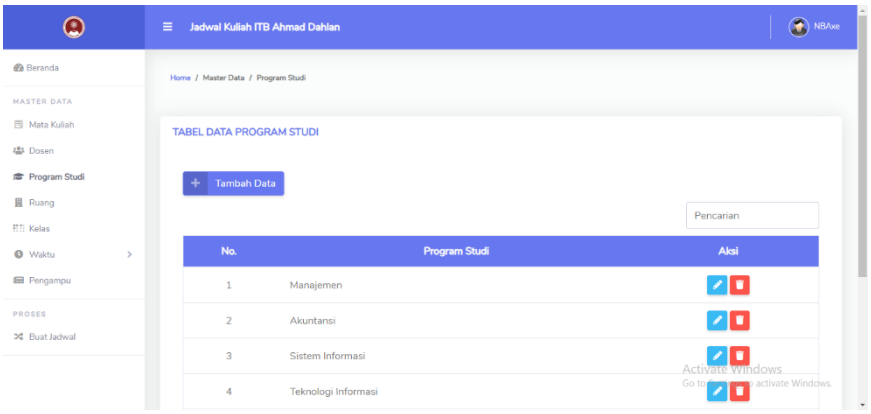


Figure 9. Room Page Display

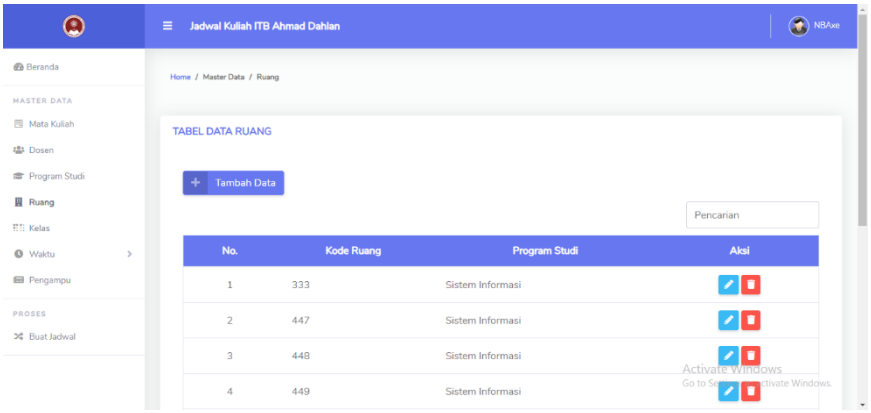


Figure 10. Class Page Display

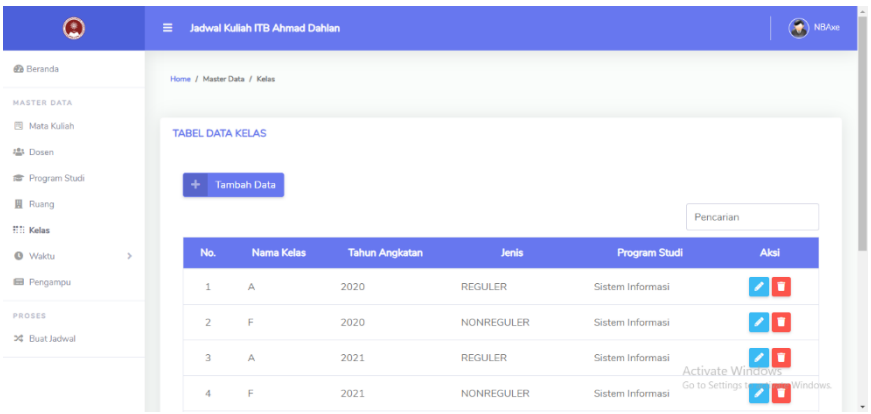


Figure 11. Hour Page Display

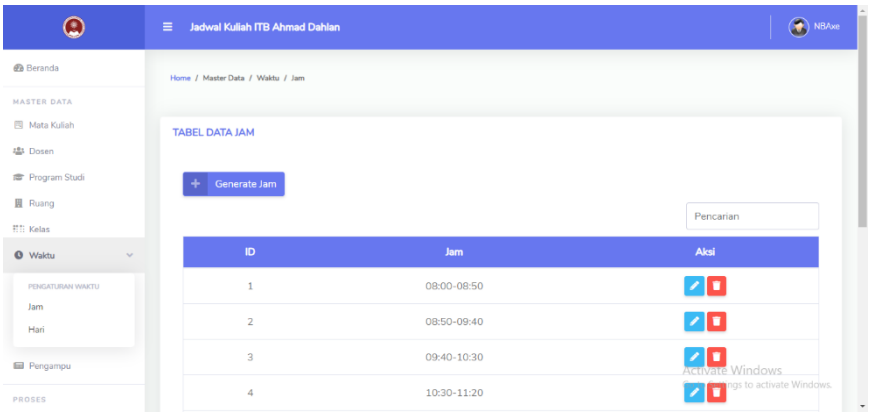


Figure 12. Day Page Display

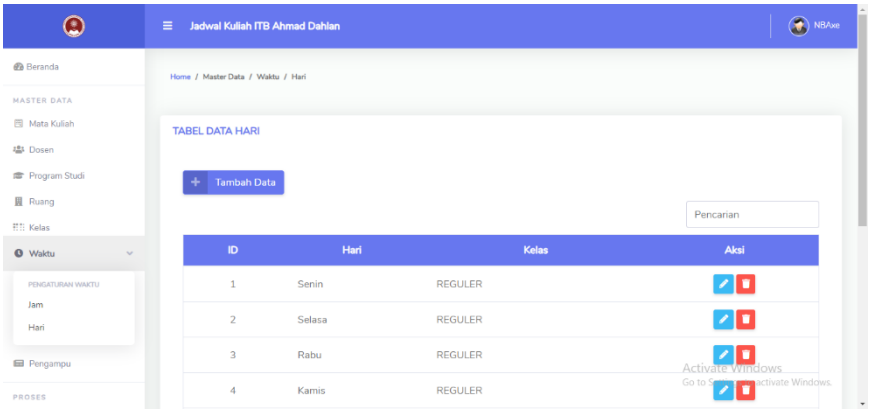
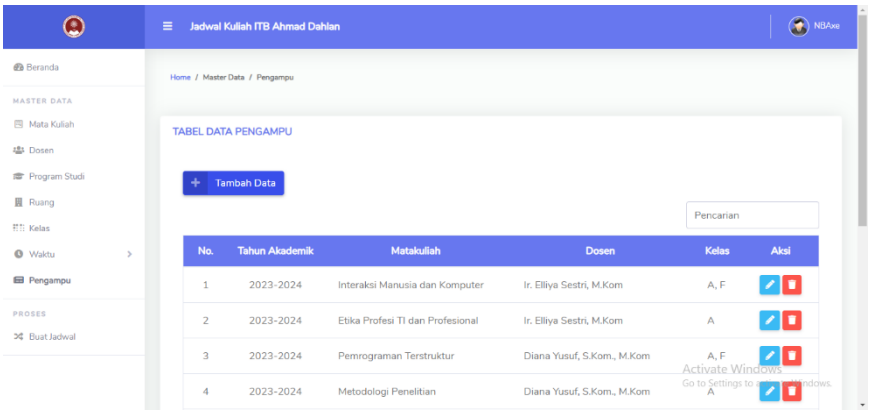


Figure 13. Supervisor Page Display



After entering all the supporting data, the next step is to create the lecture schedule. At this stage, the system is tested by changing the population, mutation probability, crossover probability, and number of generations to produce the most suitable values for the scheduling process.

Figure 14. Display of Schedule Generate Process

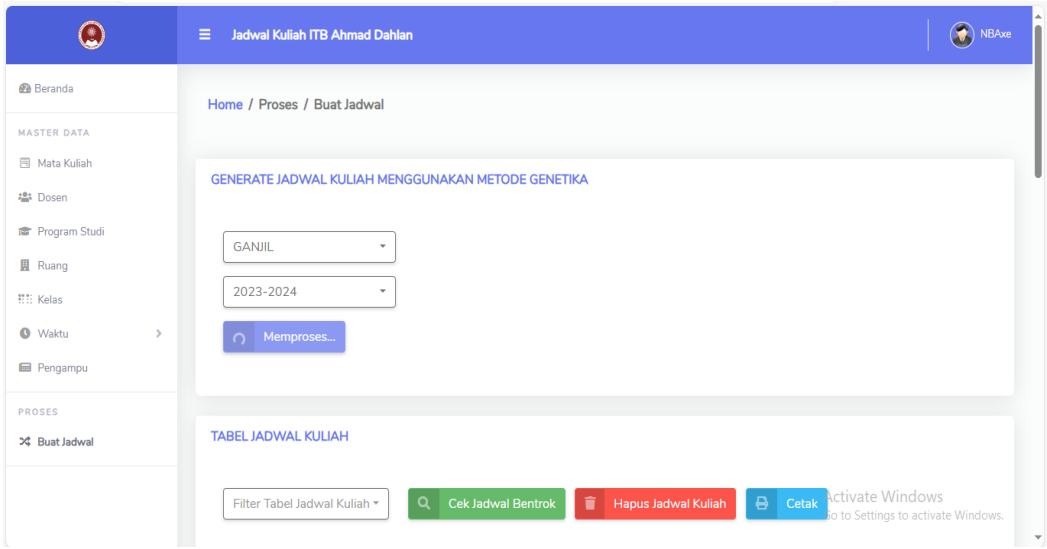


Figure 15. Notification of Successful Generate Schedule

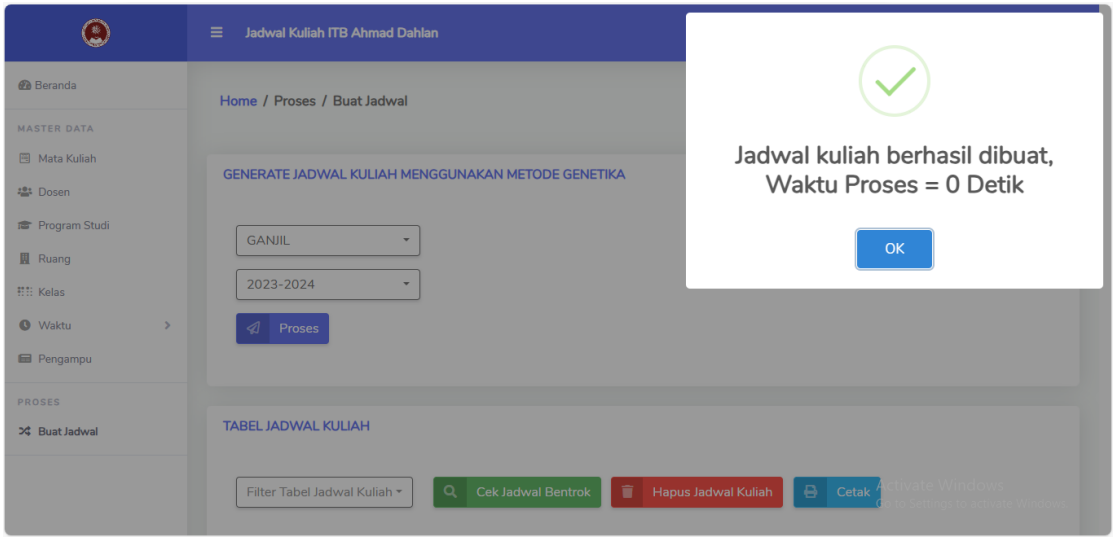
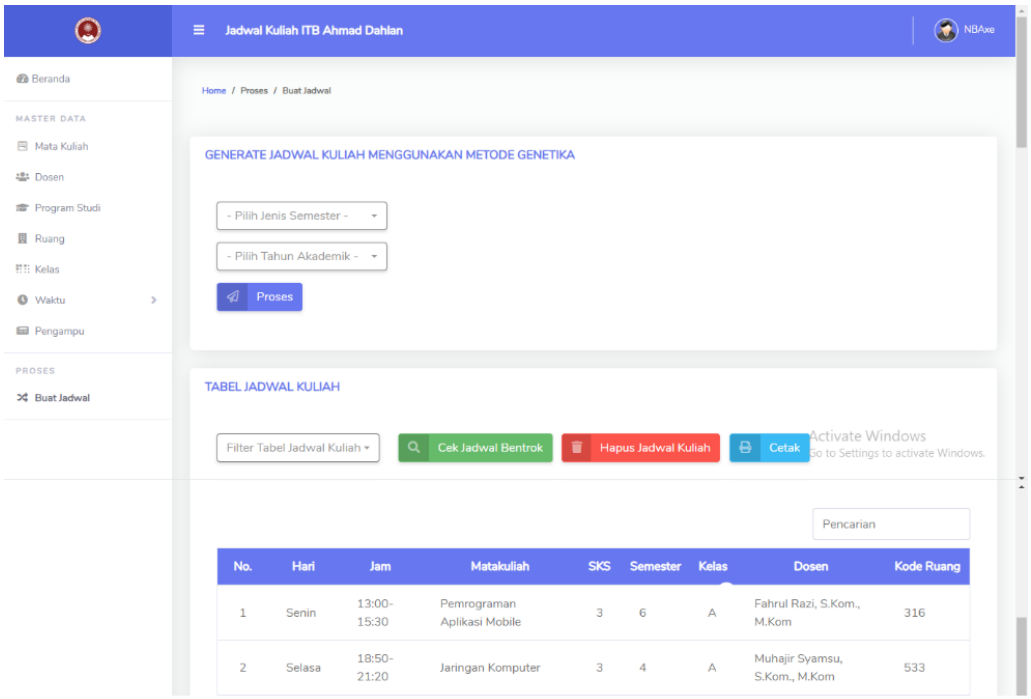


Figure 16. Result of Generate Lecture Schedule



Based on the results of the genetic algorithm process, the resulting scheduling information system includes 62 courses with 29 lecturers who have been arranged in accordance with the provisions. The courses taken by a class at a certain time have been randomly divided, but there are no schedule clashes, both in terms of time, lecturers, and rooms used. After an in-depth analysis, the output results show that there are no clashes between classes, lecturers, courses, times, and rooms. These scheduling results can then be stored in a database or exported into PDF format.

CONCLUSION

This research successfully developed a genetic algorithm-based adaptive lecture scheduling system for ITB Ahmad Dahlan, which is able to produce efficient and adaptive lecture schedules, and can overcome various obstacles such as lecturer and classroom availability. The system works by combining course, lecturer, room, time, and class data into a gene, which then forms a chromosome to be used in the genetic algorithm process. This process includes chromosome selection, fitness value calculation, and if necessary, crossover and mutation to optimize the schedule and resolve conflicts. Evaluation shows that the system is effective and efficient in reducing schedule conflicts and increasing user satisfaction thanks to its flexibility and ability to respond to changing conditions.

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