OPTIMIZATION OF CLASS PROVISION IN THE IMPLEMENTATION OF MOVING CLASS USING THE SIMPLEX METHOD

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ABSTRACT

Allocation of class provision in the implementation of moving classes is an important thing that needs to be considered to obtain optimal learning. The problem of optimizing class provision is still an obstacle to most problems in the field of education. One of them occurred in the implementation of moving classes at SMAN 1 Panji, which provided classes based on students' interests and talents. The curriculum deputy has difficulty determining the number of classes provided according to the subjects that students are interested in, to obtain optimal class provision. This study aims to solve the problem of optimizing class provision in the implementation of moving classes for grade 11 at SMAN 1 Panji with the right allocation of student interests in order to obtain optimal results. The method used is a descriptive qualitative method with a case study. Data collection methods include field studies (observation and interviews) and literature reviews. Meanwhile, data analysis uses the simplex method and MATLAB software. Data analysis techniques using observation and interviews. Meanwhile, based on the optimization results, the recommended class solution for the implementation of moving class for grade 11 at SMAN 1 Panji is 24 IPA (Natural Sciences) classes and 16 IPS (Social Sciences) classes. On the other hand, 0 Mathematics and Informatics classes (not required to be provided). Furthermore, by using MATLAB software, the same results are obtained as using the simplex method, but with a simple, effective, and efficient algorithm, of course, with precise results, and the use of this software aims to avoid calculation errors.

Keywords: Moving Class, Simplex Method, Branch and Bound.

PRELIMINARY

A nation's human resource quality and its level of development are both affected by its educational system. A new generation that can adapt to the ever-changing dynamics of our modern day will be born from well-educated parents and teachers (Lince, 2022). To help realise an education system capable of generating excellent generations, Indonesia employs the Independent Curriculum, which prioritises engaging students in meaningful learning. Through the use of an activity program called Moving Class, the Independent Curriculum enables students to customize their education to fit their unique interests (Rahman et al., 2024). Teachers have a great chance to spark student engagement with the Moving Class program because students get to pick the class that best suits their interests (Yulhakim, et al. 2023).

At SMAN 1 Panji, one of the policies put in place is the Moving Class learning system. One modification to the traditional university-based educational model is the Moving Class system. Also, the Moving class system is an activity system in and of itself because it requires students to actively participate in their own learning. This is in contrast to previous systems, where a teacher would physically attend each class to facilitate learning; however, under the Moving class system, students are now expected to actively participate in their own learning by keeping track of when and where class is being held. Simultaneously, the educator remains in the lecture hall. Consequently, student engagement is essential for the successful implementation of the Moving Class style of learning. To ensure that students actively engage in learning, their actions will be evaluated from both an academic and an emotional perspective (Saputro, 2022). The Moving Class also hopes to help students find their niches in college by providing them with the tools they need to pursue in-depth coursework in areas that really interest individuals (Rahman et al., 2024). In implementing the Moving class method, SMAN 1 Panji provides four elective classes (interests), namely IPA (Natural Sciences), where students will be focused on studying three subjects (Biology, Physics, and Chemistry), IPS (Social Sciences), where students will be focused on studying three subjects (Geography, Sociology, and Economics), Informatics and Mathematics because the eight subjects in these four classes are very influential in the college entrance exam. Therefore, students in grade 10 are asked to determine the direction of the college major they are interested in and will pursue until grade 12. In grade 11, students are mapped out to study elective subjects according to the direction of the college major they are interested in through the Moving class learning method. Students are not obligated to enrol in every topic offered under the Moving Class method. The goal is to make it easier for students to decide how to continue their studies, but each student is still free to pick one subject based on their interests and skills.

The truth is that SMAN 1 Panji's implementation of the Moving Class program was fraught with difficulties. First, there is a shortage of qualified teachers and other school staff, which leads to insufficient classroom space and other educational infrastructure issues. Because there are only so many available classes, some students will not be able to enrol in the ones they really want. Secondly, the Moving Class model requires substantial adaptation on the part of all parties involved, including educational institutions, parents, students, and instructors, due to the substantial shift in learning processes from the traditional approach.

It is important to devise a strategy to optimise the allocation of courses during the

implementation of Moving classes in order to ensure that all students receive classes based on their interests, given the issues that arise in the Moving class learning at SMAN 1 Panji, specifically that some students do not receive classes related to their areas of interest. Using the simplex approach, a linear programming technique, will aid in solving the SMAN 1 Panji challenge of optimising the supply of classes during the deployment of Moving Class. Various strategies or techniques are available within linear programming, a subfield of operations research, to solve problems based on their specific requirements (Goli & Nasseri 2020). Here, the best way to solve this problem is via the simplex algorithm. Optimal values can be found using the simplex method, a solution approach in linear programming (Budianti et al., 2020).

Optimal value determination has also been accomplished in a number of prior investigations by means of the simplex method. As research conducted by (Aini et al., 2021), (Untari, et al. 2023), (Ambarsari et al., 2024), (Lina et al., 2020), (Aningke et al., 2020) and (Jamal & Sari 2022) it maximises profits through simplex optimisation of manufacturing. In addition, in their research, (Khamid & Suyatno 2021) and (Pangestu, et al. 2022) use the simplex method to determine the design for using limited raw materials.

Profit maximisation, optimum design, and assignment are all topics covered in the aforementioned study as they pertain to the simplex approach. The study just aims at calculating production and company profits, even if it describes the simplex approach as a decision-making methodology. Still, research on the simplex method's efficacy in addressing issues in particular contexts and academic disciplines is lacking, particularly in the field of education. In 2023, the simplex method was also used to optimize parking provision at the Aminah Islamic Hospital in Blitar City by (Amanullah & Bani 2023). In his research, the results were still obtained in decimal form and were rounded to whole numbers to obtain optimal results. In the research that will be carried out at this time, an advanced method is used, namely branch and bound, to obtain integer results. Combinatorial optimisation issues, such as integer programming (IP) or mixed integer programming (MIP) problems, are often solved using the branch-and-bound (B&B) algorithmic strategy (Beck & Sharon 2023). This method was developed to complement the Simplex method, which is only capable of solving linear programs with continuous variables. We still get decimal results based on the calculation results using the previous simplex method. Therefore, the Branch and Bound method will be used to get round results. This also creates a gap between this research and previous research. Therefore, (Fadia et al., 2024) prior to conducting this research, a literature review was carried out to ascertain the applicability of the simplex method to the problems that would be addressed.

The results indicated that the simplex method could be employed to optimise the provision of classes in the implementation of Moving Class.

To ensure that all students at SMAN 1 Panji have access to classes in their chosen majors, this study's original contribution is the application of the simplex approach as a decision-making tool to allocate classes within the context of Moving Class. Because of these issues at SMAN 1 Panji, the researcher has decided to run a study titled "Optimizing Class Provision in the Implementation of Moving Class Class 11 SMAN 1 Panji Using the Simplex Method" to find out how many classes are needed to ensure that all 11th graders at SMAN 1 Panji have the opportunity to take classes in their areas of interest.

METHODS

This section will explain the research steps carried out in the field. This research was conducted at SMAN 1 Panji, Situbondo. The research object was grade 11. The steps to determine the optimal class provision in the implementation of moving classes for grade 11 at SMAN 1 Panji can be seen in Figure 1 below:
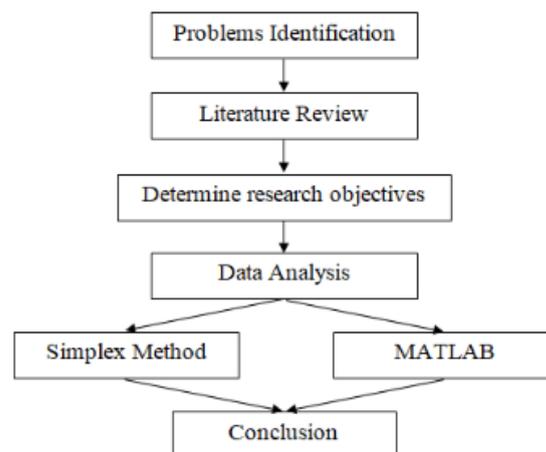

Figure 1. Research Flowchart

The following is a detailed explanation of the research flowchart :

1. Data was collected by interviewing the Principal and Deputy Curriculum of SMAN 1 Panji. The data (Ismail, et al. 2022) in the form of:
   a. Class data will be provided during the implementation of the moving class.
   b. Data on the subjects of interest in the class will be provided.
   c. Data on teaching hour quotas for elective subject teachers at SMAN 1 Panji.
   d. Data on the capacity of the number of students in 1 class and the total number of students in class 11 of SMAN 1 Panji.
   e. Data on the number of teachers at SMAN 1 Panji.

f. Data validated with the SMAN 1 Panji moving class guidebook.
2. Analyze data and model it into a mathematical form to become a linear program.
3. Calculation using the simplex method.

When it comes to optimisation, one linear programming technique that may be utilised is the simplex approach. Applying the simplex approach to a problem with limits or limitations allows one to find the optimal solution (Rastryana et al., 2023). Transforming the mathematical model of the issue into a canonical form that can be processed in a simplex table is the first step in solving the problem using the simplex approach. Then, this method works iteratively by improving the basic solution until it reaches the optimal solution. Iteration is the process of repeating steps in the simplex method, including selecting input and output variables and updating the simplex table to approach or achieve an optimal solution to a linear programming problem. Each iteration involves selecting variables to enter and leaving the basis based on optimality and feasibility criteria. In real applications, the simplex method is used in various fields, such as production management, resource allocation, logistics, and financial optimization.

The simplex method in solving optimization problems has two objectives: maximizing and minimizing (Latief et al., 2023). With this method, researchers can maximize or reduce the provision of classes by considering existing constraints, such as limited subject teachers, elective subjects, or available courses. Although the simplex method is very effective for solving problems with many variables and constraints, other methods, such as the interior point method, are more efficient in some cases. However, the simplex method remains the primary tool in linear optimization because of its powerful concept and wide application in the real world.

In its implementation, the simplex method is a method in linear programming that systematically starts from a basic feasible solution to another basic feasible solution, which is done repeatedly until an optimum solution is achieved (Widodo, 2020). In the simplex method, an iteration process is carried out by selecting variables that will enter and exit the basis based on specific rules, such as optimality and feasibility criteria. The main steps in this method include :

   a. Determine the Mathematical Model
   b. Change the constraints and objective function into canonical/ready simplex form.
   c. Arrange the objective function and constraints into a simplex table.
   d. Checking Optimality
4. Solution using the Branch and Bound method.

   a. This solution model can be adapted to various forms of integer linear programming solutions. This branch and bound model can be used and completed well (Zuserain et al., 2021)

5. Solution using the Branch and Bound method.

This solution model can be adapted to various forms of integer linear programming solutions. This branch and bound model can be used and completed well (Zuserain et al., 2021).

RESULT AND DISCUSSION

Table 1. JP Teacher Teaching Data, Many Students, Many Teachers, Class Selection Combination

Constraint	Mathematics	Science	Informatics	Sosial	Availability
JP Teacher	25	30	30	15	1080
Students	35	35	35	35	1383
Teachers	3	4	2	1	112
Combination	3	3	1	1	278

After obtaining the above data (table 1), the next step is to :

1. Modeling data into mathematical form. To get the right formulation, use the symbols X_1, X_2, X_3, X_4 and F_{max} Where :

    X_1 = The number of Mathematics classes provided

    X_2 = The number of Science classes provided

    X_3 = The number of Informatics classes provided

    X_4 = The number of Social Sciences classes provided

    F_{max} = Total provision of classes in the implementation of the Moving class.

2. Determine the objective function to be optimized.
    $$F_{max} = X_1 + X_2 + X_3 + X_4$$

3. Create boundaries (constraints).

    $$25X_1 + 30X_2 + 30X_3 + 15X_4 \leq 1080$$
    $$35X_1 + 35X_2 + 35X_3 + 35X_4 \leq 1383$$
    $$3X_1 + 4X_2 + 2X_3 + X_4 \leq 112$$
    $$3X_1 + 3X_2 + X_3 + X_4 \leq 278$$

4. Change the constraints and objective function into canonical/ready simplex form.
    a. Canonical form of constraint.

    $$25X_1 + 30X_2 + 30X_3 + 15X_4 + X_5 = 1080$$
    $$35X_1 + 35X_2 + 35X_3 + 35X_4 + X_6 = 1383$$
    $$3X_1 + 4X_2 + 2X_3 + X_4 + X_7 = 112$$
    $$3X_1 + 3X_2 + X_3 + X_4 + X_8 = 278$$

b. Canonical form of the objective function.

$$F_{max} = X_1 + X_2 + X_3 + X_4 + 0.X_5 + 0.X_6 + 0.X_7 + 0.X_8$$

5. Arrange the objective function and constraints into a simplex table.

Table 2. Simplex table.

C_i	C_j	1	1	1	1	0	0	0	0		
	X_i/X_i	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	B_i	R_i
0	X_5	0	0	10	0	1	$-\dfrac{2}{7}$	-5	0	$\dfrac{874}{7}$	
1	X_4	$\dfrac{1}{3}$	0	$\dfrac{2}{3}$	1	0	$\dfrac{4}{105}$	$-\dfrac{1}{3}$	0	$\dfrac{1612}{105}$	
1	X_2	$\dfrac{2}{3}$	1	$\dfrac{1}{3}$	0	0	$-\dfrac{1}{105}$	$\dfrac{1}{3}$	0	$\dfrac{2537}{105}$	
0	X_8	$\dfrac{2}{3}$	0	$-\dfrac{2}{3}$	0	0	$-\dfrac{1}{105}$	$-\dfrac{2}{3}$	1	$\dfrac{19967}{105}$	
	Z_j	1	1	1	1	0	$\dfrac{3}{105}$	0	0	$\dfrac{1383}{35}$	
	$Z_j - C_J$	0	0	0	0	0	$\dfrac{3}{105}$	0	0		

In the 4th iteration simplex table, the number of classes that must be provided for the Mathematics subject is obtained (X_1) is 0, is 0, science (Natural Science) subjects (X_2) is 24,162, Information subject (X_3) is 0 and the subject of IPS (Social Science Education) (X_1) is 15,352. The simplex table also shows the values $Z_j - C_J$ There are no more negative values so that the results obtained are optimal. So the provision of classes for elective subjects in the implementation of Moving class at SMAN 1 Panji uses the simplex method, namely 39,514.

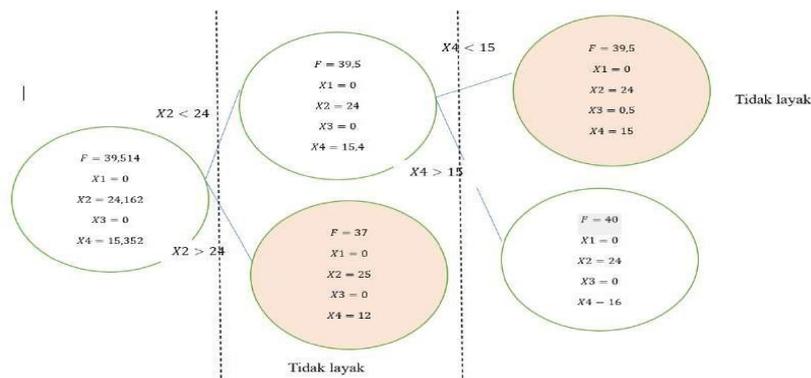6. Solution using the Branch and Bound method.

Figure 2. Branch and Bound Method Iteration

Based on the calculation results using the Branch and Bound method, the solution obtained by adding constraints (limits) produces the following results $X_1 = 0$, $X_2 = 24$, $X_3 = 0$ dan $X_4 = 16$. Based on these results, the optimum integral solution that has been obtained is :

$$F_{max} = X_1 + X_2 + X_3 + X_4$$
$$F_{max} = 0 + 24 + 0 + 16$$
$$F_{max} = 40$$

So, 24 IPA (natural sciences) classes and 16 IPS (social sciences) classes must be provided in the implementation of the Moving class for class 11 at SMAN 1 Panji. In contrast, 0 Mathematics and Informatics classes do not need to be provided.

CONCLUSION

Based on the results of the research and completion of the case study conducted regarding the optimization of class provision in the implementation of the Moving class for class 11 of SMAN 1 Panji using the simplex method, several things can be concluded as follows :

a. Implementing the simplex method and the Branch and Bound method can provide an optimal solution for efficiently allocating class provision according to each department's needs, the number of students, and the number of teaching hours available for subject teachers. This method allows for informed decision-making based on measurable numerical data.

b. The optimization results show that class provision can be designed more efficiently by considering limiting variables such as teacher teaching hours, number of teachers, number of students, and a combination of student subject selection interests. This

c. contributes to optimizing the provision of excess classes and minimizing schedule clashes

d. Based on the optimization results, the recommended class solution for implementing the Moving class for class 11 at SMAN 1 Panji is 24 IPA (Natural Sciences) classes and 16 IPS (Social Sciences) classes. In contrast, 0 Mathematics and Informatics classes (do not need to be provided).

Based on the optimization results, the solution obtained is that the provision of Mathematics and Informatics classes is 0 or does not need to be provided, even though these two elective subjects are necessary for students to prepare themselves to take the entrance exam for the college of their dreams. Therefore, it is recommended to include these two elective subjects in the Natural Sciences (IPA) class because they are in the same group.

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