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Optimization of Marketing Workforce Scheduling Using Metaheuristic Genetic Algorithms

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ABSTRACT

Employee scheduling is very important because it creates sequences and workflows that ensure that all tasks are covered on time. Optimal scheduling to determine work duration, employee quality, and service fulfillment to increase marketing targets, that is, to get many prospective customers and maximize operational time for marketing services. This research is intended to optimize employee scheduling models and to maximize work operational time in accordance with many marketing activities using genetic metaheuristic algorithms and work progress can be monitored. Genetic metaheuristic algorithm makes scheduling optimization system to automate scheduler breaker this method makes it easy to optimize the scheduling of workforce needed in accordance with the preferences and work shifts of each employee. Therefore, employee scheduling is very important so that the monitoring process of the Head of the Bureau (Kabir) can run well and get an optimal scheduling decision in accordance with the time and workload appropriate for each employee. It can be concluded that genetic metaheuristic methods can prove optimal scheduling results for marketing. Based on the results of this study, the findings of this study are practical for implementation

Key words: Scheduling, Workforce Marketing, Metaheuristic Genetic Algorithms.

1. INTRODUCTION

The Problem of Scheduling and Routing problem is described as assigning personnel to visits that are requested at various promotional locations, follow up and stand by. This problem focuses on combining scheduling and routing problems [1]. Such problems are NP-hard [2,3] When there are tens or hundreds of employees, with hundreds or thousands of employees shifting that require employee allocation, work activities come from solutions that emerge [4]. Limited resources can be one of the most common problems for corporate development globally [5]. With so many promotional activities and work in the office [6], so far research has been carried out to create an optimal schedule of activities so that some realistic constraints such as limited resources [7]. In roster settings, when workers do not work shifts that meet their preferences and skills are related to loss of efficiency. Maybe there are no shifts that match the Employee (either because of skill requirements or shift start time, etc.) or there may be no employees that match this shift (the same, there are no employees with the right skills or no employees that allow allocation for this change, etc). To reduce the size of the search space, this has traditionally been seen as two different problems and resolved independently. In the proposed implementation, two problems in creating shifts and allocation of employees are solved simultaneously [8]-[10]. While this increases the complexity of the problem, a combined search space can allow higher quality results to be obtained in scheduling Workforce [11]. This problem assumes that each resource will be able to be allocated to have several skills.

This paper focuses on expanding the problem of scheduling the multiple-skill marketing workforce by learning to consider the efficiency of the workforce involved in performing various skills. This issue has caught the attention of researchers in recent years. In marketing, each activity requires several skills, each skill can be carried out by different human resources and each person has the ability to perform several skills. In addition, the performance or efficiency of the workforce in carrying out various skills activities can increase from time to time [7]. For this purpose, genetic algorithms metaheuristic formulation is proposed for marketing scheduling problems. The main objective of the model presented in this paper is to minimize the forefront of work activities. The main advantage of this model is to take the main real assumptions and bring the model closer to the real conditions. Thus, genetic optimization based metaheuristic algorithms are developed to approach the optimal solution of the model.

Optimization is a method of mathematical approach that aims to obtain maximum operational time objectives. There are a variety of methods that can be used to optimize, but for these cases, more modern techniques such as genetic metaheuristic algorithms [1][12]-[14] methods are needed. The metaheuristic method is known as a method that is able to

solve complex problems quickly [15]. Metaheuristics is an optimization tool to solve this problem. Metaheuristic algorithms find solutions by combining the interaction between local search procedures and higher strategies to create processes that are able to get out of optimal local points and search in the solution space to find global solutions.

Optimal workforce scheduling specifically related to research performance is what is most needed, in this study conducted to prove that optimal scheduling can improve the quality of research performance can be realized [16]. They must ensure that these marketing service resources are optimally aligned with the stability of their core work [17]. Utilizing technology and innovation strategies to help and to increase the workforce and maximize work in accordance with the skills [18]. This era brings new responsibilities for employees to balance competitive changes in the workplace [19][20]. The results show that the proposed method can identify this problem

2. LITERATURE REVIEW

In modern marketing services [21], [22], each employee has the ability to do more than one job per day. Jobs have a work shift sequence and work needs to be lived according to the ability of employees. The problem is choosing employees for the job and determining who can do the job with a variety of different job jobs in marketing. [23] Proposed a genetic algorithm approach to solving the problem of personnel scheduling involving many tasks, including assigning shifts to workers. using composite chromosome coding to overcome shift assignment problems The computational results presented here also include comparisons with the results obtained by formulating the problem as a linear mixed-integer programming model and then solving it with a commercial solver. [24] In his study discussed the problem of scheduling tasks. A certain number of maintenance tasks, with a predetermined period of time, must be assigned to available care workers. The availability of care workers is defined in the shift schedule, which is considered known. Each care assignment has a preferred start time based on the nursing home client's time preference. Furthermore, each care worker has a level of qualification. Based on their education and expertise, care workers are hierarchically divided into three different qualification levels (QL). Depending on the education needed and the complexity of care [25], [26], health care assignments are given to health workers with a certain level of qualification. Propose Genetic Algorithms combined with ILP to get an optimal schedule. [27] proposed a FEAL model for rescheduling checks and using genetic algorithms as optimization techniques to minimize makespan at production execution times. [28] proposed a mathematical formulation and heuristic hybrid heuristic design showing extraordinary performance that finds an optimal or near-optimal solution in a very limited CPU time [29]. Focusing on determining the ideal mix of full-time and part-time workers needed every week to ensure a satisfactory level of service during check-out operations. [1] proposed a genetic algorithm to solve multi-project scheduling problems. [8] proposed using mathematical modeling and C erlang for workforce management analysis for workforce management aimed at monitoring business processes. [9] Proposed a Mathematical Method, a programming-based decision support system for nurse scheduling with nurse-patient ratios, the number of shifts that need a lot and rest days. [10] Uses scenario-based sampling and Stochastic programming methods to predict call center staff scheduling. [12] Metaheuristic methods for efficient resource allocation and the effects of the distribution of computational tasks between BoT application resources and cloud systems. [13] proposed a genetic algorithm for scheduling completion at an institute for a collection of study groups, courses and units. The professor provides a continuous learning process. [14] proposed a genetic algorithm and MPGA for optimizing workflow scheduling in the cloud with security restrictions.

From 16 (sixteen) literature reviews, it can be seen various studies conducted by the method used. It can also be concluded that workforce management scheduling technology has penetrated various industrial fields. There are indications that the optimal marketing scheduling system has not been much studied. Opportunities for research on workforce marketing scheduling systems to maximize operational time can be understood by various industries and it is interesting to further develop this research.

3.MODEL FORMULATION AND SOLUTION APPROACH

The main solution that is formed automatically is discrete, which focuses on forming work activities that will be used as a reference. From the survey literature reviewed, it can be easily observed that work related to completion time, total work and employee skills have not been taken into account. Completion time plays a major role in determining optimal work schedules, skills, and shifts that are suitable for use with work well done. Thus, this type of goal uses the Genetic Algorithm approach.
The problem is related to flexible work activities, where there are limited employees available to process on many jobs. The problem is to assign each employee to do various jobs so that the maximum completion time and total work time for all work are minimized according to the specified work time.

In this problem, there are alternatives available but not all employees can go through all jobs. There are a total of 94 jobs, there are three types of jobs available, with each employee having the ability to do several jobs in one shift. Processing time for work is given in figure 1. The goal is to maximize existing marketing and minimize maximum turnaround time.

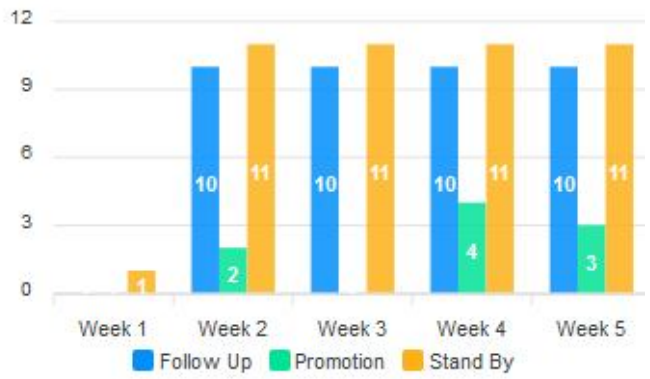

Figure 1: Type of work and total work activities

For the results of scheduling workforce, the optimal solution is the solution that has the optimal number of workers and meets the work rules. However, as explained earlier, schedule performance must also be measured with respect to other characteristics such as skills, work history, etc. Therefore, it is useful to produce some good solutions for the final assessment. The mathematical programming formulation for this problem is based on the following formulation [30], [31]:

In the optimization of workforce marketing, there are several constraints that must be resolved. Each employee has the same work duration (40 hours/week) and scheduling is carried out for 24 days/month.

$$\text{MaxZ} = \sum_{i=1}^{3} = \sum_{j=1}^{7} = \sum_{k=1}^{24} = \sum_{p=1}^{24} X_{ijkp} \quad (1)$$

Retrieve data from i jobs, employees, hours of work, and workdays and retrieve data from them according to work needs and employee preferences. Genetic metaheuristic algorithms will continue to function maximize operational time.

Table 1: Notations

Parameters
i= Job (1, promotion activity, 2, stand by 3, follow up) j= Employees (1, 2, 3, ..., 7) k= Hours (1 = 00: 00-01: 00, 2 = 01: 00-02: 00, ..., 24 = 23: 00-24: 00) p = Day (date) (1, 2, 3, ... 24) → Monday - Saturday n = Student assistance promotion (1, 2, ..., 10)
Decision variables
Q_p= Number of prospective new students enrolling in period p H_{kp}= The number of people needed for the promotion of hours to k in period p $S_{ij} = \begin{cases} 1, \text{employee j can do the work i} \\ 0, \text{vice versa} \end{cases}$ $X_{ijkp} = \begin{cases} 1, \text{if employee j works at work i at hour k on day p and } S_{ij} = 1 \\ 0, \text{vice versa} \end{cases}$ $M_{nkp} = \begin{cases} 1, \text{If a student participates in promotional activities at k hours on day p} \\ 0, \text{vice versa} \end{cases}$

2) Managers (employees 1) must be on stand by at 08:00 - 17:00 Monday - Friday.

$$X_{21kp} = 1 \qquad k \in \{8,9,\ldots 17\} \quad \forall p \backslash \{6,12,18,24\} \quad (2)$$

3) All employees can do stand by work in the office.

4) Employees 2, 3, 4 can do all the work stand by, follow up and Promotion.

$$S_{2j} = 1 \qquad \forall j \quad (3)$$

$$\sum_{i=1}^{3} S_{ij} = 3 \qquad j \in \{2,3,4\} \quad (4)$$

5) Working hours 40 hours/week or 160 hours/month for every employee.

$$\sum_{p=1}^{24} \sum_{k=1}^{24} \sum_{i=1}^{3} X_{ijkp} \quad (5)$$

6) Working hours per day (Monday-Friday) every employee shifts 08:00 - 17:00 can be 7 hours or more, with many employees 5 people.

7) Working hours per day (Monday - Friday) each employee shifts 12:00 - 21:00 can be 7 people or more, with many employees 2 people.

8) Working hours Saturday shift 09:00 - 14: 00 can be 5 hours or more with many employees 1 person.

$$\sum_{j=1}^{7} \sum_{i=1}^{3} \sum_{k=8}^{17} X_{ijkp} \geq (5X7) \qquad \forall P \backslash \{6,12,18,24\} \quad (6)$$

$$\sum_{j=1}^{7} \sum_{i=1}^{3} \sum_{k=12}^{21} X_{ijkp} \geq (2X7) \qquad \forall P \backslash \{6,12,18,24\} \quad (7)$$

$$\sum_{j=1}^{7} \sum_{i=1}^{3} \sum_{k=9}^{14} X_{ijkp} \geq 5 \qquad P \in \{6,12,18,24\} \quad (8)$$

9) Employees who take part in promotional activities are a maximum of 2 people.

$$\sum_{j=1}^{7} X_{1jkp} \leq 2 \qquad \forall k, \forall p \quad (9)$$

10) There are at least 2 people in the office on stand by / follow up

$$\sum_{j=1}^{7} X_{ijkp} \geq 2 \qquad \forall k \quad i \in \{2,3\} \quad p \in \{6,12,18,24\} \qquad (10)$$

11) Promotional activities i are filled with a maximum of 2 staff and the rest are students assistance at hour k p.

$$\sum_{j=1}^{7} = 1 X_{ijkp} + \sum_{n=1}^{10} = 1 \; M_{nkp} = H_{kp} \qquad \forall k, \forall p \qquad (11)$$

The validation process is done by testing the results of optimization with invalid / valid combination candidates. A position takes the value "0" or "1" if the corresponding features are each invalid or validated [32]. The data used as input in the validation process are the results of verification. Results that are processed by the optimization model are declared to have passed the validation test if the results obtained do not violate the boundaries of the case being modeled. Limitations that should not be violated by the optimization model. If there is one step that results in an invalid value. The optimal solution that has been declared valid, can produce optimal results until the results of getting a binary "1" is obtained at the experimental stage. Scheduling will produce optimal results with a total fittest of 94 jobs.

The optimization process is done with the help of a computer. The computer can optimize if its cause can be modeled according to the language understood by the computer. Some components need to be prepared before the process of change can be limited, the optimization of entities/subjects and some data is processed to consider the decisions taken.

The limits of the conceptual model are transformed into mathematical notation. To be able to convert into variables or parameters, as well as several entities involved such as various activities of work activities, working hours, employees and some of the tested models are formed as an index.

4. RESULT DAN DISCUSSION

The process of analyzing the resulting solution, from sensitivity analysis, is needed to choose the parameter settings of the constraints for the model that is in accordance Java program code was developed to carry out numerical experiments [34]. The initial population is produced by 94 chromosomes. The fitness value of each chromosome is calculated. Then two genetic operators are applied to the population depending on their probability. This process is repeated for the desired number of iterations and when the population has reached an optimal value, i.e. the fitness value does not decrease even after a number of iterations, the best chromosome is displayed (which has the least fitness value or best matches the chromosome). The chromosome that has the best fitness value after iteration is:

with the case study [33]. Data obtained by conducting direct discussions with the head of the marketing bureau (Kabir). Based on the results of the discussion obtained the data of making traditional schedules from the history of admission of new students 2017-2019, data on promotional activities during 2018, Work Shift, 3 types of marketing work activities consisting of promotional activities, follow up and be prepared and the number of marketing staff available. The data will be further developed as experimental data in this study.

Completion of workforce marketing scheduling research focuses on the use of genetic algorithm metaheuristic methods. The main solution If there is no match it will get a binary "0" that is made will do randomly to get the best individual for the next generation to get the results of generation and total perfect fittest. The process of natural selection begins with the selection of the fittest individuals from a population. They produce offspring that inherit the characteristics of parents and will be added to the next generation. If parents have better fitness, their offspring will be better than parents and have a better chance of survival. This process continues over and over and eventually, generations with the strongest individuals will be found. This idea can be applied to search for problems. We consider a set of solutions to a problem and choose the best set of solutions from them. Five phases are considered in genetic algorithms. These stages can be seen in Figure 2, Below.

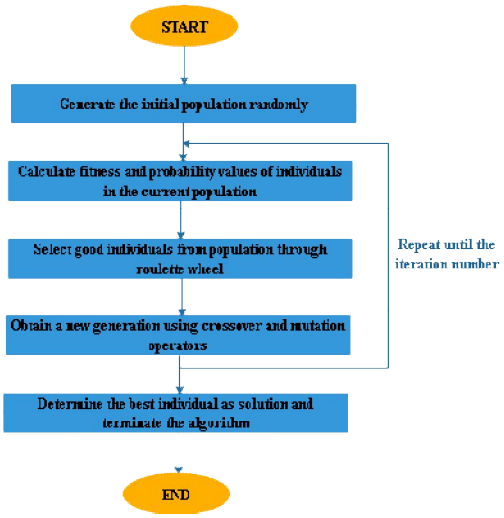

Figure 2: Chronology of Optimizing Metaheuristic Scheduling of Genetic Algorithms

Total Processing Time = 0.005 minutes.
The suitability value for this chromosome is 94 converted to 193 jobs to already assign.

The chromosome having the best fitness value after the iterations is:

1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Tests were carried out using direct software applications and the regulation of metaheuristic genetic algorithms was carried out. The test results using the dataset can be seen in Table 2 obtained in the last 10 generations.

Table 2: Result of Testing Using Dataset

Generation	Fittest	Processing Time
Generation 490	Fittest: 70	0.0024 ms
Generation 491	Fittest: 71	0.0025 ms
Generation 492	Fittest: 72	0.0025 ms
Generation 493	Fittest: 75	0.0022 ms
Generation 494	Fittest 74	0.0024 ms
Generation 495	Fittest: 77	0.0019 ms
Generation 496	Fittest: 77	0.0017 ms
Generation 497	Fittest: 78	0.0021 ms
Generation 498	Fittest: 81	0.0023 ms
Generation 499	Fittest: 89	0.0023 ms
Generation 500	Fittest: 91	0.0022 ms
Generation 501	Fittest: 94	0.0022 ms

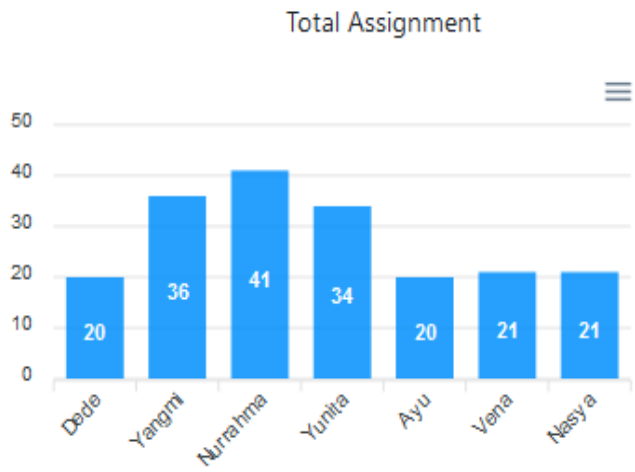

Figure 3: The Result of the Genetic Algorithm Assigned

Based on Table I, it can be seen that generations up to 501 with a total score of 94. Each employee selected with all jobs assigned to each employee with the support of total genetic running skills algorithm gets 193 job details that have been assigned according to the constraint in figure 3. Each generation gets the best results from the previous generation.

5. CONCLUSION

This study asks a model for solving multi-skill scheduling problems and staff allocation problems for various activities in marketing services. The decision model completes the goal to complete efficiency, development cycle and operational time in accordance with work shifts. Programming models with genetic metaheuristics are formulated to model decision problems that are designed to solve models with many marketing work activities [41][42]. In this algorithm, genetic metaheuristics are used to produce a schedule to update the division of labor and staff skills calculated in the process. We use the real world to test the validity of the proposed models and algorithms to get results in generation 501 with the complete gene yield, which is 94 fittest with a total processing time of 0.05 minutes. Genetic Algorithms Found to Provide Good Solutions for Complex Scheduling Problems[43][44].

In future work, personalized decision methods for the selection of final solutions must be developed in accordance with management requirements. In addition, the effects of factors such as teamwork can improve the compilation of staff efficiency improvements. Other possible extensions of our model must be considered, which might include adding projects and tasks, employee entry and exit schedules and so on [38]-[40].

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