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OPTIMIZING THE PREFERENCE OF STUDENT-LECTURER ALLOCATION PROBLEM USING ANALYTICAL HIERARCHY PROCESS AND INTEGER PROGRAMMING

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Abstract

This paper focuses on solving a student-lecturer allocation problem by optimizing declared preferences. Typically, many students undertake an internship program every semester and many preferences need to be taken when assigning students to lecturer for supervision. The aim is to maximize student's total preference. Analytic Hierarchy Process (AHP) technique is used in ranking the preference criteria and alternatives to form a preference matrix. Then, an Integer Programming (IP) model is developed by considering related constraints, which involves lecturer capacity according to academic position and matching gender of student to lecturer. This study demonstrates the effectiveness of using AHP technique in prioritizing preference criteria and facilitates finding the best solutions in the context of multiple criteria by using preference matrix. The IP model shows that all constraints are satisfied, and students' total preferences is maximized. The study demonstrates that the proposed method is efficient and avoids biased assignment. The satisfaction of the gender related constraint and preferences toward lecturers contributes significantly to satisfaction among students and staff.

Keywords: Analytic hierarchy process, Integer programming, Internship program, Preference criteria, Student-lecturer allocation problem.

1. Introduction

The student-lecturer allocation problem is defined as a problem of assigning a set of students to a set of lecturers based on declared preferences. This problem is considered as a type of assignment problem. The main idea is to find an optimum allocation of the resource's number to an equal number of demands [1]. An assignment is optimal if the benefit or total cost is optimized. Assignment problem manages the analysis on how to assign *n* objects to *m* objects in the best possible (optimal) way [2]. The objective of solving the student-lecturer allocation problem is to maximize the total preferences and at the same time fulfil the problem's requirements. The difficulty of this problem would increase whenever the number of student increase and various preferences were considered. Furthermore, real-world assignment problems are normally complex as they involve various constraints and require significant computational effort. This problem has been cited variously as one of the fundamental combinatorial optimization problems in operations research and is relevant in the context of various applications.

The assignment problem is also a well-known problem discussed in the literature within educational activities. Examples of such applications are student project allocation [3, 4], student project allocation with preferences over projects [5], new student allocation problem [6], student-case assignment problem [7], quadratic assignment problem [8], exam-timeslot-room assignment of examination timetabling problem [9] and classroom assignment problem [10]. The student-lecturer allocation problem is categorized under this type of application. For a review on assignment problem within the education domain, refer [11].

This paper discusses a student-lecturer allocation problem of an internship program at a university. In completing university degree requirements, students are required to enrol on an internship program. Hamaidi et al. [12] and White [13] mentioned that the internship program involves intensive guidance from supervisors, which allow students to improve their understanding and practical skills. Typically, each student is assigned to one academic supervisor while, a supervisor has more than one student to be supervised [14]. Studies by White [13] have found that the challenges in internship program are due to lack of encouragement, assistance, guidance, explanation from the supervisors and low motivation of students. Thus, effective student-lecturer assignment by considering various criteria should be introduced to avoid for more supervision and guidance problems. Due to these issues, this study seeks to investigate and solve the student-lecturer allocation problem by allocating the internship students to academic supervisor (lecturer) based on student's preferences in the School of Quantitative Sciences (SQS) at Universiti Utara Malaysia (UUM).

The current practice of assigning internship students to lecturers in SQS is manually and randomly done by the internship coordinator according to their respective academic programs and capacity of supervision by a lecturer. During the assignment, students are not allowed to have preferences on the acceptable lecturer for supervising them, while the lecturer is not given an opportunity to have a preference on the student that he/she is willing to supervise. This means that students are not allowed to choose their preference lecturer as their internship supervisor, and they were assigned manually and randomly by internship coordinator according to their program. There was no specific requirement or preferences that have been taken into consideration. Normally, each lecturer is assigned to a certain number of students at a time without considering the student's preferences. However, if the intake of the internship course of the session is low or if the lecturer holds a higher administrative position or supervising many postgraduate students, the internship coordinator will minimize the assigned number of internship students. Moreover, based on a survey, it is also found that most students prefer to work with same-gender of lecturer, which they think that they can easily discuss with.

Previous studies have shown that Analytic Hierarchy Process (AHP) provides advantages, which include the expert opinions and evaluation of multi-criteria that makes the comparison more adaptable and able to justify expert's preferences [15]. Thus, AHP is suitable to be used for ranking in this study. In assignment problem, Integer Programming (IP) is found to be the most suitable model for modelling [2]. Since the problem of this study is not too large and complicated thus IP is suitable to be implemented and guarantees for an optimal solution [16].

This paper presents a solution to a student-lecturer allocation problem of the internship program at UUM by using AHP and IP. Student preferences are considered as the criteria for choosing a supervisor of an individual internship program. Considering students preferences is very important for ensuring that the allocation is effective and leads to a satisfactory experience of students especially in the assignment of their preferable lecturer. In this study, a new constraint to allocate students to supervisor based on gender preferences is introduced.

The study begins with identifying the preference criteria of students towards the internship's supervisor through literature review and semi-structured interview, where respondent are students who are going to undertake an internship program. AHP technique is used in ranking the five criteria (specialization, academic position, availability, professional support and relationship) and alternatives. The alternative is classified as academic positions, which are lecturer, senior lecturer, associate professor and professor. The ranking provided by using AHP is used as information to form a preference matrix. Then, a mathematical model is developed and solved by considering the related constraints, which are lecturer capacity based on academic position and gender matching to maximize student's preferences.

This paper is organized as follows: Section 2 discusses the literature review on the approaches in solving the investigated problem. The methodology in solving the allocation problem is presented in Section 3. Section 4 discusses the result and analysis. Finally, the conclusion and future work are presented in Section 5.

2. Literature Review

This section presents a review on preference criteria considered in previous works and followed by ranking techniques to prioritize the chosen criteria. Finally, previous approaches used in solving allocation problem are discussed.

2.1. Preference criteria

Preference criteria such as research interest, lecturer's expertise and professional support are very important criteria in the successful implementation of allocation since it can satisfy many parties. Faudzi et al. [17] investigate the criteria involved in student-lecturer allocation problem, which are field of specialization, availability, professional support, and relationship. In solving the allocation of student-project with preferences, Manlove and O'Malley [5] consider lecturers' preferences over projects and desire to supervise a project that is similarly related to their research. Jamil et al. [18] highlight this criterion in their study to analyse industry feedback on students' practicum performance and learning outcomes at the end of industrial practicum attachment. Student's placement in the departments is preferred to be in accordance with their field of specialization in their respective academic programs.

Feiman-Nemser and Parker [19] discuss the availability of lecturer to offer expertise and suggestions to the students. This communication leads to good service and professional support or encouragement to the students throughout the time and if it is failed then it can lead the students to achieve low grade and knowledge from the practicum session [20].

In addition, Hamaidi et al. [12] explore the practicum practices and challenges from the student-teachers' perspectives. The study discovered that the students have benefited from the practicum practices in the development of many skills such as communication and interaction with students and management skills. Besides, common challenges have been highlighted during practicum experience such as lack of guidance, inadequate support and difficulty in communicating with practicum supervisor.

2.2. Ranking technique

Multiple Criteria Decision Making (MCDM) approaches have been used in prioritizing student preferences. Faudzi et al. [17] discuss on identifying and prioritizing the student's preference criteria towards supervisor using AHP for student-lecturer allocation problem of the internship programme. It is found that the most important preference criterion is professional support, followed by specialization, availability, relationship, gender, academic position and capacity. Pekkayat [21] compares MCDM methods, which are multi-criteria grading model (MCGM), TOPSIS, VIKOR and PROMETHEE II to rank career preference of university students. There are eight professions are comparatively ranked and found that MCGM and PROMETHEE have equal performance based on demographical properties while the performance of VIKOR is changing when regret weight changes.

Kassim et al. [22] ranked the attributes of PCs and develops computer preference index (CPI) using Rank Ordered Centroid (ROC). The findings reveal that the most important attribute is the CPU, followed by the hard drive, price, memory card, warranty, size, screen resolution, Ethernet, weight and DVD. Whilst, the CPI is constructed by using the Simple Additive Weighting (SAW) method. Angiz et al. [23] integrate AHP with Data Envelopment Analysis (DEA)-based preferential aggregation method. The aim is to introduce preferential weights and ranking aspect of each decision-maker in coming up with an optimisation model that determines the best efficiency score of each alternative. These efficiency scores are then used to rank the alternatives and determine the group decision weights.

2.3. Approaches in allocation problem

A variety of exact [3], heuristic [7, 16], and metaheuristic [14] methods are developed to solve allocation problems. According to Zukhri and Omar [16], exact methods assure to give an optimum solution to the problem while heuristic methods only try to produce a good, but not necessarily optimum solution. Though, the time taken to find an optimum solution of a complex problem of the exact method is in a much greater than the heuristics. Heuristics and metaheuristics are often used when the problem becomes too large for exact methods.

Anwar and Bahaj [3] solved a student-project allocation problem by using IP. The objective is to assign students to their first-choice project and balance staff effort in the student-projects supervision. Ghazali and Abdul-Rahman [7] proposed a constructive heuristic method to solve the student-case assignment problem to minimize total completion time for solving cases for chambering. The solution to the problem becomes crucial especially when numerous preferences are involved.

Bakar and Ramli [4] employ 0-1 IP model to assign projects to students. AHP technique is used to determine the students' preference weight while team quality is measured by the average grade point of the project team members. The study aims to balance the gender/race mix proportions across team assignments to enhance gender/racial integration and to perceive fairness.

Meanwhile, Zukhri and Omar [16] explores the Genetic Algorithm (GA) to the new student allocation problem (NSAP), which allocate new students into certain classes. Based on the chromosomal representation, partition-based approach (PBA) and centre-based approach (CBA) were proposed. CBA is found to succeed in solving NSAP than PBA.

Harper et al. [24] proposed a GA for solving project assignment problem to produce a group of potential solutions, feasibility and optimality. Then, from a list of possible projects, students must choose their preferred choices of projects. In allocating students to projects, Abraham et al. [14] proposed two optimal linear-time algorithms, based on capacity constraints and preference are presented.

3. Methodology

This study aims to maximize the total preference of student-lecturer allocation problem. Three phases of the research process were conducted, which are; Phase 1: Preference criteria identification, Phase 2: A ranking analysis using AHP, and Phase 3: model development and problem-solving of student-lecturer allocation problem.

3.1. Phase 1: Preference criteria identification

In this phase, the preference criteria for the students to choose a supervisor for an internship program were identified. The preference criteria were found from various literature reviews and interviews [17].

From the interview, most of the students preferred a same-gender of a lecturer. This is because some students are more comfortable to meet and discuss their project either through face to face meeting or phone or by emails. Academic position of a lecturer is also an important criterion for the students. Students preferred different level of lecturer position as a supervisor to supervise them throughout the internship session. The criteria were adopted from Faudzi et al. [17], however, the capacity and gender criteria were not considered since they were selected as constraints in the modelling part. Five preference criteria were used as described in Table 1. Table 2 presents a description of the alternatives related to an academic position.

Table 1. Description of criteria.

Criteria	Description
Specialization	Preference to have a supervisor that is related to the field of interest
Academic position	Preference to have a supervisor that has a higher academic position
Availability	Preference to have a supervisor that is available to give commitments so that discussion can be made regularly
Professional support	Preference to have a supervisor that is able for giving professional support and encouragement
Relationship	Preference to have a good relationship between student-supervisor during internship

Table 2. Type of alternatives based on academic position.

Type	Description
Lecturer	Has teaching ability and a relevant basis of scholarly work or professional expertise and achievement
Senior lecturer	Has demonstrated excellence in teaching for at least five years
Associate professor	Has a scholar or professional reputation that shows a high degree of teaching proficiency and commitment, and demonstrates public, professional, or university service beyond the department
Professor	Has an accomplishment record that leads to an international or as appropriate, national reputation in his or her field

Questionnaires were developed and distributed to the Industrial Statistics students of UUM, which consists of pairwise comparison of criteria and alternatives. Justifications on the importance of the preference criteria and the rating process of weightage for each parameter were provided by respondents.

Convenience sampling was used to obtain the number of students as the potential respondents where the target population met the definite criteria, such as easy to access, available at given time, or willing to participate. In this study, 40 respondents were involved. In order to deal with the inconsistency problem, all judgments were repeated, as many times as needed to lower the inconsistency of the answer [25]. A consistency check was performed by using Consistency Index (C_I) to express the degree of consistency based on Saaty [26] as in Eq. (1).

$$CI = \frac{\lambda_{max} - n}{n - 1} \qquad (1)$$

where λ_{max} is the maximum eigenvalue; n is the number of criteria. Accordingly, the Consistency Ratio (CR) is defined as in Eq. (2):

$$CR = \frac{CI}{RI} \qquad (2)$$

where the Random Index (RI) is given in Table 3.

In Table 3, n is the number of criteria. The matrix is considered acceptable if the value of the CR is less or equal to 0.1. Although the number of respondents was small, it is believed that the respondents were enough to provide the intended evaluation results as all respondents were the students from semester 6 and above.

Table 3. Random index based on Saaty [26].

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

3.2. Phase 2: Ranking analysis using AHP

In this phase, AHP was used to rank the criteria. The basic AHP procedure involves structuring a decision problem, a listing of decision alternatives, and criteria selection. It is followed by setting the priority of the criteria and sub-criteria by using pairwise comparison. Next, a pairwise comparison of decision alternatives on each criterion and sub-criterion is obtained. Consistency checking is performed in every pairwise comparison exercise and obtaining an overall relative score for each option [26]. Five identified criteria and four types of alternatives were compared by using pairwise comparison of 1-9 AHP scale of importance introduced by Saaty [26], as shown in Table 4. By using Expert Choice 11 software, AHP is used to rank the criteria and determine the student's preference weight.

Table 4. AHP scales of importance.

AHP scale of importance	**Description**
1	Equal importance
2	Equally to moderately
3	Moderate importance
4	Moderately to strong
5	Strong importance
6	Strongly to very strong
7	Very strong importance
8	Very strong to extremely
9	Extreme importance

Figure 1 shows an example of the questionnaire and was answered by one of the respondents. It explains that, between the criteria of specialization and academic position (first row), the respondent is equally to moderately preferred the specialization criterion compared with academic position criterion.

In the second row, the respondent is equally to moderately preferred the availability criterion compared with the specialization criterion. Number 9 in the left-hand side (LHS) questionnaire means that criteria A was extremely importance compared with criteria B while number 1 means criteria A was equally important as criteria B.

Figure 2 shows the pairwise comparison matrix of criteria associated with Fig. 3. The value 2 (with *) means that the respondent is equally to moderately preferred the specialization criterion compared to academic position criterion. On the other hand, the value 1/2 (with **) means that the respondent is equally to moderately preferred the availability criterion compared to specialization criterion.

Next, the same pairwise comparison was developed based on the questionnaire answered by the respondents to get the weight for each alternative (lecturer, senior lecturer, associate professor and professor) under each criterion. Figure 3 shows the alternative pairwise evaluation comparison under specialization criterion.

Criteria A	LHS												RHS					Criteria B
Specialization	9	8	7	6	5	4	3	(2)	1	2	3	4	5	6	7	8	9	Academic Position
Specialization	9	8	7	6	5	4	3	2	1	(2)	3	4	5	6	7	8	9	Availability
Specialization	9	8	7	6	5	4	(3)	2	1	2	3	4	5	6	7	8	9	Professional Support
Specialization	9	8	7	6	5	4	3	2	(1)	2	3	4	5	6	7	8	9	Relationship
Academic Position	9	8	7	6	5	4	3	2	1	2	3	4	(5)	6	7	8	9	Availability
Academic Position	9	8	7	6	5	4	3	2	(1)	2	3	4	5	6	7	8	9	Professional Support
Academic Position	9	8	7	6	5	4	3	2	1	(2)	3	4	5	6	7	8	9	Relationship
Availability	9	8	7	6	5	(4)	3	2	1	2	3	4	5	6	7	8	9	Professional Support
Availability	9	8	7	6	5	4	3	(2)	1	2	3	4	5	6	7	8	9	Relationship
Professional Support	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Relationship

Fig. 1. Example of questionnaire answered by a respondent.

Criteria	Specialization	Academic Position	Availability	Professional Support	Relationship
Specialization	-	2*	1/2**	3	1
Academic Position	1/2	-	1/5	1	1/2
Availability	2	5	-	4	2
Professional Support	1/3	1	1/4	-	1/2
Relationship	1	2	1/2	2	-

Fig. 2. Pairwise comparison matrix of criteria.

Alternative	Lecturer	Senior Lecturer	Professor	Associate Professor
Lecturer	-	1/2	1/2	1/2
Senior Lecturer	2	-	1/2	1
Professor	2	2	-	1
Associate Professor	2	1	1	-

Fig. 3. Alternative pairwise comparison matrix for specialization criterion.

3.3. Phase 3: Model development and problem-solving of student-lecturer allocation problem

In order to allocate students to lecturers, it requires a preference matrix as the assignment cost. The total preference of the student-lecturer allocation matrix was developed where the assignment is based on the allocation with maximum weightage value in order to maximize the preferences of the overall student-lecturer allocation. The data is provided in the form of preference matrix, where the values are based on the summation of subtracting the weightage value of the preference criteria with the weightage value of each alternative under each criterion.

In allocating students to a lecturer, a model of student-lecturer allocation problem was developed (as presented in section 3.3.1) according to the related constraints, which are capacity and gender. It is assumed that every student under the same type of lecturer will have the same weightage value and the weightage value was assumed to be zero if the student and lecturer have different gender. The student-lecturer allocation model was then solved by using optimization software, QM for Windows in assigning suitable lecturer to each student based on preferences and satisfying all the related constraints.

Problem formulation

In this section, the mathematical model of the student-lecturer allocation problem based on preferences is presented, which based on the basic model of the assignment problem in Basirzadeh [1].

$$Max\ Z = \sum_{i=1}^{n} \sum_{j=1}^{m} \Psi_{ij} X_{ij} \tag{3}$$

s.t.

$$\sum_{i=1}^{n} \sum_{j=1}^{m} X_{i j_l} \leq C_l;\ \forall l \tag{4}$$

$$\sum_{j=1}^{m} X_{ij} = 1;\ \forall i \tag{5}$$

$$\sum_{i=1}^{n} \sum_{j=1}^{m} X_{i_g j_g} \leq C_g;\ \forall g \tag{6}$$

$$X_{ij} = \begin{cases} 1 & \text{if student } i \text{ is assigned to lecturer } j \\ 0 & \text{otherwise} \end{cases} \tag{7}$$

where;

Ψ_{ij} = weight preference for student i choosing lecturer j

i = 1, 2,.... n

j = 1, 2, ... m

l = types of academic position, where l = {1, 2, 3, 4}

g = types of gender, where g = {0, 1}

m = number of lecturers

n = number of students

C_1 = number of students based on academic position l

C_g = number of students based on gender g

The objective function of the problem is to maximize the total preference of the student-lecturer allocation problem as shown in Eq. (3). The decision variables of X_{ij} is defined as 0-1 as presented in Eq. (7) where 1 is if student i is assigned to lecturer j and 0 is otherwise. The constraints of the problem are defined in Eqs. (4) to (6). Equation (4) shows that each lecturer is assigned to at most a certain number of students based on their academic position l. Each type of academic position; lecturer, senior lecturer, associate professor, and professor has different capacity of students to be supervised. Equation (5) explains that each student needs to be assigned to a lecturer. However, in this case, the students are required to be assigned to same gender of lecturer. Thus, Eq. (6) establishes that every allocation needs to be assigned to the same gender; i.e., male students are allocated to the male lecturer and female students are allocated to the female lecturer.

4. Results and Discussion

4.1. Demographic information

General demographic data were compiled from the respondents and the summary of the respondent's demographic background is presented in Table 5. Majority of the respondents were female, which consist of 60% of the overall sample and 40% were male. In addition, it is affirmed that the students' CGPA are above 2.50, which means that they can proceed for practicum session. Based on UUM's rules and regulation, to proceed with the practicum session, the students need to achieve CGPA of higher than 2.50 or else they need to extend their practicum session by repeating the problematic papers to repair their academic merit. In this study, majority of the respondents (52.5%) were categorized under CGPA between 3.00 and 3.50, 27.5% of the respondents with CGPA between 2.50 and 2.99, 20% of the respondents with CGPA between 3.51 and 4.00.

Table 5. Demographic backgrounds of the respondents.

Items	Sub-items	Frequency (N)	Percentage (%)
Gender	Male	16	40
	Female	24	60
Semester	6	39	97.5
	7	1	2.5
CGPA	< 2.5	0	0
	2.50 - 2.99	11	27.7
	3.00 - 3.50	21	52.5
	3.51 - 4.00	8	20

4.2. Ranking analysis

The analysis shows that some of the results were not consistent. After repeating the AHP process, the result shows its consistency with an average of 0.04. Hence, it is concluded that the result is reliable and achieves consistency based on Saaty [26]. Tables 5 and 6 show the overall average priorities of criteria and alternatives for the 40 respondents. From Table 6, it shows that professional support is preferred the most by many students, with global weight 25.59%, and followed by specialization (22.67%), availability (22.56%), relationship (20.20%), and academic position (8.98%). This shows that the students really wanted to have a supportive supervisor that can give support or encouragement when needed during their internship session.

Professional support becomes the most important criterion in choosing a supervisor. Professional support or encouragement is important to the students throughout the internship time because it shows that both are always in touch. This will permit time for the students and lecturer to consider the result of decisions taken during the internship process. Although academic position becomes the last choice among the preferable criteria, it is important to note that this criterion is also important since some students still consider the academic position as their preferences.

Meanwhile, Table 7 clarifies that most of the respondents are preferred to choose senior lecturer and lecturer as their supervisor with the weights of 27.56% and 26.24%, respectively. The students assumed that the lower the academic positions of the supervisor, the higher tendency the students can get professional support and encouragement since the supervisors may have ample time for supervising them.

However, the students still consider lecturer's specialization as their choice. Based on the results, it shows that specialization criterion is ranked as the second-best criterion. The students believed that most of the senior lecturers have enough knowledge to guide them throughout their internship process.

Table 6. Priority of criteria.

Criteria	Weightage	Rank
Professional support	0.2559	1
Specialization	0.2267	2
Availability	0.2256	3
Relationship	0.2020	4
Academic position	0.0898	5
Total weight	1	

Table 7. Priority of alternatives.

Alternatives	Weightage	Rank
Senior lecturer	0.2756	1
Lecturer	0.2624	2
Professor	0.2359	3
Associate Professor	0.2260	4
Total weight	1	

4.3. Allocation of student-lecturer based on preferences

The weightage value for each criterion and alternative obtained from the previous phase were used to develop a preference matrix. Table 8 shows the weightage value of each alternative's criteria for 40 students. The data provided in the matrix are the values, which based on the summation of subtracting the weightage value of the preference criteria with the weightage value of each alternative under each criterion. Hence, Table 9 shows the preference matrix of 40 students.

Table 8. Relative weights for each alternative of each student.

Criteria	Student 1	Student 2	…	Student 40
1. Specialization				
Lecturer	0.148	0.144	…	0.250
Senior Lecturer	0.426	0.144	…	0.250
Associate Professor	0.231	0.320	…	0.250
Professor	0.195	0.392	…	0.250
2. Academic Position				
Lecturer	0.208	0.062	…	0.364
Senior Lecturer	0.311	0.059	…	0.156
Associate Professor	0.288	0.297	…	0.300
Professor	0.193	0.581	…	0.180
3. Availability				
Lecturer	0.267	0.558	…	0.340
Senior Lecturer	0.360	0.246	…	0.281
Associate Professor	0.170	0.125	…	0.239
Professor	0.230	0.071	…	0.140
4. Professional Support				
Lecturer	0.191	0.449	…	0.268
Senior Lecturer	0.467	0.235	…	0.268
Associate Professor	0.444	0.286	…	0.300
Professor	0.222	0.143	…	0.238
5. Relationship				
Lecturer	0.111	0.286	…	0.331
Senior Lecturer	0.222	0.286	…	0.131
Associate Professor	0.444	0.286	…	0.300
Professor	0.222	0.143	…	0.238

Table 9. Preference matrix of 40 students.

	i_1	i_2	i_3	i_4	i_5	…	i_{40}
j_a	0.164	0.300	0.572	0.359	0.477	…	0.269
j_b	0.330	0.188	0.130	0.223	0.241	…	0.204
j_c	0.223	0.219	0.075	0.153	0.114	…	0.221
j_d	0.175	0.184	0.113	0.156	0.060	…	0.197

Table 10 is a summary of the number of lecturer and capacity. Each type of lecturer has a different capacity of the student to be supervised based on their workload. There are 18 lecturers and 40 students representing Industrial Statistics program.

The summary of the output obtained using the optimization approach is shown in Table 11. The optimal solution is obtained with total preference of 12.55. From the result, each student is assigned to a lecturer and each type of lecturer is assigned to the same gender of student, where *p* is referred to as female and *l* are males. Each type of lecturer is assigned to several students based on their capacity.

Lecturers a_1, a_2, a_3, a_5, a_6, a_7, a_8 are assigned to three students each while lecturer a_4 is assigned to only two students, which are students 33 and 34. Meanwhile, b_9, b_{10}, b_{11}, b_{12}, b_{13}, b_{16}, c_{17}, d_{18} are assigned to two students each, b_{14} is assigned to only one, which is student 12. On the other hand, b_{15} is not assigned to any student. Based on the presented solutions in Table 11, all constraints were full filed.

Table 10. Number of lecturer and capacity of student.

Type of lecturer	No. of lecturer	Capacity
Lecturer, (a)	8	3
Senior Lecturer, (b)	8	2
Associate Professor, (c)	1	2
Professor, (d)	1	2
Total	18	44

Table 11. Summary of the output.

Type of lecturer	Student capacity	No. of assigned students	Assigned students
j_a1_p	3	3	3_p, 6_p, 24_p
j_a2_p	3	3	21_p, 39_p, 22_p
j_a3_p	3	3	10_p, 18_p, 27_p
j_a4_l	3	3	4_l, 5_l, 34_l
j_a5_p	3	3	23_p, 31_p, 40_p
j_a6_l	3	3	2_l, 25_l, 35^l
j_a7_l	3	2	33_l, 37_l
j_a8_p	3	3	19_p, 30_p, 36_p
j_b9_l	2	2	14_l, 28_l
j_b10_p	2	2	1_p, 32_p
j_b11_p	2	2	90_p, 20_p
j_b12_l	2	2	8_l, 29_l
j_b13_p	2	2	11_p, 13_p
j_b14_p	2	1	12_p
j_b15_p	2	-	-
j_b17_l	2	2	7_l, 26_l
j_c17_p	2	2	15_p, 38_p
j_d18_l	2	2	16_l, 17_l

5. Conclusions

This paper aims to optimize the preference of student-lecturer allocation problem using AHP and IP. Five criteria are considered, which are professional support, specialization, availability, relationship and academic position. Meanwhile, a lecturer is classified into four categories, i.e., lecturer, senior lecturer, associate professor and professor. The results show that professional support rank number one follows by specialization, availability, relationship and academic position. Students have chosen senior lecturer as the first priority to supervise them. Then, the ranking goes to the lecturer, professor and associate professor. Next, students are assigned to each lecturer based on their preferences. Results show that all constraints were fulfilled. This study found that by solving a student-lecturer allocation problem of internship program based on preferences, improved satisfaction of students and the supervising staff can be achieved. The new gender-related constraint proposed in this study benefits both students and lecturers as they can easily work.

Finally, by initiating a new perspective in developing a student-lecturer allocation model by using AHP and IP, the proposed study can play a significant role in the future works especially in solving allocation problem. It is suggested that by integrating more criteria from diverse assessment methodological frameworks, the study can build strength and offers a more holistic assessment method to reflect real-world case problem. Moreover, metaheuristics approaches such as genetic algorithm or ant colony optimization also can be proposed to solve a more complex problem.

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