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A Decision Support System for student's room allocation

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ABSTRACT

This article aims to analyse the management of student housing allocation within a university. The research consists of allocating university rooms to students. As many requests for accommodation are received by the university accommodation officer each year, it will be impossible to satisfy all the requests by housing all the students in the university. Thus, a technique for ranking students is essential to select them.

We propose a decision support system based on multi-criteria decision support methods. For this purpose, we apply the three methods AHP, WSM and PROMETHEE. First, AHP to rank the weights of the criteria, then AHP, WSM and PROMETHEE to rank the students. The objective is to find out how each method ranks the students. Then to compare the ranking results obtained by these three methods. Finally, we choose the most appropriate method for this case. As a result, we find that each method can rank the students. Subsequently, AHP compared to WSM gives a very different ranking result and AHP compared to PROMETHEE has an equal half ranking. However, WSM compared to PROMETHEE has only a slight equality in ranking. From an application point of view, we observe that AHP is not very practical for multiple alternatives.

Keywords: accommodation allocation, Decision Support System, AHP, WSM, PROMETHEE.

INTRODUCTION

According to what we have identified, several authors have already been interested in the subject of student housing management [1] [2] [3]. Mayer [4] said that “*our current global situation with regard to the student housing sector is anything but consistent, and this can be a huge problem even in many developed countries*” such as the UK, India, South Africa, and Canada.

However, each university has its own procedures for allocating student accommodation. The most common is the consideration of criteria which vary in number according to each institution [5] [6].

Our research has focused on decision support systems. Since 1971 until today, several authors have investigated the application of these systems such as Eom et al. [7] [8] and Papathanasiou et al. [9]. Authors like Carlsson and Walden [10] have noted that decision support systems are currently innovative and among the technological challenges. Keenan [11] has shown that they are spread over several areas including life sciences and biomedicine, physical sciences, and social sciences.

Thus, we have developed a decision support system based on AHP, WSM and PROMETHEE to rank students and facilitate their selections during the housing allocation process.

1. ISSUES

Regarding the criteria for housing allocation, each student is considered as a specific case. The idea is to select those students who meet them. However, there is much more demands than offers, but sometimes there are many more students who meet the criteria than there is housing to be allocated [12]. So, the question which remains is: what housing applications should be admitted or rejected? And which of these students will be housing allocated?

To do this, a method needs to be chosen to fairly distribute this accommodation.

2. METHODOLOGY

Multi-criteria analysis methods are used to formulate real problems, according to three basics formulations: the choice problem, noted P_α , the sorting or allocation problem noted P_β and the ranking problem noted P_γ [13]. The allocation of accommodation to students belongs to the ranking problem (P_γ). This situation led us to choose the following three methods: AHP, WSM and PROMETHEE to solve the problem of ranking students.

2.1. Analytic Hierarchy Process (AHP)

AHP was developed by Saaty in 1970 [14]. According to its founder [15], the method is based on three concepts: hierarchical structure, priority structure and logical consistency. To find the logical consistency, the following calculations have to be made:

(1) : Medium consistency

$$\lambda_{max} = a_{ij} \frac{w_j}{w_i}$$

(2) : Consistency index

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

(3) : Consistency ratio

$$CR = \frac{CI}{RI}$$

Finally, when comparing pairs, the consistency ratio (CR) must be within 0.1. Otherwise, the results could be inconsistent.

2.2. Weigh Sum Method (WSM)

The weighted sum method combines all criteria into one scalar composite objective function using the weighted sum [16]. The steps to follow are normalisation of all alternatives,

normalisation of the weights whose sum must be equal to 1 and implementation of the weighted sum. The result is obtained by [17] :

$$R(a_{ij}) = \sum_{j=1}^n w_j a_{ij}$$

2.3. Preference Ranking Organisation METHods for Enrichement Evaluation

Brans initiated the PROMETHEE method in 1982 [18] . It is a multi-criteria method for defining the relationships of outranking, indifference, and incomparability between alternatives. Two concepts are to be considered, namely the preference index and the outranking flows. The method of calculating these flows [19] is presented below.

The result is obtained by comparing the outflows, inflows, and net flows of the alternatives.

(1) : Preference index

$$\left\{ \begin{array}{l} \pi(a_1, a_2) = \sum_{j=1}^k P_j(a_1, a_2)w_j \\ \pi(a_2, a_1) = \sum_{j=1}^k P_j(a_2, a_1)w_j \end{array} \right.$$

(2) : Outflow

$$\Phi^+(a) = \frac{1}{n-1} \sum_{x \in A} \pi(a, x)$$

(3) : Inflow

$$\Phi^-(a) = \frac{1}{n-1} \sum_{x \in A} \pi(x, a)$$

(4) : Net flow

$$\Phi(a) = \Phi^+(a) - \Phi^-(a)$$

3. PROTOTYPE

Let us recall that a DSS is structured by three main components which are: the model management system, the user interface, and the knowledge base [20]. The DSS will be composed by a Data Base, a Model Base, and a Human/Interface module.

3.1. Database

The developed DSS consists of allocating housing to students through their applications. We have implemented a relational database management system using three methods AHP, WSM and PROMETHEE. We present in the following figures some structure of this database.

3.2. Process

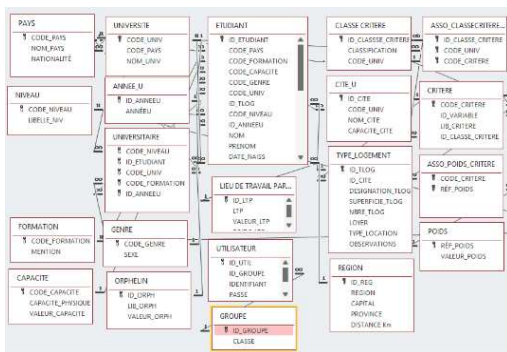


Figure 1: extract of relationships between tables

Figure 2: data entry form

The application concerns a university that has eleven criteria for evaluating students [12]. These criteria are grouped into two sets, of which the first six are basic criteria and the last five are social criteria. The following table 1 describes these evaluation criteria.

The application of the comparison scale according to Saaty [21], allowed us to obtain the criteria judgement matrix and the result of the priorities presented in figure 5. Thus, the values of the elements of logical consistency are given below.

	CP	DD	EC	LTP	OP	Poids
CP	1	3	4	4	3	0,452
DD	1/3	1	2	2	1	0,177
EC	1/4	1/2	1	1	1/2	0,096
LTP	1/4	1/2	1	1	1/2	0,096
OP	1/3	1	2	2	1	0,177

Figure 5 : priority of criteria

Logical consistency check

$$\lambda_{max} = 5.026$$

$$CI = 0.007$$

$$CR = 0.006$$

As CR<0.1 the comparison is consistent.

Now that the criteria weights are obtained, we can move on to applying the three methods to rank the students. The ranking results for each method are given in the following figure 6.

		L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
		I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		3	3	1	2	0	3	0	0	2	0	1	2	3	0	2	2	2	2	2	2	0	1	1	1	2	3
		2	4	3	3	5	1	2	7	9	8	6	8	0	4	4	2	5	7	1	6	5	1	1	8	6	5
	Note	0,076	0,054	0,072	0,053	0,037	0,047	0,039	0,039	0,039	0,037	0,037	0,037	0,035	0,036	0,036	0,033	0,033	0,030	0,031	0,029	0,029	0,028	0,028	0,028	0,028	0,027
AHP	Rang	1	3	2	4	9	5	6	6	6	10	10	10	15	13	13	16	17	19	18	20	20	22	22	22	22	26
	Note	5,781	4,794	5,292	4,736	3,549	4,570	3,958	3,958	3,958	3,820	3,820	3,820	2,882	3,208	3,208	3,407	3,071	2,524	2,933	2,796	2,796	2,658	2,658	2,658	2,520	
WSM	Rang	1	3	2	4	12	5	6	6	6	9	9	9	18	14	14	13	16	25	17	19	19	21	21	21	21	26
	Phi	0,370	0,260	0,241	0,238	0,124	0,107	0,082	0,082	0,082	0,046	0,046	0,046	-0,037	-0,052	-0,052	-0,073	-0,075	-0,080	-0,111	-0,143	-0,143	-0,182	-0,182	-0,182	-0,230	
PROMETHEE	Phi+	0,422	0,334	0,328	0,326	0,248	0,204	0,172	0,172	0,172	0,152	0,152	0,152	0,157	0,095	0,095	0,093	0,079	0,135	0,059	0,048	0,048	0,020	0,020	0,020	0,000	
	Phi-	0,052	0,074	0,087	0,088	0,124	0,097	0,090	0,090	0,090	0,106	0,106	0,106	0,194	0,147	0,147	0,166	0,155	0,215	0,170	0,190	0,190	0,202	0,202	0,202	0,230	
	Rang	1	2	3	4	5	6	7	7	7	10	10	10	13	14	14	16	17	18	19	20	20	22	22	22	26	

Figure 6: Ranking of students with AHP, WSM and PROMETHEE

3.4. Discussion

In 2000, Zhendong and Moore [22] developed a student housing management software by assigning a student to a dormitory in a building according to his or her gender and study level. In 2015, Scutariu and Alexandrescu [23] discussed campus housing allocation by proposing an application that calculates the housing share of different faculties. Youssouf [24] proposed an automated system for the allocation of student housing at the Université de Toamasina in 2015.

For our part, we developed a DSS focusing on student housing allocation using three multi-criteria decision support methods (AHP, WSM and PROMETHEE) to better compare the results obtained. And to make a choice between the method used by the university, we illustrate in terms of number and percentage in the following table 3 the two-by-two comparison of the results obtained and the similarity of student ranks.

Table 3 : similarity of student ranks on two methods

	WSM		PROMETHEE	
	Number	%	Number	%
AHP	8	30,77	13	50
WSM			4	15,38

4. CONCLUSION AND PERSPECTIVE

Three methods were studied: AHP, WSM and PROMETHEE. The result showed us that each method was able to rank the students. Nevertheless, we can report that a difficulty was encountered when using the AHP method. This being when the criteria or the alternatives are more numerous. For example, in the case of the 78 students in the Law stream and the other

applications accepted in the other streams, the students are even more numerous. It will be difficult to handle such a large square matrix.

So, in our future research, we will use the AHP method only to calculate the criteria weights. On the other hand, WSM and PROMETHEE for storing students. And in addition, we will look for another method that is easier to handle and combine with these two methods for storing students. Then, we will not stop with a simple application of the methods, but we will look for a trick allowing to recover all the ranks of the students carried out by the methods implemented in the system and to reorder the students from all their ranks.

Finally, our objective in this first analysis is then to integrate all these ranking methodologies into the developed prototype, offering end users the possibility of having several methodologies to use. And in the perspective, it will be to find the possibility of using all the results of these methods to obtain a new ranking of the students.

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