



A Decision Support System for student's room allocation

Rôlin Gabriel Rasoanaivo, Pascale Zaraté

► To cite this version:

Rôlin Gabriel Rasoanaivo, Pascale Zaraté. A Decision Support System for student's room allocation. 8th International Conference on Decision Support System Technology: Decision Support addressing modern Industry, Business and Societal needs (ICDSST 2022), EWG-DSS, May 2022, Thessaloniki, Greece. pp.30-36. hal-03726288

HAL Id: hal-03726288

<https://hal.science/hal-03726288>

Submitted on 18 Jul 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

ICDSST 2022 on Decision Support addressing modern Industry, Business and Societal needs

A Decision Support System for student's room allocation

Rôlin Gabriel Rasoanaivo¹, Pascale Zaraté¹

1 : IRIT, Université de Toulouse, CNRS, Toulouse, INP, UT3, UT1, Toulouse, France
rolin-gabriel.rasoanaivo@ut-capitole.fr, Pascale.Zarate@ut-capitole.fr

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 Enrichment 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

$$\begin{cases} \pi(a_1, a_2) = \sum_{j=1}^k P_j(a_1, a_2) w_j \\ \pi(a_2, a_1) = \sum_{j=1}^k P_j(a_2, a_1) w_j \end{cases}$$

(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

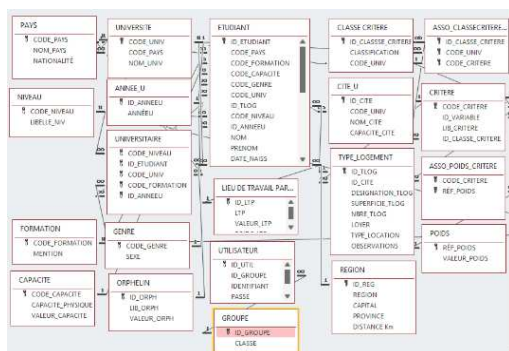


Figure 1: extract of relationships between tables

Etat civil

Codage

Civilité

NOM

Prénom(s)

Pays d'origine

Nationalité

Date de naissance

Lieu de naissance

Capacité physique

Contact

Email

Téléphone

Adresse

Région

Situation pédagogique

Université de Toamasina

Année U

Êtes-vous inscrit?

Mention

Niveau

Êtes-vous passant(e)?

Année du Bacc.

Êtes-vous boursier?

Situation générale

Êtes-vous salarié?

Nombre d'enfant à charge de parent

Lie de travail de parent

Orphelin de parent

Logement à demander

Type

Superficie

⏮

⏪

⏩

Nouveau

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.

Table 1 : Criteria for evaluating students at a university

Basic criteria	Admission requirements
Age	By level
Year of Baccalaureate	By academic year
Administrative registration	Enrolled
Examination result	Successful
Nationality	According to the case
Professional situation	Not employed

Social criteria	Value
Physical capacity (CP)	Normal = 5 ; Disability = 10
Orphan of parent (OP)	None = 0; Father or Mother = 5; Father and Mother = 10
Parent's place of work (LTP)	University = 5 ; Other = 0
Dependent child of parent (EC)	By number
Distance from home (DD)	By mileage

In relation to these two groups of criteria, the assessment procedure proceeds in two stages including the admission test for the basic criteria and the ranking by social criteria as the following figure 3 shows.

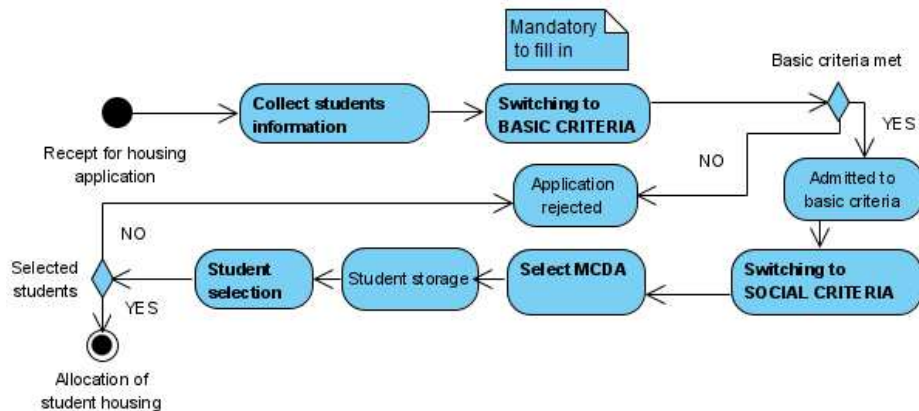


Figure 3: processing applications for student's room

3.3. Result

3.3.1. Assessment according to the basic criteria

This concerns the housing applications of students in the first year of the Computer Science and Law degrees. The result is shown in Table 2 below.

Table 2 : Result of the processing applications for student accommodation

Mention	Application received	Student meets basic criteria	Application rejected
Computer science	35	26	9
Law	101	78	23

3.3.2. Assessment according to social criteria

This second phase will deal with the 26 and 78 students meeting the basic criteria. We show for each of the three methods chosen, the result for the 26 students of the Computer Science major. To begin with, below in the figure 4 the initial judgement matrix.

Student	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1	L1
	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1	M1
	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1	I1
	A0	A0	A0	A0	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1	A1
	55	66	77	88	11	22	33	55	66	88	12	23	45	56	55	55	55	55	55	55	55	55	55	55	55	55	55	55
CP	102	100	100	100	100	100	923	100	100	100	100	100	350	100	100	100	102	100	100	399	100	923	399	100	100	100	100	100
DD	2	3	5	4	2	1	1	3	4	2	4	1	2	6	5	2	1	4	5	1	3	4	2	2	5	6	6	6
EC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5	0	0	0	0	0
LTP	5	0	5	5	0	0	10	0	5	0	0	5	10	0	0	0	5	0	0	10	5	10	0	5	0	5	0	5
OP																												

Figure 4: initial judgement matrix

	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

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.

[illegible]

3.4. Discussion

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.

	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.

REFERENCES

1. James, R., & McInnis, C. (1997). The residential arrangements of first-year students in Australia: student accommodation and adjustment to university. *Journal of The First-Year Experience & Students in Transition*, 9(2), 33–52.
2. Thomsen, J., & Eikemo, T. (2010). Aspects of Student Housing Satisfaction : A Quantitative Study. *Journal of Housing and the Built Environment*, 25, 273–293. <https://doi.org/10.1007/s10901-010-9188-3>
3. Newell, G., & Marzuki, M. J. (2018). The emergence of student accommodation as an institutionalised property sector. *Journal of Property Investment & Finance*.
4. Mayer, B. (2022). The student accommodation sector around the world. *HousingAnywhere*. Retrieved March 22, 2022, from <https://housinganywhere.com/student-accommodation-around-the-world>
5. Allocation-Policy-version-26-2020-21_0.pdf. (n.d.). Retrieved from https://www.chi.ac.uk/app/uploads/2021/11/Allocation-Policy-version-26-2020-21_0.pdf
6. student-accommodation-allocation-policy-201920.pdf. (n.d.). Retrieved from <https://intranet.royalholloway.ac.uk/students/assets/docs/pdf/student-accommodation-allocation-policy-201920.pdf>
7. Eom, H. B., & Lee, S. M. (1990). A Survey of Decision Support System Applications (1971–April 1988). *INFORMS Journal on Applied Analytics*, 20(3), 65–79. <https://doi.org/10.1287/inte.20.3.65>
8. Eom, S., & Kim, E. (2006). A survey of decision support system applications (1995–2001). *J. Oper. Res. Soc.* <https://doi.org/10.1057/palgrave.jors.2602140>
9. Papathanasiou, J., Zaraté, P., & Freire de Sousa, J. (Eds.). (2021). *EURO Working Group on DSS: A Tour of the DSS Developments Over the Last 30 Years*. Cham : Springer International Publishing. <https://doi.org/10.1007/978-3-030-70377-6>
10. Carlsson, C., & Walden, P. (2021). Decision Support Systems: Historical Innovations and Modern Technology Challenges. In J. Papathanasiou, P. Zaraté, & J. Freire de Sousa (Eds.), *EURO Working Group on DSS: A Tour of the DSS Developments Over the Last 30 Years* (pp. 1–14). Cham : Springer International Publishing. https://doi.org/10.1007/978-3-030-70377-6_1
11. Keenan, P. B. (2021). Thirty Years of Decision Support : A Bibliometric View. In J. Papathanasiou, P. Zaraté, & J. Freire de Sousa (Eds.), *EURO Working Group on DSS: A Tour of the DSS Developments Over the Last 30 Years* (pp. 15–32). Cham : Springer International Publishing. https://doi.org/10.1007/978-3-030-70377-6_2

12. Rasoanaivo, R. G. (2020, January 10). *La méthode PROMETHEE pour l'aide à la décision multicritère : application à la gestion d'attribution de logements universitaires (Cas de l'Université de Toamasina)* (Mémoire de DEA). Université de Toamasina.
13. Roy, B. (1996). Problematics as Guides in Decision Aiding. In B. Roy (Ed.), *Multicriteria Methodology for Decision Aiding* (pp. 57–74). Boston, MA : Springer US. https://doi.org/10.1007/978-1-4757-2500-1_6
14. Saaty, R. W. (1987). The analytic hierarchy process—what it is and how it is used. *Mathematical Modelling*, 9(3), 161–176. [https://doi.org/10.1016/0270-0255\(87\)90473-8](https://doi.org/10.1016/0270-0255(87)90473-8)
15. Saaty, T. L. (1990). How to make a decision: The analytic hierarchy process. *European Journal of Operational Research*, 48(1), 9–26. [https://doi.org/10.1016/0377-2217\(90\)90057-1](https://doi.org/10.1016/0377-2217(90)90057-1)
16. Application Of Weight Sum Model (WSM) In Determining Special Allocation Funds Recipients | Handoko | The IJICS (International Journal of Informatics and Computer Science). (n.d.). Retrieved March 12, 2022, from <https://www.ejurnal.stmik-budidarma.ac.id/index.php/ijics/article/view/528>
17. Weighted Sum Method - Multi Criteria Decision Making. (2020, February 20). *GeeksforGeeks*. Retrieved from <https://www.geeksforgeeks.org/weighted-sum-method-multi-criteria-decision-making/>
18. Brans, J. P., Vincke, Ph., & Mareschal, B. (1986). How to select and how to rank projects: The Promethee method. *European Journal of Operational Research*, 24(2), 228–238. [https://doi.org/10.1016/0377-2217\(86\)90044-5](https://doi.org/10.1016/0377-2217(86)90044-5)
19. Mareschal, B., Brans, J., & Vincke, P. (1984). Prométhée : a new family of outranking methods in multicriteria analysis. *undefined*. Retrieved from <https://www.semanticscholar.org/paper/Prom%C3%A9th%C3%A9%3A-a-new-family-of-outranking-methods-in-Mareschal-Brans/a8f3612f9e89944a61c5b64001a6fc0f3080a643>
20. Sprague, R. H. (1980). A Framework for the Development of Decision Support Systems. *MIS Quarterly*, 4(4), 1–26. <https://doi.org/10.2307/248957>
21. Saaty, T. L. (1977). A scaling method for priorities in hierarchical structures. *Journal of Mathematical Psychology*, 15(3), 234–281. [https://doi.org/10.1016/0022-2496\(77\)90033-5](https://doi.org/10.1016/0022-2496(77)90033-5)
22. Zhendong, J., & Moore, R. (2000). *Specification of Software Systems for Managing Student Accommodation and a Research Laboratory Network*. February 2001 UNU/IIST, P.O. Box 3058, Macau.
23. Scutariu, A., & Alexandrescu, A. (2015). Allocating accommodation in a university Campus, 9.
24. Youssouf, H., & Rahajaniaina, A. (2015). *Automatisation de la gestion d'attribution de logement « Cas de l'Université de Toamasina »*. Tamatave : Université de Toamasina.