

A Multi-Criteria Analysis of University Housing Options Using Weighted Sum Model

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Abstract

This study presents a novel application of the Multi-Criteria Decision-Making (MCDM) Weighted Sum Model (WSM) technique to assist students in selecting suitable university housing options. We identified five key criteria—location, affordability, amenities, room type, and social environment—based on a survey of prospective students' preferences. Using the Analytic Hierarchy Process (AHP), we calculated the weights for each criterion, reflecting the priorities of the surveyed students. We then applied the MCDM-WSM methodology to rank the housing options by calculating the weighted scores for each criterion. Our findings reveal a ranked list of university housing options that can guide students in making well-informed decisions based on their needs and preferences. The study demonstrates the significance of using advanced decision-making techniques in transforming complex decision-making processes into more structured, transparent, and reliable approaches. Furthermore, it highlights potential research gaps and future research directions to enhance the quality of choices and cater to the diverse needs of students in selecting university housing.

Keywords: Multi-Criteria Decision-Making (MCDM); Weighted Sum Model (WSM); University Housing Selection; Analytic Hierarchy Process (AHP); Decision Support System.

1. Introduction

Selecting suitable university housing is a critical decision for students, as it profoundly impacts their academic performance, social experiences, and overall well-being. Given the plethora of housing options available, students face the daunting challenge of making informed choices that cater to their unique preferences and needs. Although several decision-making tools and models have been proposed in the literature, there remains a research gap in providing comprehensive and user-friendly solutions tailored to individual student priorities. This article aims to address this gap by examining the significance of integrating the Weighted Sum Model (WSM) (Nejati et al. 2014) into Decision Support Systems (DSS) to streamline (Sari et al. 2018; Kharisman Ndruru 2020; Khaidir 2014) the selection of optimal university housing options.

The Weighted Sum Model (WSM) is a popular multi-criteria decision-making (MCDM) technique that assigns weights to individual criteria, aggregating the weighted scores to compute an overall evaluation score. In the context of university housing, criteria may encompass factors such as location, affordability, amenities, and social environment. Decision-makers can rank their choices by giving weights to these factors (Chou and Gusti Ayu Novi Yutami 2014; Mateo 2012; Kurian, P.R, and V.R 2019).

Decision Support Systems (DSS) are information systems designed to facilitate decision-making activities by providing structured methodologies, data, and tools for analyzing and solving complex problems (Karismariyanti 2011; Sanjani, Hartati, and Sudarmaningtyas 2014; Perera, Carvalho, and Soares 2014; Tanjung et al. 2018). Integrating the Weighted Sum Model within a DSS allows for more effective processing of various housing options, taking into account user

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preferences and presenting a ranked list of the most suitable alternatives. This connection allows the DSS to provide individualized recommendations that match individual tastes, improving university housing decision-making for students.

The significance of this study lies in addressing the research gap by proposing a robust and tailored solution for university housing selection. By leveraging the Weighted Sum Model within a Decision Support System, students can make well-informed housing decisions that best match their priorities and contribute to their academic and social success. The subsequent sections will delve into the complexities of the Weighted Sum Model and examine its implementation in Decision Support Systems for the purpose of enhancing the efficiency of the university housing selection procedure.

2. Methods

The present section expounds on the methodology utilized in our investigation to incorporate the Weighted Sum Model (WSM) into a Decision Support System (DSS) aimed at determining the most suitable university housing alternatives. The proposed method consists of four main steps: defining criteria, collecting data, weighting criteria, and applying the WSM.

2.1. Defining Criteria

The initial stage of the Multiple Criteria Decision Making-Weighted Sum Model (MCDM-WSM) entails the identification of pertinent criteria for the assessment of various alternatives for university housing (Haswan 2017; Sheng et al. 2005). Through conducting a thorough examination of relevant academic sources and administering surveys to potential enrollees, the subsequent essential factors were determined:

- a. **Location:** The ideal location should be in close proximity to the campus, easily accessible by public transportation, and equipped with essential facilities such as grocery stores, restaurants, and medical services.
- b. **Affordability:** The monthly rental fee and its accompanying expenses, including utilities, maintenance, and insurance.
- c. **Amenities:** The provision of amenities and provisions such as wireless internet connectivity, laundry facilities, designated areas for academic work, fitness centers, and security measures.
- d. **Room Type:** The available lodging options include a variety of room types, including single occupancy rooms, shared occupancy rooms, and apartments.
- e. **Social Environment:** The availability of social interaction opportunities, such as residential life programs, communal spaces, and events.

2.2. Collecting Data

Following the establishment of the criteria, data was gathered on diverse university housing alternatives, encompassing on-campus dormitories, off-campus apartments, and private housing. The aforementioned data was collected from various sources, including university websites, housing agencies, and online housing platforms. In order to maintain uniformity and facilitate comparability, the gathered data was subjected to standardization and presented in a consistent format.

2.3. Weighting Criteria

The subsequent stage entails allotting weights to individual criteria in accordance with their respective significance in the process of decision-making. A survey was conducted among a sample of potential students to gather their preferences with respect to the identified criteria. The weights for each criterion were calculated using the Analytic Hierarchy Process (AHP), which accurately reflects the priorities of the surveyed students.

2.4. Applying the Weighted Sum Model

Utilizing the gathered data and assigning appropriate weights to the criteria, we employed the Weighted Sum Model to assess and prioritize the available housing alternatives offered by the university. The Weighted Scoring Methodology (WSM) is utilized to determine the overall score of each housing option. This is achieved by multiplying the standardized value of each criterion by its corresponding weight, followed by summing the outcomes. The Weighted Sum Model can be expressed mathematically through the following formula:

$$Total\ Score = \sum (Criterion\ Value \times Criterion\ Weight)$$

The university housing options were ranked based on their total scores utilizing the prescribed formula. The degree of suitability of a housing option for a prospective student is positively correlated with the total score, which is determined by the consideration of their preferences and priorities.

The Weighted Sum Model can be integrated into a Decision Support System to help find the best university housing options. Students can use the MCDM-WSM tool to make informed housing decisions based on their preferences and priorities.

3. Result and Discussion

The process of selecting appropriate and all-encompassing criteria is of utmost importance in order to generate precise and dependable outcomes. The present study involved a comprehensive examination of the literature, consultation with subject matter experts, and administration of surveys to potential students to ascertain the most pertinent factors in the selection of university housing. The weights for each criterion were computed to reflect the priorities of the surveyed students. The following table displays the criteria and their respective weights:

Table 1. Weight Criteria

Criteria	Weight
Location	0.30
Affordability	0.25
Amenities	0.20
Room Type	0.15
Social Environment	0.10

The aforementioned weights denote the comparative significance of individual criteria within the context of the process of making a decision. The results of the survey indicate that Location (0.30) is the primary criterion for the students, whereas Social Environment (0.10) is the least significant factor. The aforementioned weights are intended for utilization in the ensuing stages of the MCDM-WSM methodology, with the aim of assessing and arranging the university housing alternatives in accordance with the preferences and priorities of potential students.

Table 2. Data Criteria

Housing Option	Location (Score)	Affordability (IDR)	Amenities (Score)	Room Type (Score)	Social Environment (Score)
Dormitory A	5	1000	4	3	5
Dormitory B	4	1100	3	4	4
Apartment A	3	900	5	5	3
Apartment B	2	800	2	5	2
Private House	1	1200	1	4	1

The MCDM-WSM methodology will be employed for the purpose of selecting university housing. This will involve the utilization of the data, criteria, and weights that have been gathered. The procedure encompasses the subsequent stages:

- a. The data should be normalized for each criterion.
- b. The normalized values should be multiplied by their respective weights.
- c. Score each dwelling option.
- d. Sort housing alternatives by cumulative scores.

The following is a systematic procedure for computing the university housing selection utilizing the MCDM-WSM methodology:

Step 1: Normalize the data

To evaluate each criterion, it is necessary to divide the value of the housing option by the maximum value within that specific criterion. The Location, Amenities, Room Type, and Social Environment variables will be normalized within the range of 0 to 1. Conversely, the Affordability values will be inverted as a lower cost is deemed more desirable.

Table 3. Normalize Data

Housing Option	Location (Normalized)	Affordability (Normalized)	Amenities (Normalized)	Room Type (Normalized)	Social Environment (Normalized)
Dormitory A	1	0.67	0.80	0.60	1
Dormitory B	0.8	0.61	0.60	0.80	0.8
Apartment A	0.6	0.75	1	1	0.6
Apartment B	0.4	1	0.40	1	0.4
Private House	0.2	0.57	0.20	0.80	0.2

Step 2: Multiply the normalized values by their corresponding weights

Multiply the normalized values of each criterion by their respective weights obtained

Table 4. Normalized Weight Value

Housing Option	Location (Weighted)	Affordability (Weighted)	Amenities (Weighted)	Room Type (Weighted)	Social Environment (Weighted)
Dormitory A	0.30	0.1675	0.16	0.09	0.1
Dormitory B	0.24	0.1525	0.12	0.12	0.08
Apartment A	0.18	0.1875	0.20	0.15	0.06
Apartment B	0.12	0.25	0.08	0.15	0.04
Private House	0.06	0.1425	0.04	0.12	0.02

Step 3: Calculate the total score for each housing option

Calculate the aggregate score by adding the weighted values of each housing alternative.

Table 5. Total Score

Housing Option	Total Score
Dormitory A	0.7975
Dormitory B	0.7125
Apartment A	0.7775
Apartment B	0.6475
Private House	0.3645

Step 4: Rank the housing options based on their total scores

The available housing alternatives are arranged in descending order according to their cumulative scores, with the option that has the highest score being deemed the most appropriate choice based on the student's preferences and priorities.

Table 6. Ranking

Rank	Housing Option	Total Score
1	Dormitory A	0.7975
2	Apartment A	0.7775
3	Dormitory B	0.7125
4	Apartment B	0.6475
5	Private House	0.3645

The aforementioned ranking functions as a tool to aid students in the process of selecting the housing option that best aligns with their individual preferences and priorities. The utilization of the MCDM-WSM methodology enables students to make judicious decisions concerning their housing preferences in the university, thereby ensuring that they opt for the most suitable alternative that aligns with their requirements.

The following is a Python pseudo code that implements the complete Multiple Criteria Decision Making-Weighted Sum Model process for the selection of university housing.

4. Conclusion

The MCDM-WSM methodology was employed to prioritize university housing alternatives, taking into account the preferences and priorities of potential students. By utilizing a methodical methodology, we discerned pertinent criteria, allocated weights to each criterion, standardized the data, and computed the weighted scores. The aforementioned ranking offers significant insights to students when selecting the most appropriate housing alternative that corresponds with their requirements and inclinations. The utilization of a Decision Support System employing the MCDM-WSM methodology facilitated the conversion of a convoluted decision-making process into a methodical, lucid, and dependable approach. The aforementioned analysis possesses the capability to be tailored to suit the unique preferences of each student, rendering it a versatile instrument for the purpose of selecting university housing. The research findings indicate that the utilization of sophisticated decision-making strategies can have a substantial impact on the caliber of decisions made by students with respect to their housing choices at the university.

Despite the successful application of the MCDM-WSM methodology to university housing selection, our study acknowledges the presence of research gaps and potential areas for future research. One of the research gaps in our study is the limited number of criteria considered for ranking the housing options. While we identified five key criteria, there may be other factors that significantly influence students' housing preferences. Additionally, the weights assigned to the criteria were based on the surveyed students' preferences, which may not be universally applicable.

Future Research Directions:

- a. Expand the list of criteria: Future studies could explore additional criteria, such as safety, availability of public transportation, accessibility for students with disabilities, or environmental sustainability, to provide a more comprehensive evaluation of university housing options.
- b. Tailored MCDM-WSM models: Researchers could develop tailored MCDM-WSM models to cater to specific student groups or individual preferences. These customized models could account for varying priorities among different demographics, such as international students, graduate students, or students with families.
- c. Comparison with other MCDM techniques: Comparing the performance of the WSM technique with other MCDM methodologies, such as the Analytic Network Process (ANP), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), or VIKOR, could provide insights into the most suitable technique for university housing selection.
- d. Incorporation of qualitative data: Future research could explore the integration of qualitative data, such as students' experiences and perceptions, into the MCDM-WSM process to provide a more holistic understanding of the factors influencing housing preferences.
- e. Researchers could create a decision help tool. This tool would utilize the MCDM-WSM technique and help students make informed housing decisions that meet their needs. The tool would emphasize usability.

The academic community can improve university housing selection by identifying and examining research gaps and supporting students in making educated choices that meet their requirements and preferences. Further research can improve this procedure.

References

- Chou, Jui Sheng, and Gusti Ayu Novi Yutami. 2014. "Smart Meter Adoption and Deployment Strategy for Residential Buildings in Indonesia." *Applied Energy* 128 (September): 336–49. <https://doi.org/10.1016/j.apenergy.2014.04.083>.
- Haswan, Febri. 2017. "Decision Support System For Election Of Members Unit Patients Among Praja." *International*

- Journal of Artificial Intelligence Research* 1 (1): 21. <https://doi.org/10.29099/ijair.v1i1.14>.
- Karismariyanti, Magdalena. 2011. “Simulasi Pendukung Keputusan Penerima Beasiswa Menggunakan Metode Composite Performance Index.” *Jurnal Teknologi Informasi*.
- Khaidir, A. 2014. “Sistem Pendukung Keputusan Penyeleksian Calon Siswa Baru Di SMA N 1 Badar Dengan Metode MFEP (Multifactor Evaluation Process).” *Jurnal Pelita Informatika Budi Darma* 5 (3): 148–53.
- Kharisman Ndruru, Radius. 2020. “Penerapan Metode Additive Ratio Assessment (ARAS) Dan Rank Order Centroid (ROC) Dalam Pemilihan Jaksa Terbaik Pada Kejaksaan Negeri Medan.” *Seminar Nasional Teknologi Komputer & Sains (SAINTEKS)*, 367–72.
- Kurian, Mary C., Shalij P.R, and Pramod V.R. 2019. “Maintenance Strategy Selection in a Cement Industry Using Analytic Network Process.” *Journal of Quality in Maintenance Engineering* 26 (4): 509–25. <https://doi.org/10.1108/JQME-07-2017-0048>.
- Mateo, José Ramón San Cristóbal. 2012. “Weighted Sum Method and Weighted Product Method.” In *Green Energy and Technology*, 83:19–22. https://doi.org/10.1007/978-1-4471-2346-0_4.
- Nejati, Mohsen, Iraj Mahdavi, Reza Hassanzadeh, Nezam Mahdavi-Amiri, and Mohamadsailm Mojarad. 2014. “Multi-Job Lot Streaming to Minimize the Weighted Completion Time in a Hybrid Flow Shop Scheduling Problem with Work Shift Constraint.” *International Journal of Advanced Manufacturing Technology* 70 (1–4): 501–14. <https://doi.org/10.1007/s00170-013-5265-6>.
- Perera, Lokukaluge P., J. P. Carvalho, and C. Guedes Soares. 2014. “Solutions to the Failures and Limitations of Mamdani Fuzzy Inference in Ship Navigation.” *IEEE Transactions on Vehicular Technology* 63 (4): 1539–54. <https://doi.org/10.1109/TVT.2013.2288306>.
- Sanjani, Lukman Arif, Sulis Janu Hartati, and Pantjawati Sudarmaningtyas. 2014. “RANCANG BANGUN SISTEM INFORMASI PENGAJIAN PEGAWAI DAN REMUNERASI JASA MEDIS PADA RUMAH SAKIT BEDAH SURABAYA.” *Jurnal Sistem Informasi* 3 (1): 87–93.
- Sari, Desi Ratna, Agus Perdana Windarto, Dedy Hartama, and Solikhun Solikhun. 2018. “Sistem Pendukung Keputusan Untuk Rekomendasi Kelulusan Sidang Skripsi Menggunakan Metode AHP-TOPSIS.” *Jurnal Teknologi Dan Sistem Komputer* 6 (1): 1. <https://doi.org/10.14710/jtsiskom.6.1.2018.1-6>.
- Sheng, Weiguo, Stephen Swift, Leishi Zhang, and Xiaohui Liu. 2005. “A Weighted Sum Validity Function for Clustering With a Hybrid Niching Genetic Algorithm.” *IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS—PART B: CYBERNETICS* 35 (6): 1156–67.
- Tanjung, Nur S, Putri Dani Adelina, Martina K Siahaan, Elvitrianim Purba, and Joli Afriany. 2018. “Sistem Pendukung Keputusan Pemilihan Guru Teladan Dengan Menggunakan Metode Composite Performance Index (CPI).” *Jurnal Riset Komputer (JURIKOM)*.