

GROUP DECISION MAKING UNDER MULTIPLE CRITERIA
MIDTERM EXAM

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Due date: May 4, 2021, 18:00

Please submit your files to ninova before 18:00.

All questions related to the questions are welcomed via e-mail (ozgurkabak@gmail.com), via WhatsApp (0532-4274535) or by direct phone call (0532-4274535).

This is an individual exam. Do not cheat! Academic misconduct or cheating will not be tolerated!

- *You may use printed lecture notes and other related sources and related files in your own computer. You may use excel for calculations.*
- *Do not communicate or share files with your peers.*

Instructions:

- You may answer the questions on word file or handwritten on a paper, and use excel for calculations.
- You have to convert the word file or handwritten papers to a pdf file to upload on ninova.
- If you use excel, please prepare a single excel file. Each question should be in a separate sheet.
- Please upload your answers on ninova as a single pdf file and an excel file.

QUESTIONS

1. (20 pts.) Members of a football club will select an executive committee that consists of 3 members. 8995 members voted 6 candidates (A, B, C, D, E, F) by the using a preferential voting system. The members are asked their first, second, third, fourth preferences. Following pattern of votes is reached:

First preference	Second preference	Third preference	Fourth preference	Number of votes
A	B	C	D	550
A	C	D	B	450
A	D	E	F	120
B	A	D	C	180
B	D	E	F	140
B	C	F	A	800
C	A	E	B	1700
C	B	D	F	190
D	C	A	F	950
D	A	F	B	975
D	C	E	B	450
E	C	A	B	250
E	F	D	A	1450
F	E	C	B	790

- a) Find the selected committee members using Single Transferable Vote, Droop quota and Gregory method for transfers.

- b) Find the selected committee members using Single Transferable Vote, Droop quota and Weighted Inclusive Gregory Method for transfers.
- c) Find the selected committee members using Single Transferable Vote, Droop quota and Meeks Method for transfers.
- d) Compare the results you find in parts a, b, and c. Discuss the properties of the transfer methods based on the results.

2. (20 pts.) Please classify the following papers based on the classification scheme for MAGDM literature defined in Kabak and Ervural (2017).

- Noori, A., Bonakdari, H., Morovati, K., & Gharabaghi, B. (2020). Development of optimal water supply plan using integrated fuzzy Delphi and fuzzy ELECTRE III methods—Case study of the Gamasiab basin. *Expert Systems*, 37(5), e12568.
- A.İ. Ölçer, A.Y. Odabaşı, A new fuzzy multiple attributive group decision making methodology and its application to propulsion/manoeuvring system selection problem, *European Journal of Operational Research*, Volume 166, Issue 1, 1 October 2005, Pages 93-114
- Fan, Z.-P., Ma, J., Jiang, Y.-P., Sun, Y.-H., & Ma, L. (2006). A goal programming approach to group decision making based on multiplicative preference relations and fuzzy preference relations. *European Journal of Operational Research*, 174(1), 311–321.
<http://doi.org/10.1016/j.ejor.2005.03.026>

3. (20 pts.) Suppose 190 voters indicate their preferential votes to four candidates (A, B, C, D). The following pairwise comparison table is constructed based on their votes. For instance, 94 voters preferred B over A. One candidate will be selected based on these preferences.

	A	B	C	D
A		96	99	88
B	94		94	97
C	91	96		92
D	102	93	98	

- a) Find the winner using Nanson’s function.
- b) Find the winner using the Schulze method (Schulze, 2011).
- c) Discuss the properties of Nanson’s function and Schulze methods in terms of reversal symmetry, independence of irrelevant alternatives, and monotonicity.

4. Consider the following supplier selection problem.

A supplier management board of a company is evaluating suppliers in order to decide if a change is appropriate. There are four potential suppliers that need to be evaluated. The board decided to ask each of the three sector managers of the company to provide their evaluations of the suppliers. The managers are very busy and they work in different buildings. It would be complicated to get them together to discuss what the important criteria are to evaluate the suppliers. Under these circumstances, the board will let each manager to evaluate the companies independently, according to a set of criteria that they think it is appropriate and to provide their own weight vector.

The first manager, who is a budget manager, is biased to the financial aspects of the decision and considered the price per batch (in thousands) (C_1^1), warranty (in days) (C_2^1) and payment conditions (C_3^1). The second manager is a production manager and is focused on the overall aspects of the suppliers and considered the price (C_1^2), delivery time (in hours) (C_2^2), production capacity (C_3^2), product quality (C_4^2) and the time to respond to a support request (in hours) (C_5^2). The third manager is the commercial manager and is biased to the capacity to advertise and the final satisfaction of the clients. So, she

considered the product lifespan (in years) (C_1^3), social and environment responsibility (C_2^3), quality certifications (C_3^3) and the price (C_4^3). The weight vectors of each one of the decision makers are: $w^1 = (0.5, 0.25, 0.25)$, $w^2 = (0.2, 0.2, 0.2, 0.2, 0.2)$ and $w^3 = (0.25, 0.12, 0.23, 0.4)$.

The decision matrices are presented in Tables 1-3. The linguistic evaluations were converted to numerical values as shown in Table 4. For the values given in 0-1 scale, 1 presents the highest performance and 0 is the lowest performance.

Also, the supplier management board provided the following weight vector for the decision makers $w_d = (0.3, 0.4, 0.3)$.

Based on the above given information, the supplier management board of the company want to rank the suppliers.

a) (15 pts.) Considering the properties of the above-given problem, design a multiple attribute group decision making approach that includes Borda score and A-TOPSIS method (Tavana and Hatami-Marbini, 2011). Write the steps of your approach clearly.

b) (25 pts.) Rank the alternatives using the method that you have proposed in part a.

Table 1. Decision matrix for the first manager

Alternatives	C_1^1 (in thousand \$)	C_2^1 (in days)	C_3^1 (linguistic term set)
A ₁	260	90	Good
A ₂	250	90	Poor
A ₃	350	180	Good
A ₄	550	365	Intermediate

Table 2. Decision matrix for the second manager

Alternatives	C_1^2 (in thousand \$)	C_2^2 (in days)	C_3^2 (0-1 scale)	C_4^2 (linguistic term set)	C_5^2 (in hours)
A ₁	260	72	0.9	Intermediate	36
A ₂	250	96	0.6	Poor	36
A ₃	350	54	0.55	Good	24
A ₄	550	68	0.5	Excellent	12

Table 3. Decision matrix for the third manager

Alternatives	C_1^3 (in years)	C_2^3 (linguistic term set)	C_3^3 (0-1 scale)	C_4^3 (in thousand \$)
A ₁	3.5	Very poor	0.3	260
A ₂	3.0	Very poor	0.2	250
A ₃	4.5	Poor	0.6	350
A ₄	5.0	Intermediate	0.9	550

Table 4. Linguistic variables for the ratings

Linguistic Terms	Corresponding numerical value
Very poor	1
Poor	2
Intermediate	3
Good	4
Excellent	5

References

Kabak, Ö., & Ervural, B. (2017). Multiple attribute group decision making: A generic conceptual framework and a classification scheme. *Knowledge-Based Systems*, 123, 13-30.

Schulze, M. (2011) "A new monotonic, clone-independent, reversal symmetric, and Condorcet-consistent single-winner election method", *Social Choice and Welfare*, 36, pp 267–303.

Tavana, M., & Hatami-Marbini, A. (2011). A group AHP-TOPSIS framework for human spaceflight mission planning at NASA. *Expert Systems with Applications*, 38(11), 13588-13603.

GOOD LUCK!