Short Note on risk ranking. What is outranking methodology? Illustration with a simple example.

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Introduction to the example

Let's consider 5 alternatives A, B, C, D, E, scored on 2 criteria C1 and C2 (Table 1). To make it simple, the 2 criteria have the same scale, from 1 to 20. Also, let's consider that a high score means a high risk.
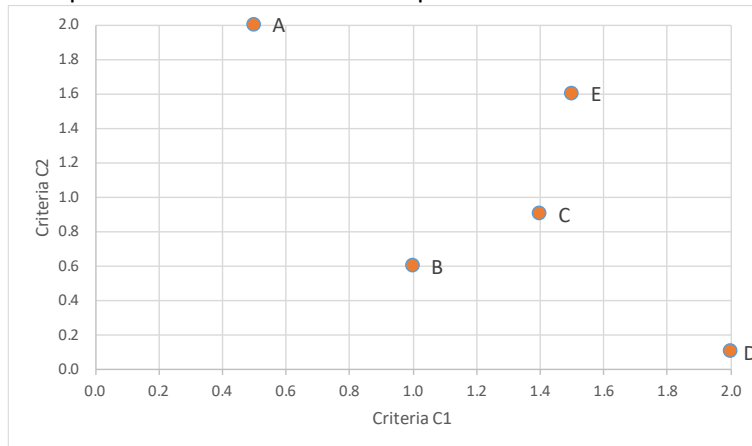
Alternatives	C1	C2
A	5.0	20.0
B	10.0	6.0
C	14.0	9.0
D	20.0	1.0
E	15.0	16.0

Table 1 : Example of 5 alternatives A, B, C, D, E, scored on 2 criteria C1 and C2.
A high score means a high risk. That means for instance that Alternative A is the less risky on Criteria C1 and the riskiest on Criteria C2.

Our objective is to select one alternative among the five ones. Which one to select? Selecting an alternative is making a decision.
Outranking method is a multicriteria decision analysis (mcda) method to assist when a decision has to be made.

Let's plot the alternatives on a 2D-plot with C1 in x-axis and C2 in y-axis.

If we decide to multiply the values obtained on C1 and C2, i.e. to calculate the surface, the alternative D gets the smallest surface. **D is the less risky alternative**.
Making a multiplication is basically what is done in food safety to calculate the risk: risk=severity x likelihood.

Alternatives	Criteria		Multiplication (surface)
	C1	C2	
A	5.0	20.0	100.0
B	10.0	6.0	60.0
C	14.0	9.0	126.0
D	20.0	1.0	20.0
E	15.0	16.0	240.0

Table 2: Multiplication calculation

The outranking methodology is a different approach, it is a comparison between alternatives. It counts how often an alternative outranks the other ones on the criteria (Table 3).

Comparison of alternatives	phipositive	phinegative	phitotal	
A is 4 times above and 4 times below	0.25	0.25	0	Table 3:
B is 2 times above and 6 times below	0.125	0.375	-0.25	Outranking
C is 4 times above and 4 times below	0.25	0.25	0	calculations
D is 4 times above and 4 times below	0.25	0.25	0	
E is 6 times above and 2 times below	0.375	0.125	0.25	

In Table 2, Phipositive is calculated from the number of times the alternative is above the other ones, phinegative from the number of times the alternative is below the other ones. Phitotal is the difference between phipositive and phinegative.

In this example, using an outranking method, alternative A, C and D are equivalent, **B is the less risky** and E the riskiest.

To conclude on risk ranking using an outranking methodology:

- The outranking method compares the alternatives;
- It can be applied when the alternatives are expressed as numbers (as illustrated here with the simple example) but also when they are expressed as ordinal values;
- Outranking method does not have a compensatory effect: bad performances on some criteria are not counterbalanced by good performances on other criteria;
- It can be applied with more than 2 criteria; it is actually with many criteria that the method helps in making decision since with many criteria, the visualisation in a plot is difficult, not to say impossible.

To learn more about outranking mcda methodology:

Brans, J. P., Vincke, P., & 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

Roy, B. (1968). Classement et choix en présence de points de vue multiples. RAIRO - Operations Research - Recherche Opérationnelle, 2, 57-75. http://www.numdam.org/item/RO_1968__1962_1961_1957_1960/

Wątróbski, J., Jankowski, J., Ziemba, P., Karczmarczyk, A., & Zioło, M. (2019). Generalised framework for multi-criteria method selection. Omega, 86, 107-124. https://doi.org/10.1016/j.omega.2018.07.004

Some applications of outranking mcda in food safety

Anses. (2020). Méthodologie de hiérarchisation des dangers biologiques et chimiques dans les aliments Retrieved from https://www.anses.fr/fr/system/files/BIORISK2016SA0153Ra.pdf

Eygue, M., Richard-Forget, F., Cappelier, J.-M., Pinson-Gadais, L., & Membré, J.-M. (2020). Development of a risk-ranking framework to evaluate simultaneously biological and chemical hazards related to food safety: Application to emerging dietary practices in France. Food Control, 115, 107279. https://doi.org/10.1016/j.foodcont.2020.107279

Fazil, A., Rajic, A., Sanchez, J., & McEwen, S. (2008). Choices, choices: the application of multi-criteria decision analysis to a food safety decision-making problem. J Food Prot, 71(11), 2323-2333. https://doi.org/10.4315/0362-028x-71.11.2323