Highlights

How demand pattern identification and multicriteria ABC classification can guide management decisions

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- literature review about multicriteria classification;

- literature review about demand pattern classification;

- generative method to force consistency of pairwise comparisons matrix;

- importance of the correct balance of product criteria weights assigning;

- importance of ABC multicriteria and demand pattern classifications for forecasting;

- brief description of COPSolver: library for solving the multicriteria classification problem;

- brief description of COPSolver: library for solving the demand pattern classification problem.

How demand pattern identification and multicriteria ABC classification can guide management decisions

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Abstract

Multicriteria classification is usualy very important to the decision-making in manufacturing management process. For such classification, the attribution of weights to the criteria strongly influences the coherence of the results found. Saaty's Analytic Hierarchy Process (AHP) is an important method for assigning weights to multiple criteria. AHP's logic is not complicated at all but, since matrices of pairwise comparisons of criteria are usually generated manually and based only on some employee know-how, there is a huge complexity on generating a consistent pairwise matrix. Especially when many criteria are used. This paper presents a constructive algorithm that can be used to adjust inconsistent matrices, forcing such matrices to have a better consistency rate. We tested this algorithm by applying the AHP method, for

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multicriteria ABC classification, to companies in two sectors. As a result we observed that the algorithm can adjust the pairwise matrices in just a few seconds, avoiding the manual work that would be done in weeks, therefore showing that it is an important resource for applying the AHP method. We also present in this paper an analysis of the importance of the attribution of the weights to the criteria and show how the multicriteria and demand pattern classifications may influence the decision on the choice of the appropriate forecasting method.

1. Introduction

2. Algorithm for forcing pairwise matrix consistency

3. COPSolver

4. Data collected

To test the two developed COPSolver libraries (COPSolver: library for solving the multicriteria classification problem and COPSolver: library for solving the demand pattern classification problem), we used data from three companies from three different sectors (plastic packaging manufacturing, furniture trades and car mechanics). In the case of the company from the car mechanics sector, only the data relating to truck repairs was used; in the

case of the other two companies, all the data obtained from all the products sold over 5 years (last 60 months prior to the data collection date) was used. One year's data (last 12 months prior to the data collection date) was used for the ABC multicriteria classification. The files containing the formatted data used for all the tests and the results can be found at tbfraga.github.io/COPSolver/benchmarks.

5. Tests and results

5.1. Pairwise comparisons matrix and consistency rate

Table 1 presents the modifications made by the software 'COPSolver: library for solving the multicriteria classification problem' in the pairwise comparisons matrix and the consequent change in the consistency rate (CR) for the data colected from the three companies selected for this study.

As we can see in this table, the pairwise comparison weights are adjusted primarily according to the weights assigned to the first three criteria. Thus, although there is a change in the pairwise comparison weights, which may be significant, the weights assigned to the first three criteria will be preserved. The change will be made in the weights of the other criteria in order to force the consistency of the pairwise comparisons matrix. Another important point to note in the method is that the algorithm stops when the desired consistency rate is reached. So, it is more likely that there will be significant changes in the fourth criterion and the next ones. Therefore, it is important that the criteria are ordered in such a way that the three most relevant

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car mechanics company

	CR = 0.216							CR = 0.085						
	sb	lt	rp	cr	ob	np	cm	sb	lt	rp	cr	ob	co	cm
sb	1.00	3.00	3.00	5.00	7.00	9.00	9.00	1.00	3.00	3.00	3.00	7.00	9.00	9.00
lt	0.33	1.00	3.00	5.00	7.00	9.00	9.00	0.33	1.00	3.00	3.00	5.00	9.00	9.00
rp	0.33	0.33	1.00	3.00	9.00	9.00	9.00	0.33	0.33	1.00	1.00	3.00	3.00	9.00
cr	0.20	0.20	0.33	1.00	5.00	9.00	9.00	0.33	0.33	1.00	1.00	3.00	3.00	9.00
ob	0.14	0.14	0.11	0.20	1.00	5.00	9.00	0.14	0.20	0.33	0.33	1.00	1.00	9.00
np	0.11	0.11	0.11	0.11	0.20	1.00	9.00	0.11	0.11	0.33	0.33	1.00	1.00	9.00
cm	0.11	0.11	0.11	0.11	0.11	0.11	1.00	0.11	0.11	0.11	0.11	0.11	0.11	1.00

furniture trades company

	CR = 0.151							CR = 0.096						
	lt	sb	rp	cr	cm	np	ob	lt	sb	rp	cr	cm	np	ob
lt	1.00	0.20	0.14	0.20	7.00	0.11	5.00	1.00	0.20	0.14	0.33	7.00	0.20	5.00
sb	5.00	1.00	0.33	0.33	5.00	0.14	7.00	5.00	1.00	0.33	1.00	5.00	0.33	7.00
rp	7.00	3.00	1.00	0.33	5.00	0.14	3.00	7.00	3.00	1.00	1.00	7.00	1.00	3.00
cr	5.00	3.00	3.00	1.00	9.00	0.33	9.00	3.00	1.00	1.00	1.00	7.00	1.00	9.00
cm	0.14	0.20	0.20	0.11	1.00	0.11	1.00	0.14	0.20	0.14	0.14	1.00	0.11	1.00
np	9.00	7.00	7.00	3.00	9.00	1.00	9.00	5.00	3.00	1.00	1.00	9.00	1.00	9.00
ob	0.20	0.14	0.33	0.11	1.00	0.11	1.00	0.20	0.14	0.33	0.11	1.00	0.11	1.00

plastic packaging manufacturing company

	CR = 0.625						CR = 0.085					
	np	cr	lt	ob	sb	rp	np	cr	lt	ob	sb	rp
np	1.00	3.00	7.00	7.00	5.00	5.00	1.00	3.00	7.00	9.00	5.00	9.00
cr	0.33	1.00	3.00	0.20	0.20	0.20	0.33	1.00	3.00	3.00	1.00	5.00
lt	0.14	0.33	1.00	5.00	7.00	7.00	0.14	0.33	1.00	3.00	3.00	7.00
ob	0.14	5.00	0.20	1.00	0.33	3.00	0.11	0.33	0.33	1.00	1.00	3.00
sb	0.20	5.00	0.14	3.00	1.00	3.00	0.20	1.00	0.33	1.00	1.00	3.00
rp	0.20	5.00	0.14	0.33	0.33	1.00	0.11	0.20	0.14	0.33	0.33	1.00

Table 1: Pairwise comparisons matrix and consistency rate changes for three companies (results found by COPSolver) - legend: sb = substitutability; lt = lead-time; rp = repairability; cr = criticality; ob = obsolescence; np = net-profit; cm = commonality;

criteria for the company are among the first. Then the next most relevant criteria can be ordered from last to fourth position.

5.2. Analysis of the ABC multicriterio classification

5.3. Analysis of the demand pattern classification

car mechanics company

multc. ABC clssf. cutoff 0.35 %; 0.70 %			demand pattern classification 75 sales between October 2020 and July 2023			
				total	A	B	C
A	10	23.81 %	smooth	18.75 %	20.00 %	16.67 %	0 %
B	15	35.71 %	slow-moving	6.25 %	10.00 %	0.00 %	0 %
C	17	40.48 %	sporadic	75.00 %	70.00 %	83.33 %	0 %

furniture trades company

multc. ABC clssf. cutoff: 0.35 %; 0.70 %			demand pattern classification			
				total	A	B	C
A	26	10.24 %	smooth	31.58 %	73.08 %	30.00 %	24.82 %
B	80	31.50 %	slow-moving	18.62 %	19.23 %	33.75 %	9.93 %
C	148	58.27 %	sporadic	49.80 %	7.69 %	36.25 %	65.25 %

plastic packaging manufacturing company

multc. ABC clssf. cutoff: 0.35 %; 0.70 %			demand pattern classification 5,967 sales between November 2019 and February 2023			
				total	A	B	C
A	128	5.49 %	smooth	15.31 %	22.66 %	23.97 %	10.42 %
B	726	31.12 %	slow-moving	5.53 %	1.56 %	8.68 %	4.33 %
C	1,479	63.39 %	sporadic	79.16 %	75.78 %	67.36 %	85.25 %

Table 2: Multicriteria ABC and demand pattern classifications for three companies (results found by COPSolver)

6. Conclusions and suggestions for future works

In this paper we presented ...

7. CRediT authorship contribution statement

T.B. Fraga: Conceptualization, Project administration, Supervision, Software, Methodology, Validation, Formal analysis, Writing – original draft, Writing – review & editing.

8. Acknowledgments

References

Flores, B. E., Whybark, D. C. (1987). Implementing Multiple Criteria ABC Analysis. *Journal of Operations Management*, Vol. 7 (1,2), pp. 79–85.

Fraga, T.B. (2023). COPSolver: open source software for solving combinatorial optimization and other decision problems - library for solving the multicriteria classification problem, in press.