

MCDA to improve resources distribution on criminal investigations at Brazilian Federal Police: sorting crime reports in importance and urgency categories

Authors

Marco A. Faveri
Caroline Mota

Federal University of Pernambuco, Recife, Brazil
Professional Postgraduate Program in Production Engineering



Presentation guide

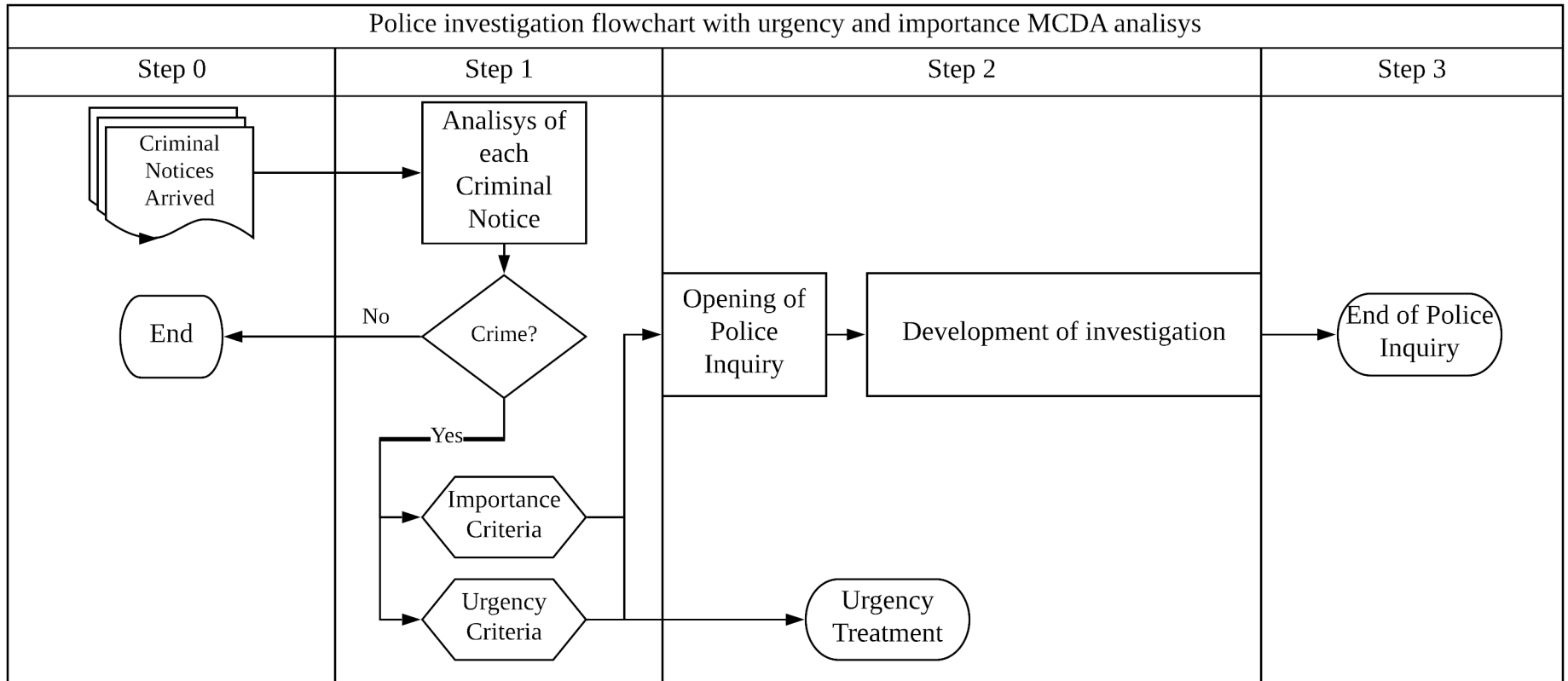
- ▷ Introduction / The Problem
- ▷ The police inquiry and crime reports in Brazil
- ▷ Methodology
- ▷ MCDA Sort models
 - ✓ FlowSort
 - ✓ Interval FlowSort
 - ✓ Fuzzy FlowSort
- ▷ Case study
- ▷ Findings
- ▷ Conclusions

Introduction / The problem



- ▷ The Brazilian Federal Police – BFP is:
 - ✓ A Law and Order agency in Brazil for federal crimes investigations, like public corruption, white collar crimes, international drug trafficking, financial crimes and others;
 - ✓ In 2019 had a budget of U\$ 350mi for current expenses;
 - ✓ Employ near of 11.000 policemen;
 - ✓ About 70.000 Crime Reports – CR arrives on BFP a year.
- ▷ These CR must be analyzed on arrival to verify the federal assignment.

Police investigation flowchart - proposed



Methodology

- ▷ Value-Focused Thinking to elicit criteria¹
- ▷ FlowSort with crispy values²
 - ✓ Importance and urgency assessment
- ▷ FlowSort with interval values³
 - ✓ Importance assessment
- ▷ FlowSort with fuzzy interval values^{4,5}
 - ✓ Importance assessment

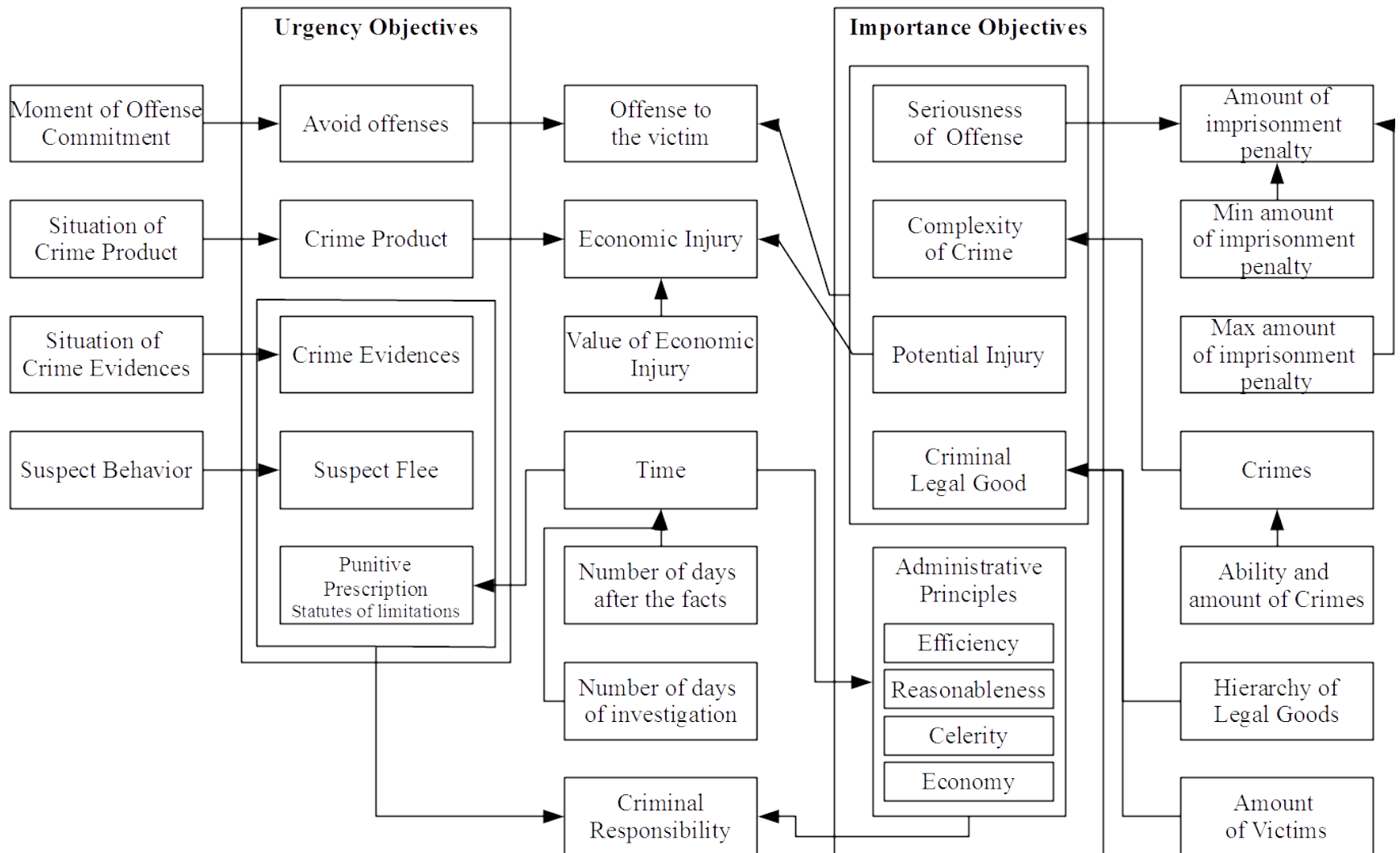
1. Keeney (1992)

2. Nemery; Lamboray (2008)

3. Janssen; Nemery (2013)

4. Campos; Mareschal; De Almeida (2015)

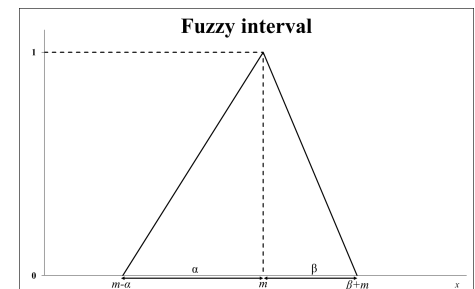
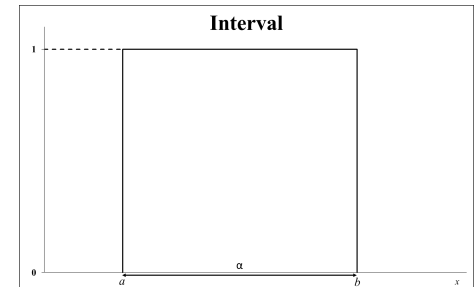
5. Faveri; Mota (2019)



Means-ends objectives network (Keeney, 1992)

Importance and urgency criteria

Importance	Crispy FS	Interval FS	Fuzzy FS
g_i 1 Imprisonment penalty			
g_i 1.1 Min. Imprisonment penalty	Max	Interval	FZ Interval
g_i 1.2 Max. Imprisonment penalty	Max		
g_i 3 Complexity of Crime	Max	Max	Max
g_i 4 Value of Economic Injury	Max	Max	Max
g_i 5 Hierarchy of Legal Goods	Max	Interval	FZ interval
g_i 6 Time After the Facts	Max	Max	Max
g_i 7 Number of Victims	Max	Max	Max



Urgency	Crispy FS
g_u 1 Moment of offense commitment	Max
g_u 2 Situation of crime product (profit)	Max
g_u 3 Situation of evidences	Max
g_u 4 Offender behavior	Max
g_u 5 Punitive Prescription	Max

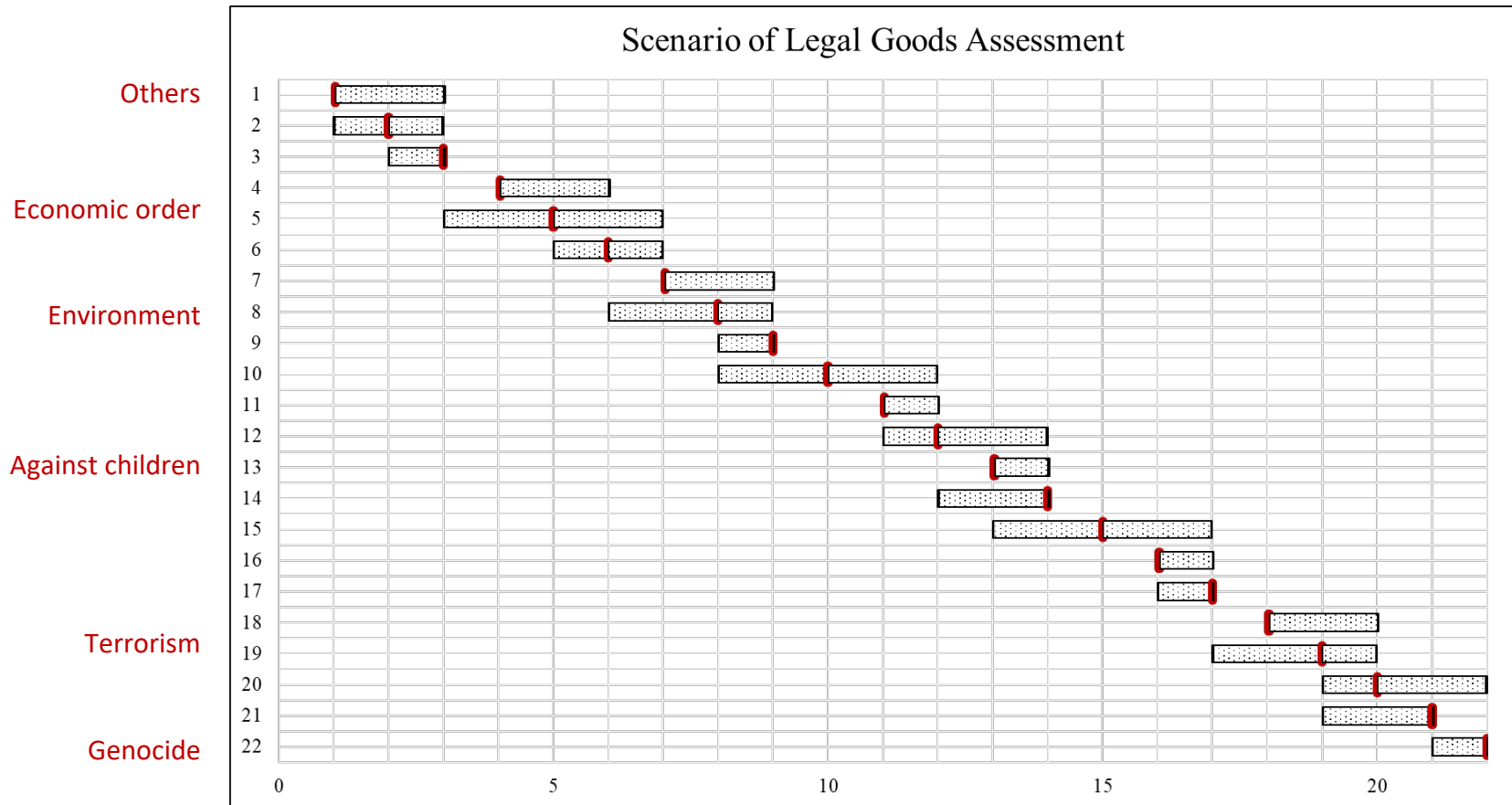
Evaluation of CR

- Imprecise information
- High hesitation
- g_i 1.1/2 interval defined by law, but the concrete min and max custody penalty will be set by the court.

Criterion for interval assessment

▷ Hierarchy of Legal Goods

Interval scenario with hesitation



Crispy values in red

Ordered categories

Importance Categories

C1	High important
C2	Important
C3	Normal
C4	Not important

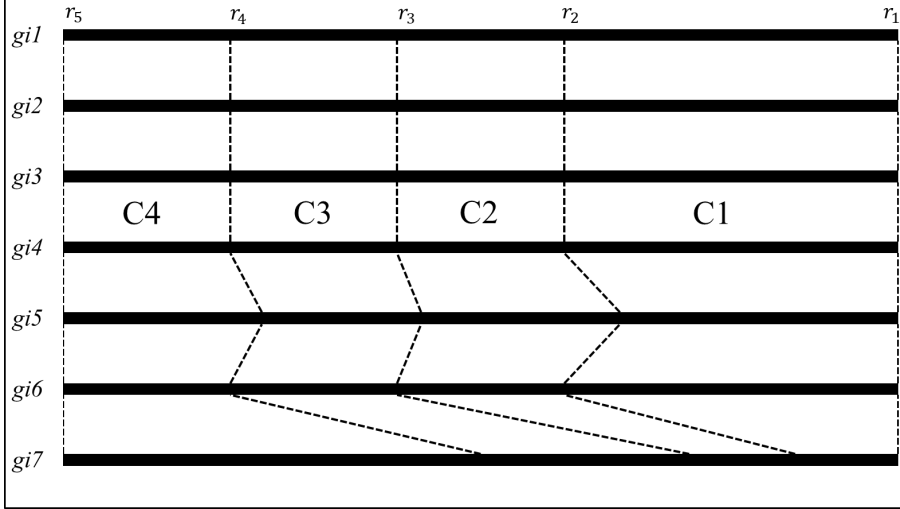


Urgency Categories

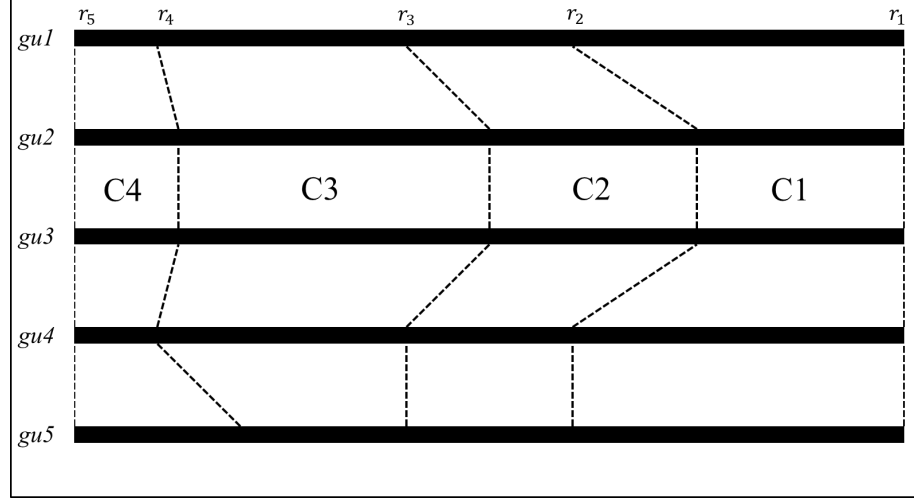
C1	High urgent
C2	Urgent
C3	Attention
C4	Normal

$C1 > C2 > C3 > C4$

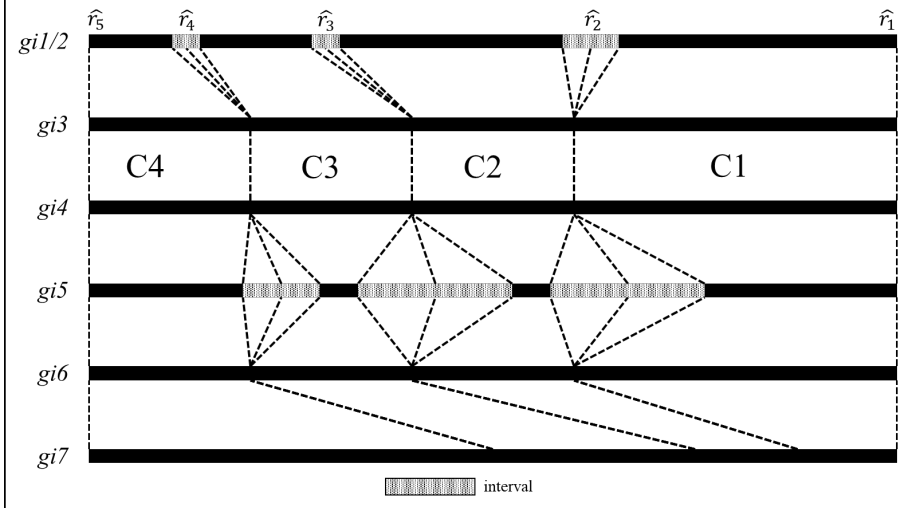
Limiting profiles for importance - crispy values



Limiting profiles for urgency - crispy values



Limiting profiles for importance - interval values



Limiting profiles for importance - fuzzy values

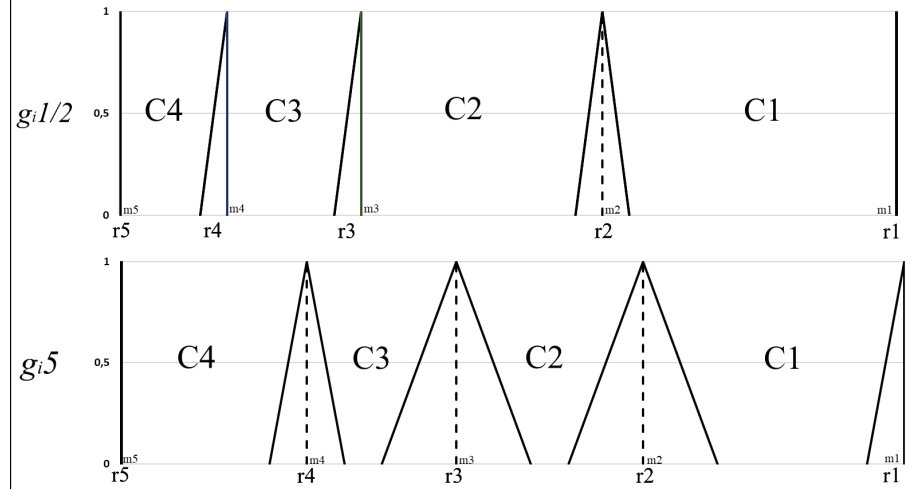


Illustration of limiting profiles

Fuzzy FlowSort

$$\mathbf{g}(\mathbf{a}) - \mathbf{g}(\mathbf{b}) = P(m, \alpha, \beta) \ominus P(n, \gamma, \delta) = P(m - n, \alpha + \gamma, \beta + \delta) = \\ P(m - n); P(m - n) - P(m - n - \alpha + \delta); P(m - n + \beta + \gamma) - P(m - n)$$

$$\pi(a, r_i) = \sum_{j=1}^k m'_j w_j, \sum_{j=1}^k (m'_j - \alpha'_j) w_j; \sum_{j=1}^k (\beta'_j - m'_j) w_j$$

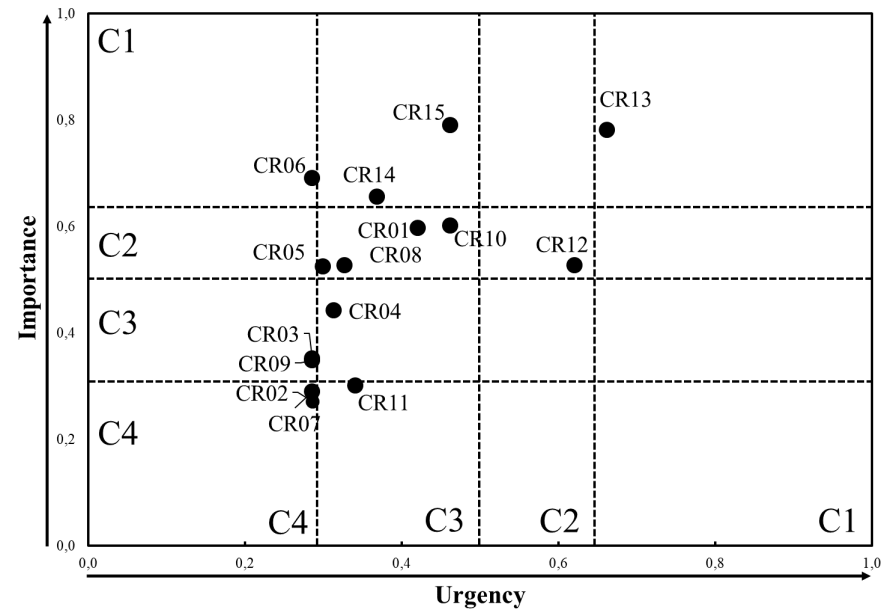
$$f(m, \alpha, \beta) = \frac{3m - \alpha + \beta}{3}$$

- ▷ Geldermann; Spengler; Rentz (2000).
- ▷ Yager's Operator (YAGER, 1981) to defuzzification.
- ▷ Campos; Mareschal; De Almeida (2015).
 - Defuzzification before computing of the flows

Case study

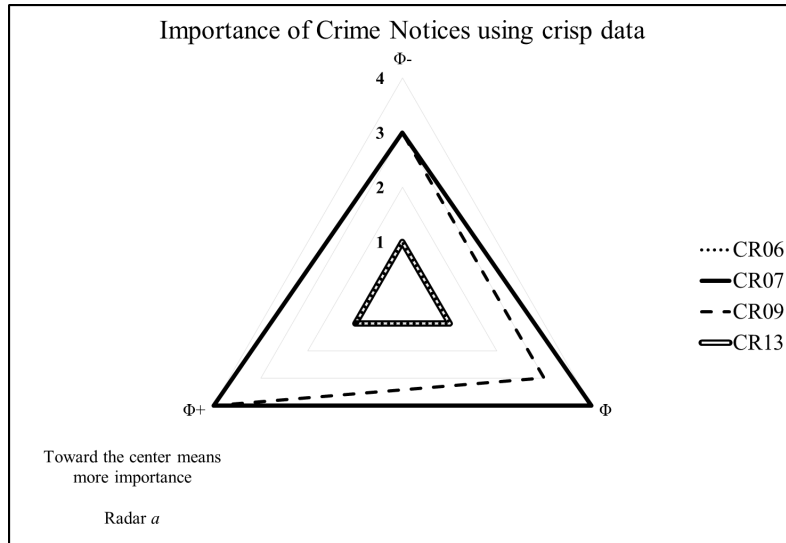
15 real or realistic Crime Reports

	Urgency			Importance			Interval			Fuzzy		
	C+	C-	C	C+	C-	C	C+	C-	C	C+	C-	C
CR01	C3	C3	C3	C2	C2	C2	C2,C3	C2,C3	C2,C2	C2	C2	C2
CR02	C4	C4	C4	C4	C3	C4	C4,C4	C3,C4	C4,C4	C4	C3	C4
CR03	C4	C4	C4	C4	C3	C3	C3,C4	C3,C3	C3,C3	C3	C3	C3
CR04	C3	C3	C3	C3	C3	C3	C3,C3	C3,C3	C3,C3	C3	C3	C3
CR05	C3	C4	C3	C3	C2	C2	C2,C3	C2,C3	C2,C2	C3	C2	C2
CR06	C4	C4	C4	C1	C1	C1	C1,C2	C1,C2	C2,C2	C2	C2	C2
CR07	C4	C4	C4	C4	C3	C4	C3,C4	C3,C4	C4,C4	C4	C4	C4
CR08	C3	C3	C3	C3	C2	C2	C2,C3	C2,C3	C3,C3	C3	C2	C2
CR09	C4	C4	C4	C4	C3	C3	C3,C4	C2,C3	C3,C3	C3	C3	C3
CR10	C3	C2	C3	C2	C2	C2	C2,C3	C2,C2	C2,C2	C2	C2	C2
CR11	C3	C3	C3	C4	C3	C4	C3,C4	C3,C4	C4,C4	C3	C3	C3
CR12	C2	C2	C2	C3	C2	C2	C2,C3	C2,C3	C2,C3	C3	C2	C2
CR13	C1	C1	C1	C1	C1	C1	C1,C1	C1,C1	C1,C1	C1	C1	C1
CR14	C3	C3	C3	C2	C1	C1	C1,C2	C1,C2	C2,C2	C2	C1	C2
CR15	C3	C2	C3	C1	C1	C1	C1,C2	C1,C1	C1,C1	C1	C1	C1

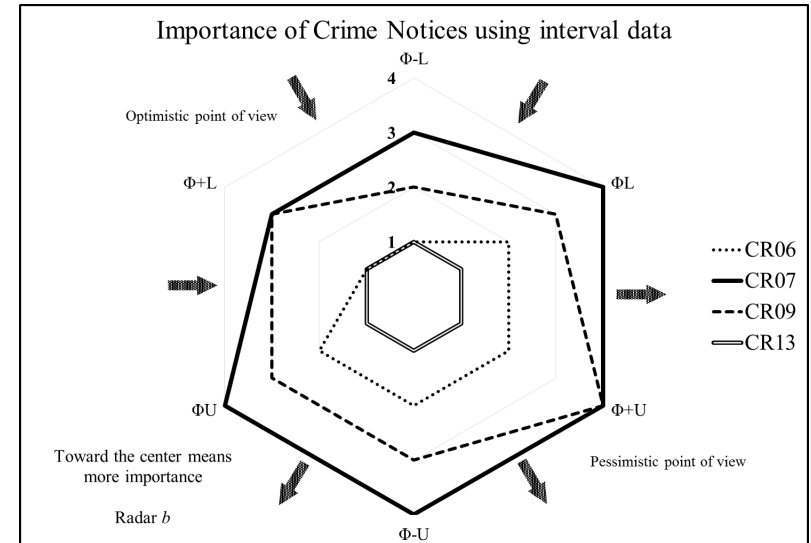


Categories in red used on importance vs urgency matrix (net flow values)

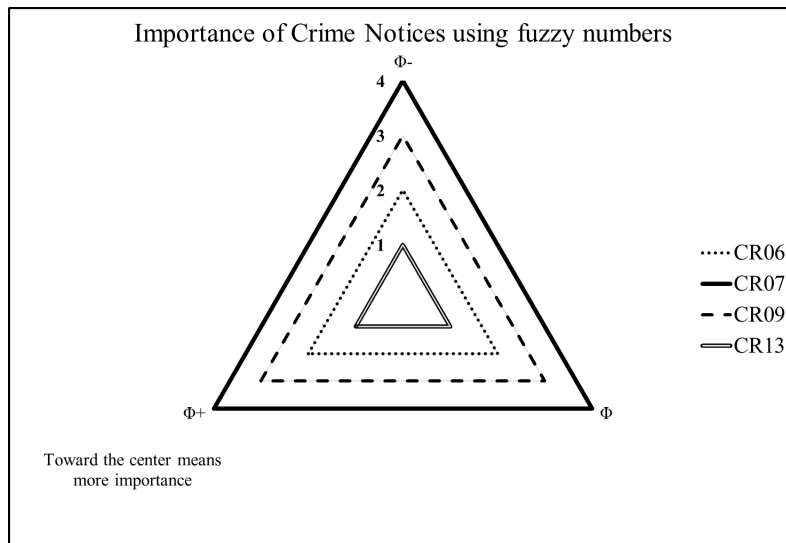
Crispy FlowSort



Interval FlowSort



Importance of Crime Notices using fuzzy numbers



Fuzzy FlowSort

- CR06 x CR13 and CR07 x CR09
- *Lower values are optimistic and upper values are pessimistic.*
- Interval and fuzzy values preserves the decision maker hesitation and offer more information to the model

Comparative analysis

Case Study Findings

- ▷ Using de FlowSort net flow, the outcome were validated with 32 experienced policemen.
- ▷ They evaluated the model outcome and
 - On importance, 89% agreed.
 - On urgency, 83% agreed.
- ▷ On real world the leaving and incoming flows and the interval and fuzzy models can relieve any doubts.

Conclusions

- ▷ The study supports appropriate use of public resources, by highlighting more important and urgent investigations.
- ▷ Applying the Interval and Fuzzy models, it was possible to observe more differences between the actions, exploring the imprecision and the uncertainty, preserving the decision maker's subjective information.
- ▷ The developing of specific applications are required to aggregate the necessary information and to report the decision maker's recommendations.



PROMETHEE 2020
days

PPGEP PRO

Programa de Pós-Graduação Profissional
em Engenharia de Produção - UFPE



Thank you!

Marco A. Faveri

mafaveri@gmail.com

faveri.maf@pf.gov.br

Caroline Mota

carolinemota@cdsid.org.br



References

- Campos, A. C. S. M., Mareschal, B., & de Almeida, A. T. (2015). Fuzzy FlowSort: An integration of the FlowSort method and Fuzzy Set Theory for decision making on the basis of inaccurate quantitative data. *Information Sciences*, 293, 115–124. <https://doi.org/10.1016/j.ins.2014.09.024>
- Geldermann, J., Spengler, T., & Rentz, O. (2000). Fuzzy outranking for environmental assessment. Case study: iron and steel making industry. *Fuzzy Sets and Systems*, 115(1), 45–65. [https://doi.org/10.1016/S0165-0114\(99\)00021-4](https://doi.org/10.1016/S0165-0114(99)00021-4)
- Faveri, M., Mota, C. (2019). Categorization of crime reports at Brazilian Federal Police with MCDA and imprecision treatment.
- Janssen, P., & Nemery, P. (2013). An extension of the FlowSort sorting method to deal with imprecision. *4OR*, 11(2), 171–193. <https://doi.org/10.1007/s10288-012-0219-7>
- Keeney, R. L. (1992). *Value-focused thinking: a path to creative decisionmaking*. Harvard University Press.
- Nemery, P. (2008). *On the use of multicriteria ranking methods in sorting problems*. Université Libre de Bruxelles.
- Nemery, P., & Lamboray, C. (2008). Flow Sort: a flow-based sorting method with limiting or central profiles. *TOP*, 16(1), 90–113. <https://doi.org/10.1007/s11750-007-0036-x>
- Yager, R. R. (1981). A procedure for ordering fuzzy subsets of the unit interval. *Information Sciences*, 24(2), 143–161. [https://doi.org/10.1016/0020-0255\(81\)90017-7](https://doi.org/10.1016/0020-0255(81)90017-7)