SUBJECTIVE DATA AND DECISION MAKING PROCESS IN RAILWAY SAFETY : THE RADIO ALERT CASE STUDY

Céline TEA
Phd student

Supported by

Bertrand MUNIER
Professor – ENSAM Paris
Director of GRID

Pierre VIGNES
SNCF – Safety department
Human factor director

CONTEXT

My PhD project deals with the introduction of subjective data in the Information System for risk management through the experimentation of a decision aid.

Collaboration with Safety Department of SNCF (National French Railway Undertaking) ➔ case study

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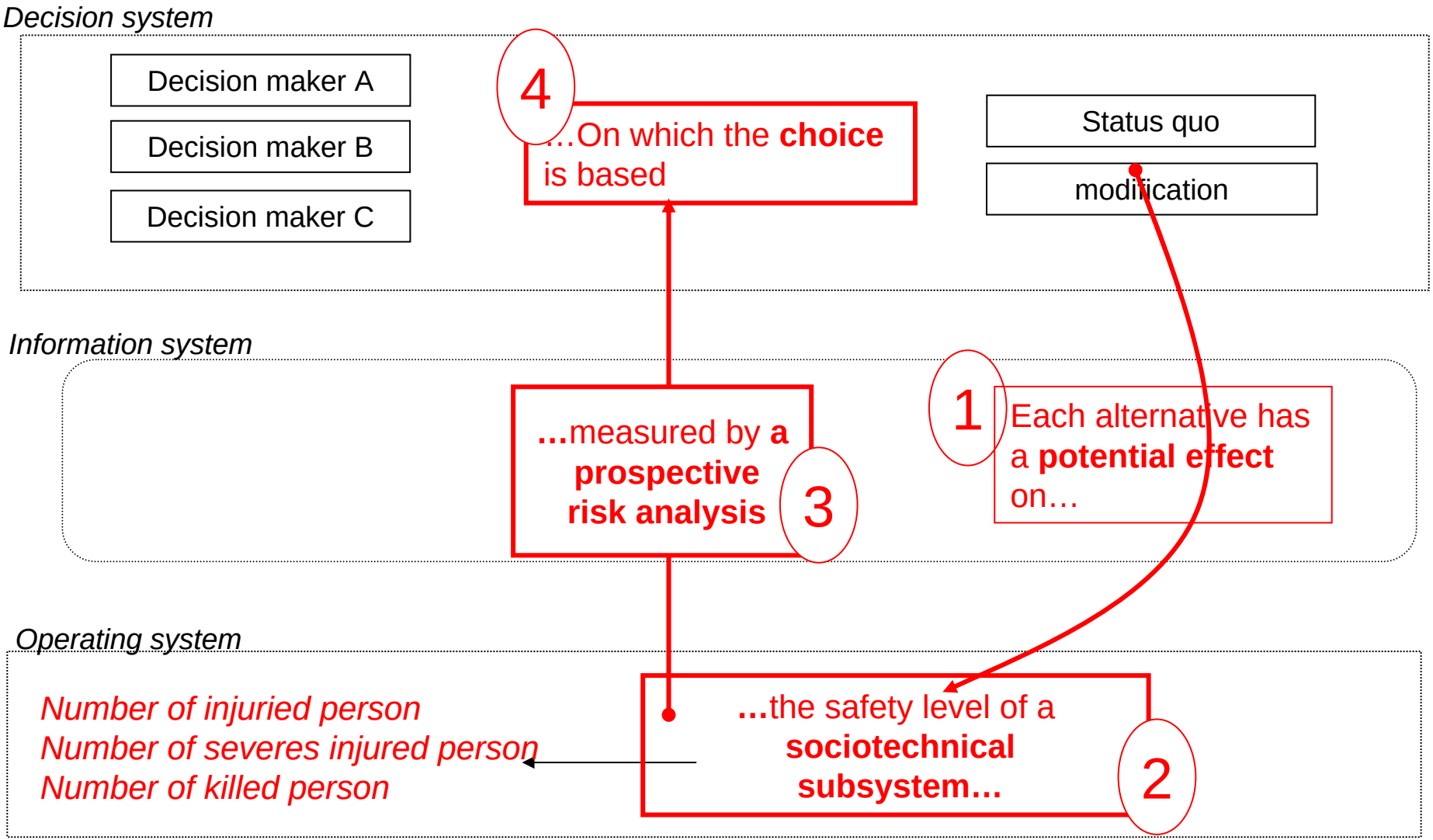
DECISION MAKING PROCESS, CASE STUDY AND SUBJECTIVE DATA

FORMAL REPRESENTATION OF THE DECISION MAKING PROCESS

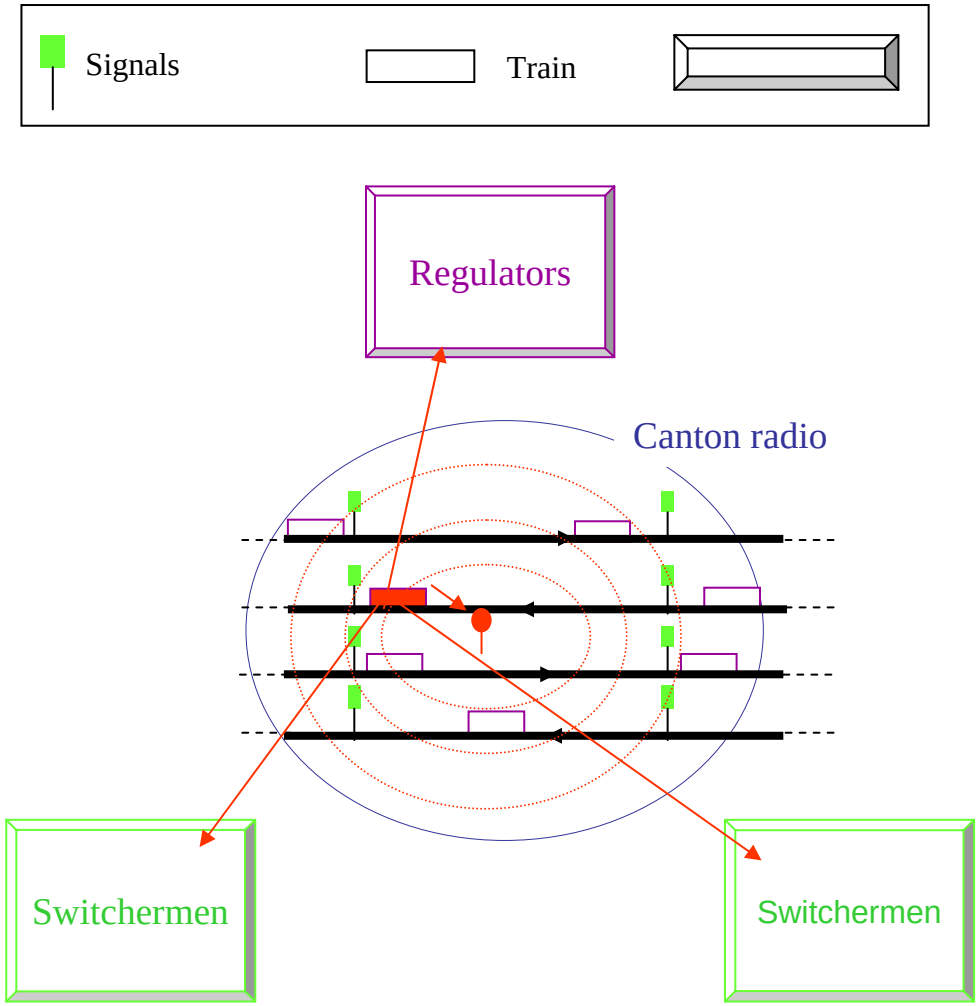


RADIO ALERTS CASE STUDY

Radio alert can be set off by a driver in case of danger or high presumption of danger on the rail. It provokes the emission of a signal heard by:

- Switchermen who have to shut signals down to stop trains and protect the danger zone;
- Drivers who have to stop in urgency;
- Regulators who are responsible for the traffic.

Everything must stop, but how do circulations restart ?
Rule 1 : restart after orders
Rule 2 : restart self sufficiency



By limiting the risk of fall, we take the risk to collide the cause of the alert….

CASE STUDY RISK STRUCTURE MAKES THE DECISION COMPLEX

No solution is dominating the other of every risks

	A	B
Fall from train	+	-
Collision with human	?	?
Collision with obstacle	-	+

→ Different impacts -A quantitative prospective risk analysis is required.

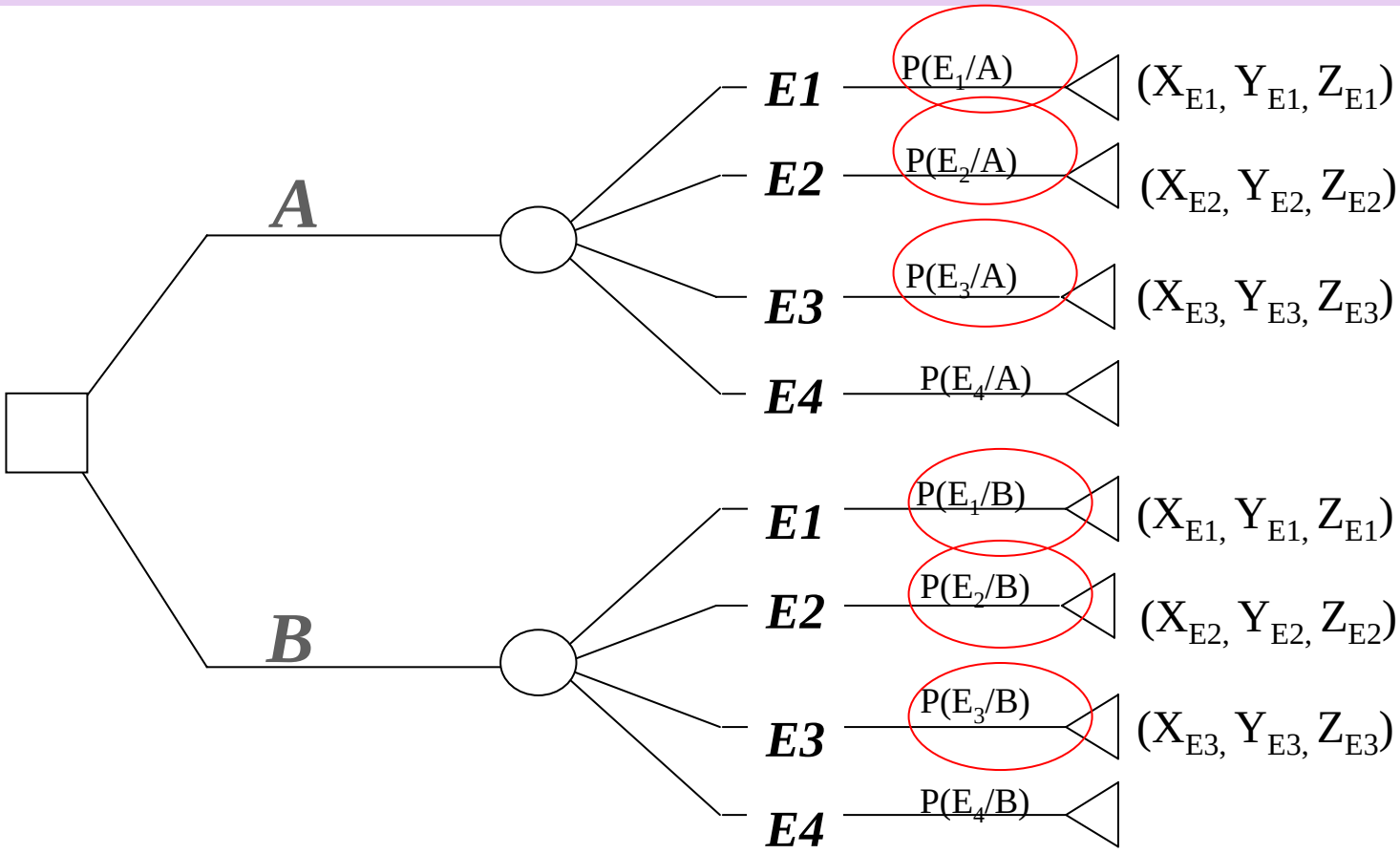
Very low probablity of severe consequences (expressed in terms of death) VS high probability of low consequences (express in terms of injured)

→ Comparing severety of death person VS injured person… Risk perception and consensus between decision makers are needed

SUBJECTIVE DATA ?

	Issue	Current practice	Suggestion
Subjective probability	Measure of the risks of each alternative	Frequence and database	Expert judgement
Utility function	How to compare two distributions of risks ?	Average value	Expected utility
Trade-off	Trade off between multiple dimensions	IDRAC scale : 1 killed = 10 severe injured person = 50 injured person	Multi Attribute Utility Theory

DECISION TREE



A: stopping rule
B: restart rule

E1: Collision with obstacle
E2: Collision with human
E3: Fall
E4: No incident

The “Safety level” by using MAUT by Keeney & Raïffa will be measured by:

$$S(D) = \sum_{i=I,HI,DP} k_i U_i^D + \sum_{\substack{i=I,HI,DP;\\ j=I,HI,DP}}^{j \neq i} k_{i,j} U_i^D U_j^D + k_{I/HI/D} U_I^D U_{HI}^D U_{DP}^D$$

$U_I^A = EU_I(\tilde{x} / A)$: Expected Utility of risk distribution of number of injuries with choice A

$k_{i,j}$: Trade off between I and J dimension

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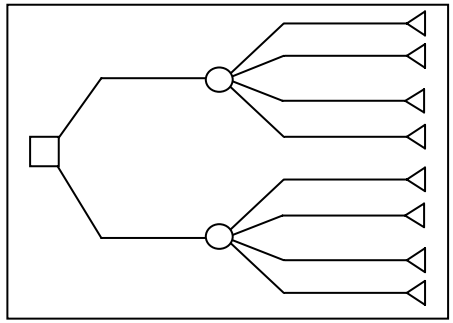
EXPERIMENTATION OF A DECISION AID

EXPERIMENT AND DECISION AID : HOW ?

STEP 1 : RISK IDENTIFICATION



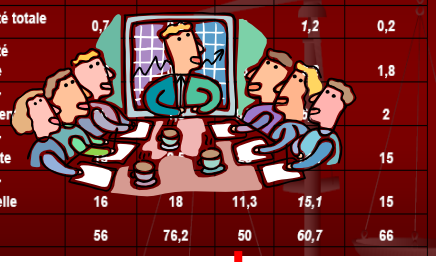
STEP 2 : RISK ASSESSMENT

Individual

x N

Collective

Distributions de probabilités	Chef de service	Chef d'équipe	Cariste	*Moyenne*	Consensus
Invalidité totale	0,7			1,2	0,2
Invalidité partielle					1,8
Douleur permaner					2
Douleur fréquente					15
Douleur ponctuelle	16	18	11,3	*15,1*	15
Fatigue	56	76,2	50	60,7	66

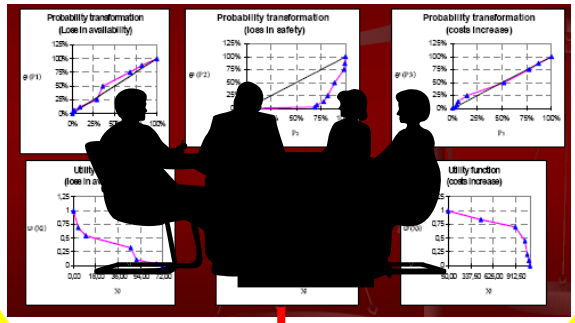


STEP 3 : SUBJECTIVE RISK PERCEPTION

Individual

x M

Collective



STEP 4 : PRESCRIPTION

DECISION RULE

ELICITATION TECHNIQUES

Technical points are developped in the article.

<table>
<tr><th></th><th>Technique ?</th></tr>
<tr><td>Subjective probability</td><td>First,
Techniques based on choices
But finally
Direct Judgement</td></tr>
<tr><td>Utility function</td><td rowspan="2">SERUM :
(Système d’Evaluation des Risques par Utilité Multicritère)

GRID / EDF
(Electricity of France).</td></tr>
<tr><td>Trade-off</td></tr>
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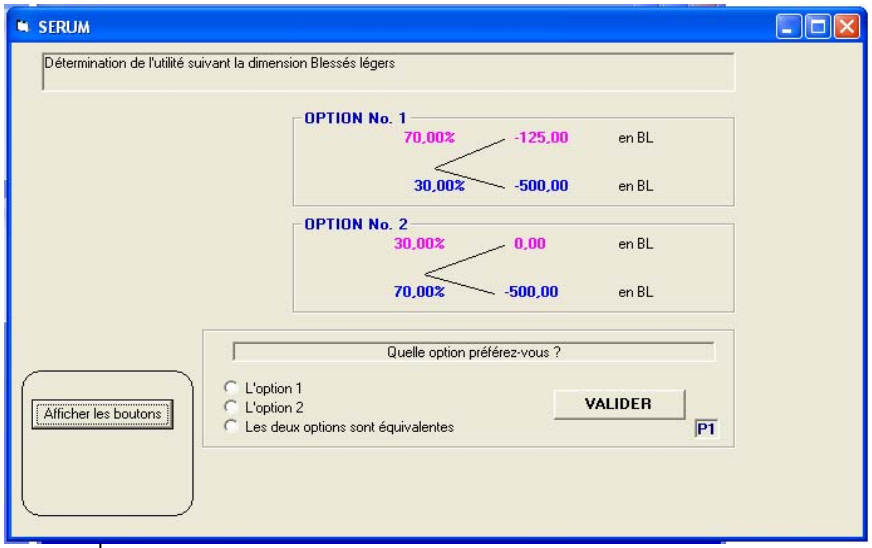
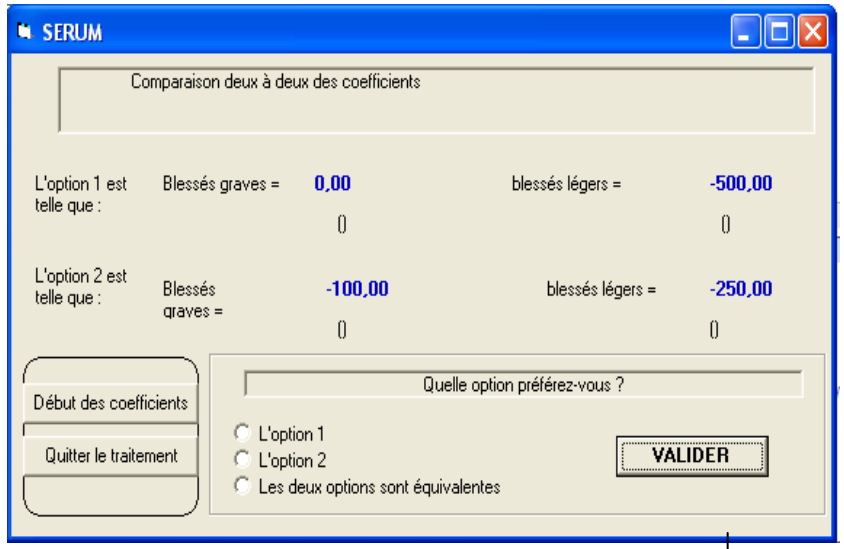
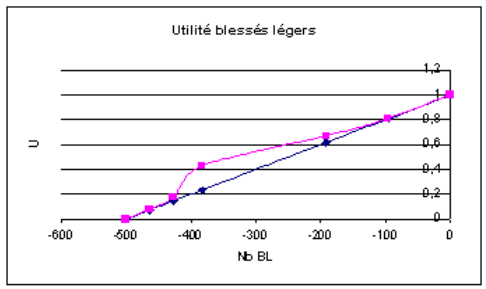
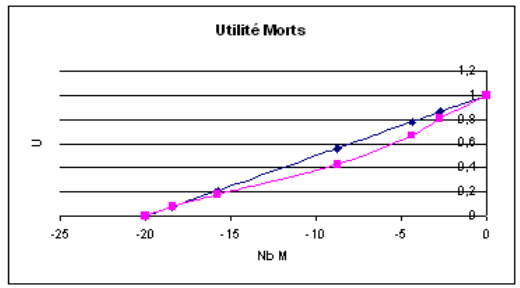
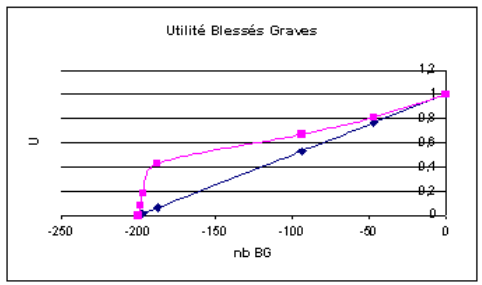
EXAMPLE OF INTERFACE FOR UTILITY FUNCTION AND TRADE OFF











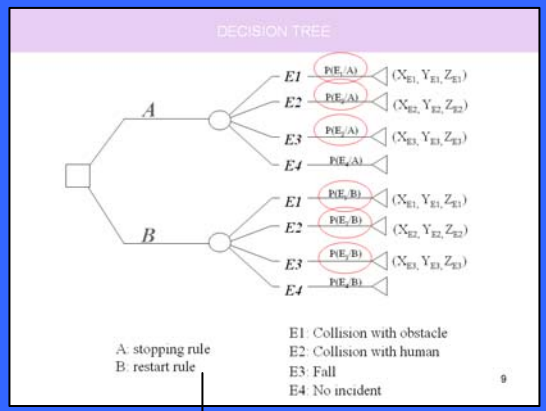
LES COEFFICIENTS DE PONDERATION

Coefficient	Valeur
Coefficient K 1	0,011
Coefficient K 2	0,039
Coefficient K 3	0,235
Coefficient K 2 3	-0,263
Coefficient K 1 3	-0,208
Coefficient K 1 2	0
Coefficient K123	1,187

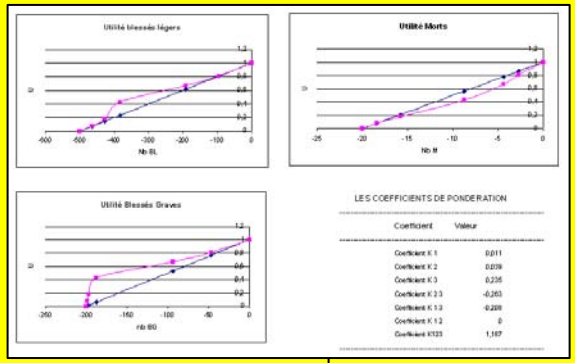
HOW TO ESTABLISH THE PRESCRIPTION ?

PROBABILITIES + CONSEQUENCES

6 DISTRIBUTION OF RISKS



UTILITY FUNCTION AND K ATTRIBUTES



TWO SCORE ARE CALCULATED
(decision rule)

ESTABLISHMENT OF A PRESCRIPTION

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AS A CONCLUSION

AS A CONCLUSION

We are currently exploiting the data collected…

To make progress, we need to overpass frontiers :

- Between scientific discipline : expert judgement, decision analysis, uncertainty analysis – idea for potential productive collaboration ?

- Theory and Practice : idea for further theoritical and pratical problems !

THANKS FOR YOUR ATTENTION