



Artificial Logic for Integrated Risk Engineering and Management

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An integrated and unifying approach



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Why an integrated and unifying approach?



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- Adopting an **integrated and unifying approach to risk analysis** and management has a **threefold beneficial effect**, namely:
 - **Helps** (decision makers) **keeping a systemic view of the overall risk** (associated with phenomenon/system being analysed)
 - **Avoids** the creation of **grey zones** and **conflicting views** (both typical of the risk compartmentalisation)
 - **Creates strong scope economies** (as risks are analysed and modelled independently on their nature)



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Conflicting views: design, safety, security



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**Production
Designer**



Open layout

**Damages
Safety Manager**



Stored layout

A hydrogen storage

**Target
Security Manager**



Undergrounded layout

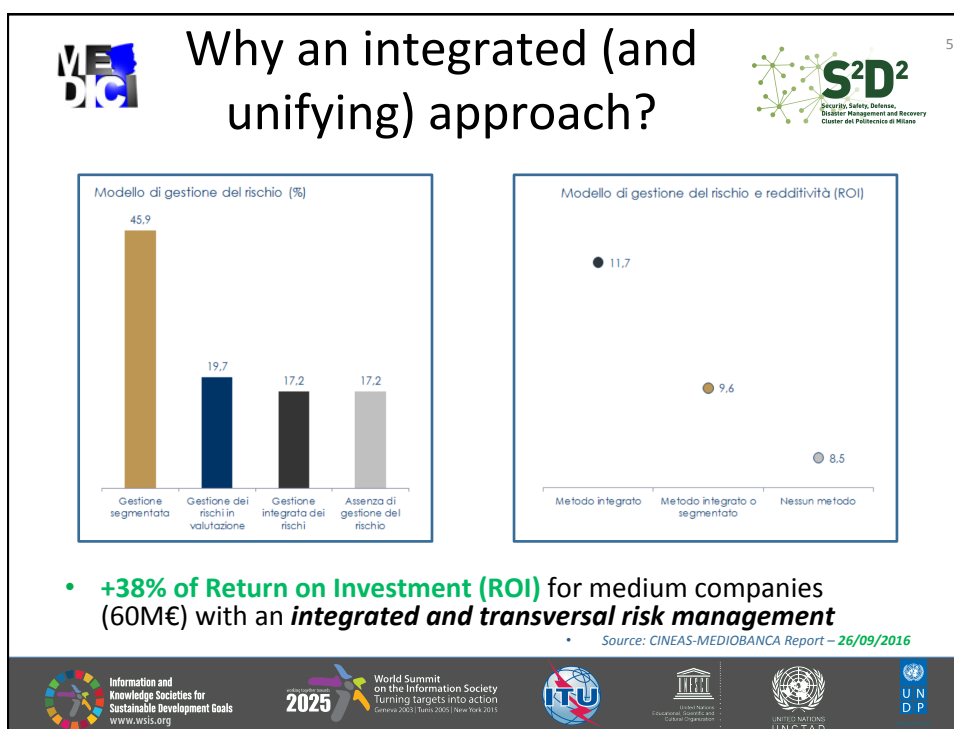


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What's a unifying approach?

ME DIC S²D² Security, Safety, Defense, Disaster Management and Recovery Cluster del Politecnico di Milano

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- What does it mean adopting **a unifying approach to the analysis of risk**?
- It means **analysing all risks** with a methodological approach capable of **representing the systemic complexity of the system**
- To that goal it is necessary to:
 - analysing **the system as a set of functions**, independently of their nature and typology (Human, Technological and Organisational), **correlated both logically and stochastically**
 - moving **from a "paper and pencil" approach** to a **"simulated approach"** capable of **producing the entire universe of possibilities** (which probability sums up to 1)

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The Artificial Logic Bayesian Algorithm (ALBA)



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The Artificial Logic Bayesian Algorithm (ALBA)



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- The **Artificial Logic Bayesian Algorithm*** (ALBA) allows to **analyse systems/phenomena of unthinkable complexity** with today's methods, thus enabling to:
 - **Create a complete partition** (i.e., the entire universe of possible scenarios/stories)
 - **Manage scenarios** at different level of abstraction
 - **Prioritise criticalities** by contribution to the risk (and not to the sole probability)

*Risk-based decision making in complex systems: The ALBA method - 10.1109/IEEM.2016.7797921



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The Artificial Logic Bayesian Algorithm (ALBA)



- The **Artificial Logic Bayesian Algorithm** (ALBA) consists of 5 steps, namely:
 - the input file creation
 - the semantic check
 - the consequences definition
 - the risk profiling
 - the critical functions identification



The Artificial Logic Bayesian Algorithm (ALBA)



Security, Safety, Defense,
Disaster Management and Recovery
Center of Excellence of Mitre

Logic-Stochastic Simulation

Risk Profile Comparison

Critical Functions Identification

CONSTITUENT TOTAL NUMBER : 381900

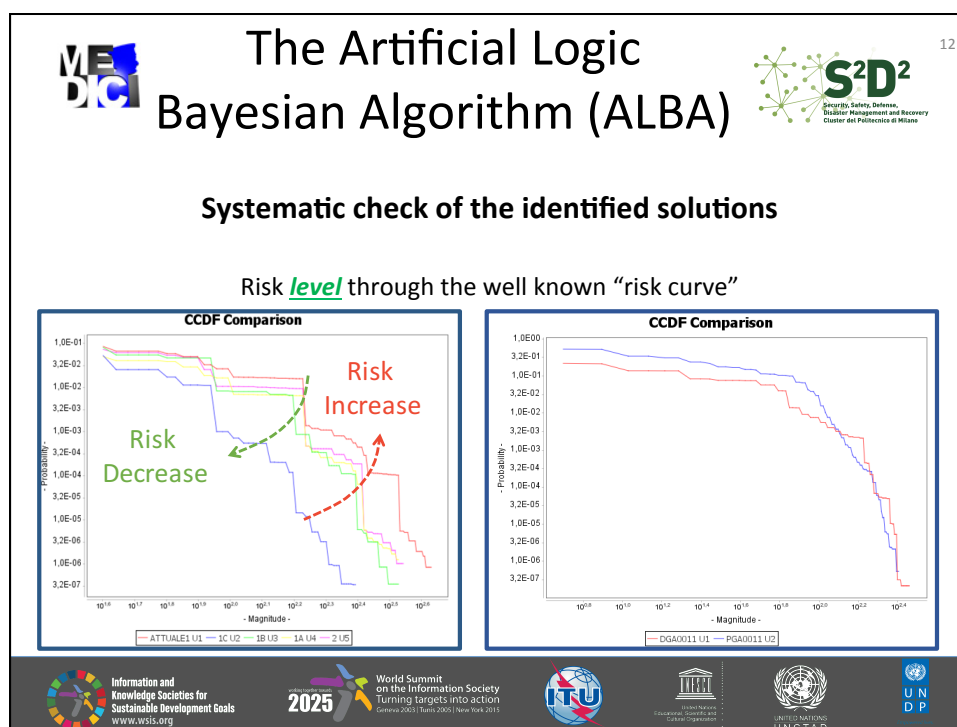
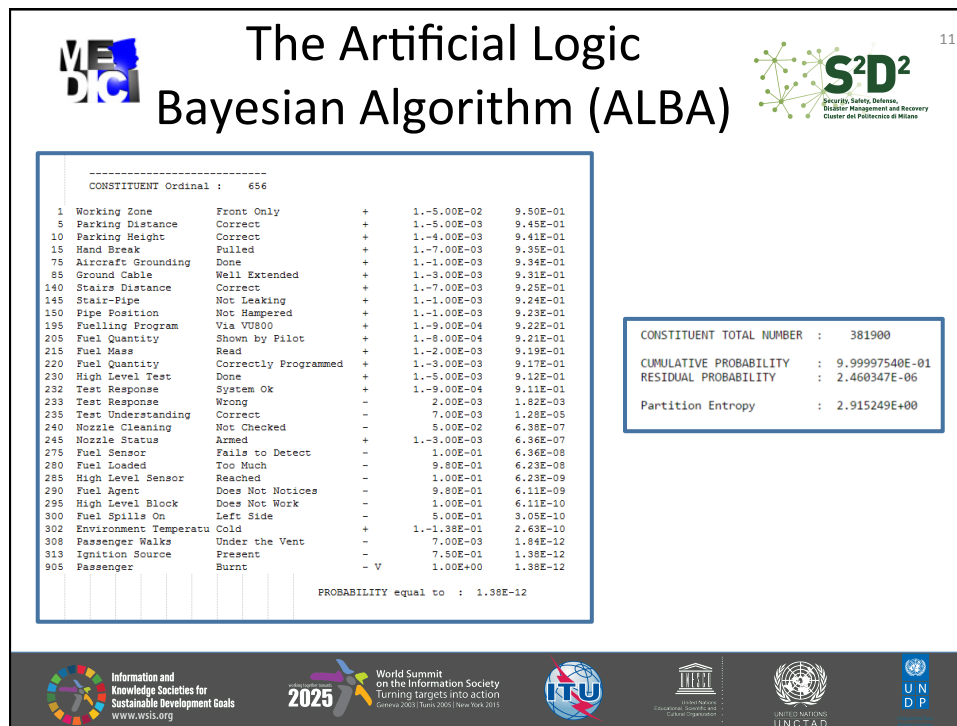
CUMULATIVE PROBABILITY : 9.99997540E-01

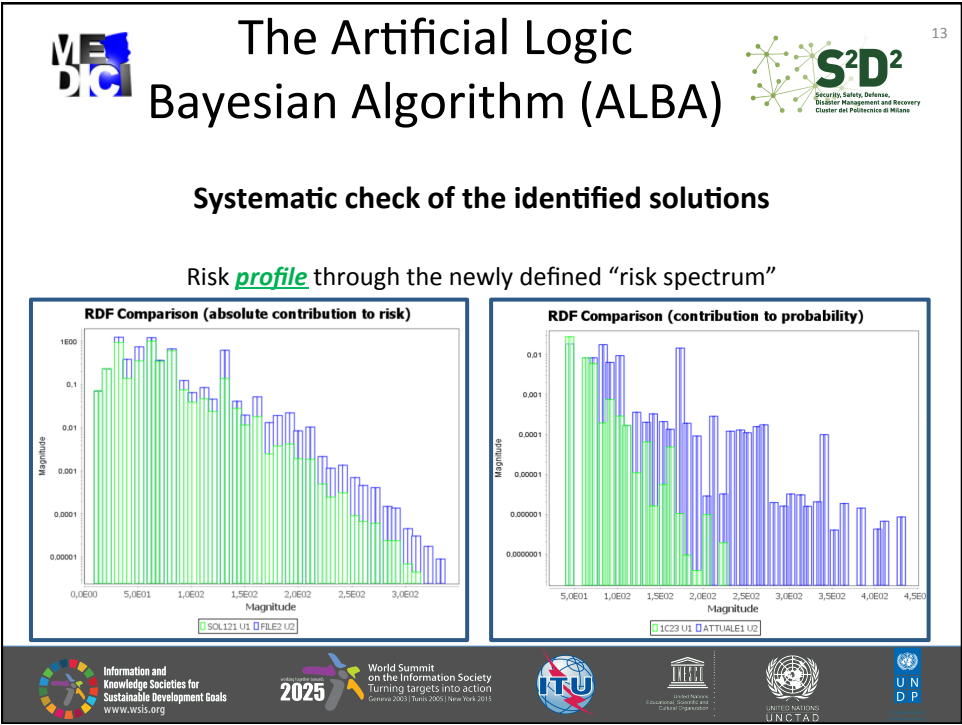
RESIDUAL PROBABILITY : 2.468347E-06

Partition Entropy : 2.915249E+00

CONSTITUENT Countdown : 656

Countdown	Function	Value	Countdown	Function	Value
1	Working Situation	Force Only	1	Working Situation	Force Only
2	Parking Situation	Correct	2	Parking Situation	Correct
3	Parking Height	Correct	3	Parking Height	Correct
4	Access Block	Dislike	4	Access Block	Dislike
5	Access Block	Dislike	5	Access Block	Dislike
6	Access Block	Dislike	6	Access Block	Dislike
7	Access Block	Dislike	7	Access Block	Dislike
8	Access Block	Dislike	8	Access Block	Dislike
9	Access Block	Dislike	9	Access Block	Dislike
10	Access Block	Dislike	10	Access Block	Dislike
11	Access Block	Dislike	11	Access Block	Dislike
12	Access Block	Dislike	12	Access Block	Dislike
13	Access Block	Dislike	13	Access Block	Dislike
14	Access Block	Dislike	14	Access Block	Dislike
15	Access Block	Dislike	15	Access Block	Dislike
16	Access Block	Dislike	16	Access Block	Dislike
17	Access Block	Dislike	17	Access Block	Dislike
18	Access Block	Dislike	18	Access Block	Dislike
19	Access Block	Dislike	19	Access Block	Dislike
20	Access Block	Dislike	20	Access Block	Dislike
21	Access Block	Dislike	21	Access Block	Dislike
22	Access Block	Dislike	22	Access Block	Dislike
23	Access Block	Dislike	23	Access Block	Dislike
24	Access Block	Dislike	24	Access Block	Dislike
25	Access Block	Dislike	25	Access Block	Dislike
26	Access Block	Dislike	26	Access Block	Dislike
27	Access Block	Dislike	27	Access Block	Dislike
28	Access Block	Dislike	28	Access Block	Dislike
29	Access Block	Dislike	29	Access Block	Dislike
30	Access Block	Dislike	30	Access Block	Dislike
31	Access Block	Dislike	31	Access Block	Dislike
32	Access Block	Dislike	32	Access Block	Dislike
33	Access Block	Dislike	33	Access Block	Dislike
34	Access Block	Dislike	34	Access Block	Dislike
35	Access Block	Dislike	35	Access Block	Dislike
36	Access Block	Dislike	36	Access Block	Dislike
37	Access Block	Dislike	37	Access Block	Dislike
38	Access Block	Dislike	38	Access Block	Dislike
39	Access Block	Dislike	39	Access Block	Dislike
40	Access Block	Dislike	40	Access Block	Dislike
41	Access Block	Dislike	41	Access Block	Dislike
42	Access Block	Dislike	42	Access Block	Dislike
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57	Access Block	Dislike	57	Access Block	Dislike
58	Access Block	Dislike	58	Access Block	Dislike
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67	Access Block	Dislike	67	Access Block	Dislike
68	Access Block	Dislike	68	Access Block	Dislike
69	Access Block	Dislike	69	Access Block	Dislike
70	Access Block	Dislike	70	Access Block	Dislike
71	Access Block	Dislike	71	Access Block	Dislike
72	Access Block	Dislike	72	Access Block	Dislike
73	Access Block	Dislike	73	Access Block	Dislike
74	Access Block	Dislike	74	Access Block	Dislike
75					







The Artificial Logic Bayesian Algorithm (ALBA)



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CRITICAL FUNCTION	PRIORITY	RISK	RISK %
240 Nozzle Cleaning Not Checked	1	4.898E-01	3.06082E+01 %
Cumulative Risk % : 3.06082E+01 %			
Nr. of Constituents : 631			
Constituents Range : (1 - 631)			
275 Fuel Sensor Fails to Detect	2	1.952E-01	1.21992E+01 %
Cumulative Risk % : 4.28075E+01 %			
Nr. of Constituents : 201			
Constituents Range : (632 - 832)			
230 High Level Test Not Done	3	1.006E-01	6.28605E+00 %
Cumulative Risk % : 4.90935E+01 %			
Nr. of Constituents : 635			
Constituents Range : (833 - 1467)			
215 Fuel Mass Not Read	4	9.401E-02	6.00011E+00 %
Cumulative Risk % : 5.50936E+01 %			
Nr. of Constituents : 719			
Constituents Range : (1468 - 2180)			
220 Fuel Quantity Wrongly Programmed	5	9.019E-02	5.63660E+00 %
Cumulative Risk % : 6.07002E+01 %			
Nr. of Constituents : 689			
Constituents Range : (2181 - 2869)			



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Examples of applications



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Example 1

Organisational (re-)design



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Organisational (re)design (SEA Milan Airport)



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- The **approach** can be applied to **whatever context** to analyse **whatever risk**
- From an organisational-managerial standpoint **the most innovative application** case developed is that of the SEA Milan Airport Company to **transform their organisational set-up through a risk-based approach**
- The (worldwide) **airport system** from the 1st January 2017 **had**, by Law, **to implement a change management function/process** (a function that in the process industry domain is active since a decade)



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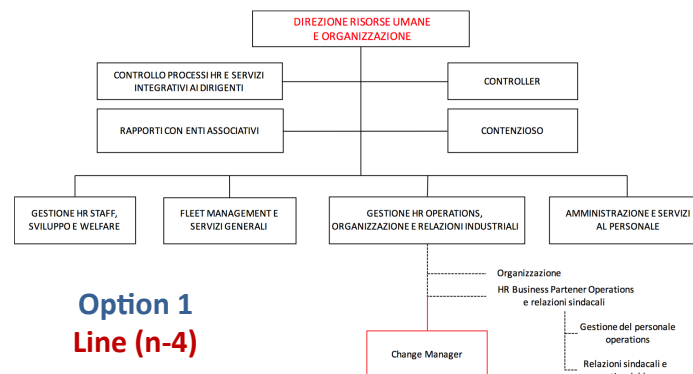


Organisational (re)design (SEA Milan Airport)



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- The 3 (three) possible solutions identified by the company management were as follows:

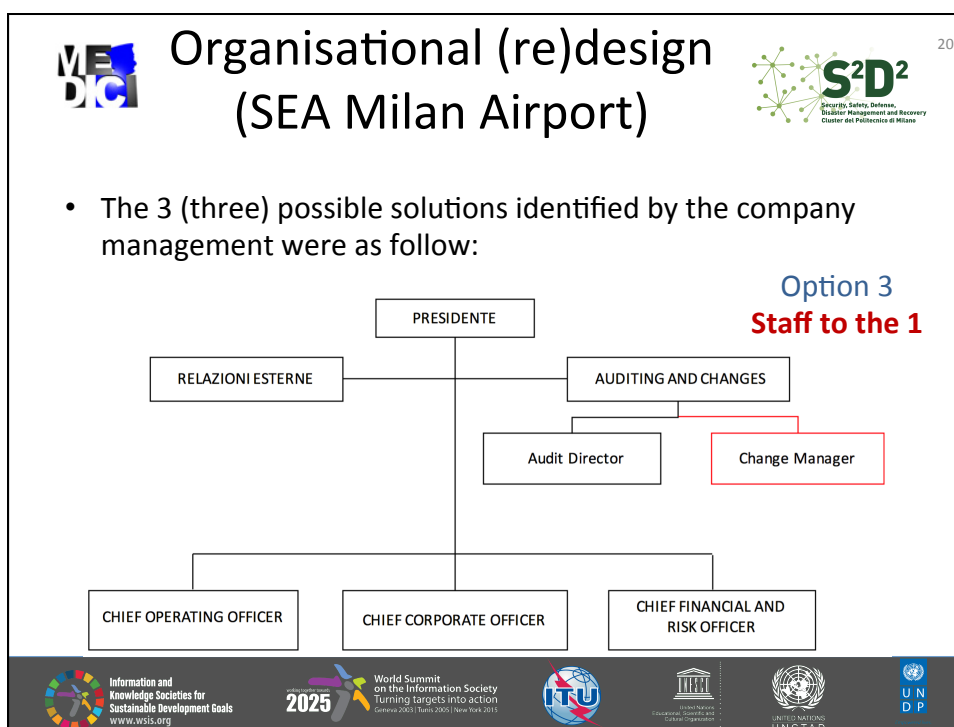


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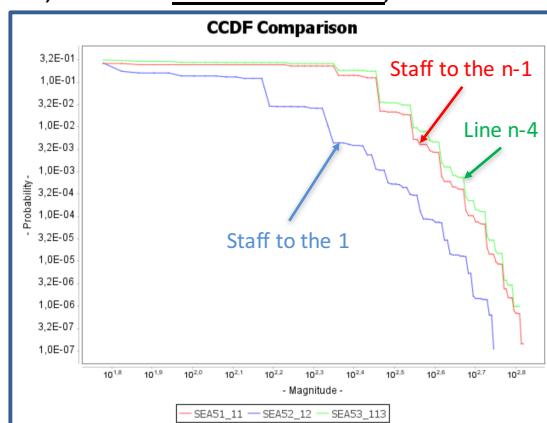


Organisational (re)design (SEA Milan Airport)



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- The results, as usual ***counterintuitive***, have been as follows:



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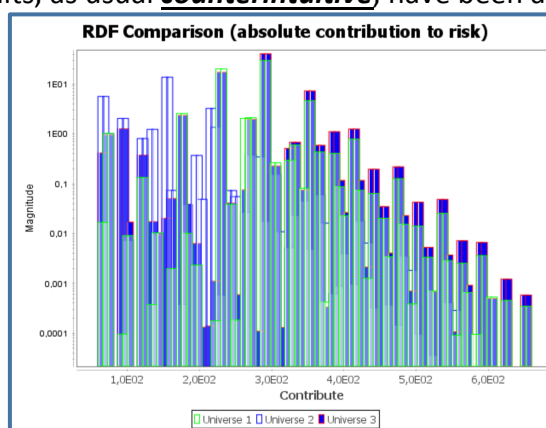


Organisational (re)design (SEA Milan Airport)



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Example 2

Corporate (Training) Process



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(Re)design of Company Training Process (SAIPEM)



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- A second “unconventional” application of the is the *(re)design of the company training process* (at corporate level)
- SAIPEM is an engineering company, operating primarily in the oil and gas industry, that employs something around **52.000 people scattered all over the globe in the most environmentally harsh and logistically remote areas of the planet...** and they need to be trained as their job is risky
- The corporate *training function involves many other company functions* both at corporate and site level, thus *making the process particularly complex to analyse and envisage* (inefficiencies are typically extremely high and hard to control)



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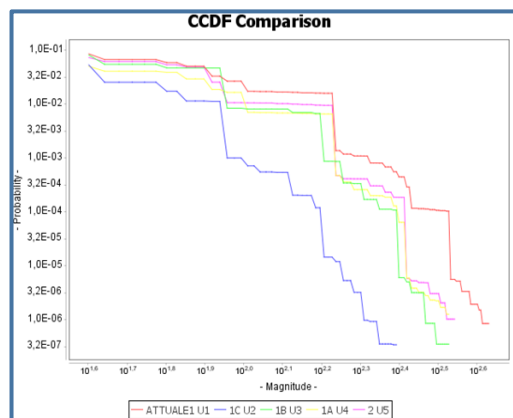


(Re)design of Company Training Process (SAIPEM)



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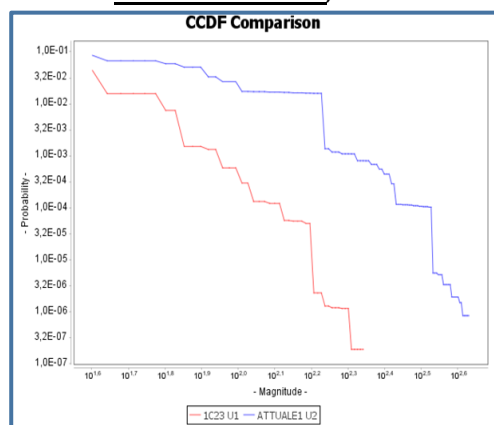


(Re)design of Company Training Process (SAIPEM)



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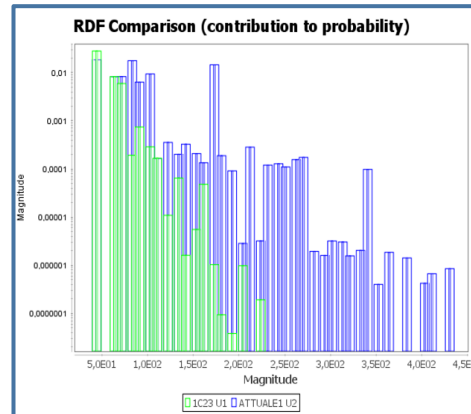


(Re)design of Company Training Process (SAIPEM)



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Example 3

Germany's Energy Transition



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Germany's Energy Transition


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- The third most challenging application is the envisioning of the *risks associated with the country transition from fossil-based to renewable-based energy production*
- *Horizon of analysis is 2030-2050* (i.e., 15 to 35 years from now)
- The analysis is being performed in *cooperation with the Institute for Technology Assessment and Systems Analysis (ITAS) of the KIT University*
- The analysis is ongoing...










Some Applications


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- **Health care:**
 - Optimisation of Elective surgery (neurosurgery and otolaryngology)
 - Department Activities Optimisation of a Long-term Care Support Structure (Syndrome Lateral Sclerosis, Alzheimer, Vegetative State)
 - Reduction of the Over-triage of Greater Milan's Emergency Sanitary System (112) – Major Trauma Centre
- **Infrastructures:**
 - Refuelling with Passengers on Board (airport)
 - (Re)Design of Milan Airport's Emergency Response System (airport)
 - (Re)Design of the Organisational Set-up for the Introduction a New Corporate Function/ Process (airport)
- **Counterterrorism:**
 - Design of Terrorist Attack from Open Source Intelligence (OSINT) (airport and aqueduct)










Some Applications



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- **Security:**
 - Design Support of an Antitheft ICT System
 - Design Support of an Anti-aggression ICT System
 - Design Support of Risk-based Border Crossing Points
- **Process:**
 - (Re)Design of the Corporate Training System of a Multinational Engineering Company (SAIPEM)
 - Optimisation of a Glue Production Process
 - Optimisation of Technical Gases Production Process
 - Optimisation of the Welding and Laying Process of Marine Oil Pipeline



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That's all

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