RISK ANALYSIS METHODS AND TOOLS FOR ENGINEERING PROJECTS: AN EXPERIENCE OF ELETROBRAS FURNAS IN BRAZIL

FLAVIO SOHLER
PhD., DSc., MSc., PMI-PMP, PMI-RMP

fsohler@gmail.com
fsohler@furnas.com.br
Eletrobras Furnas Centrais Elétricas S.A.

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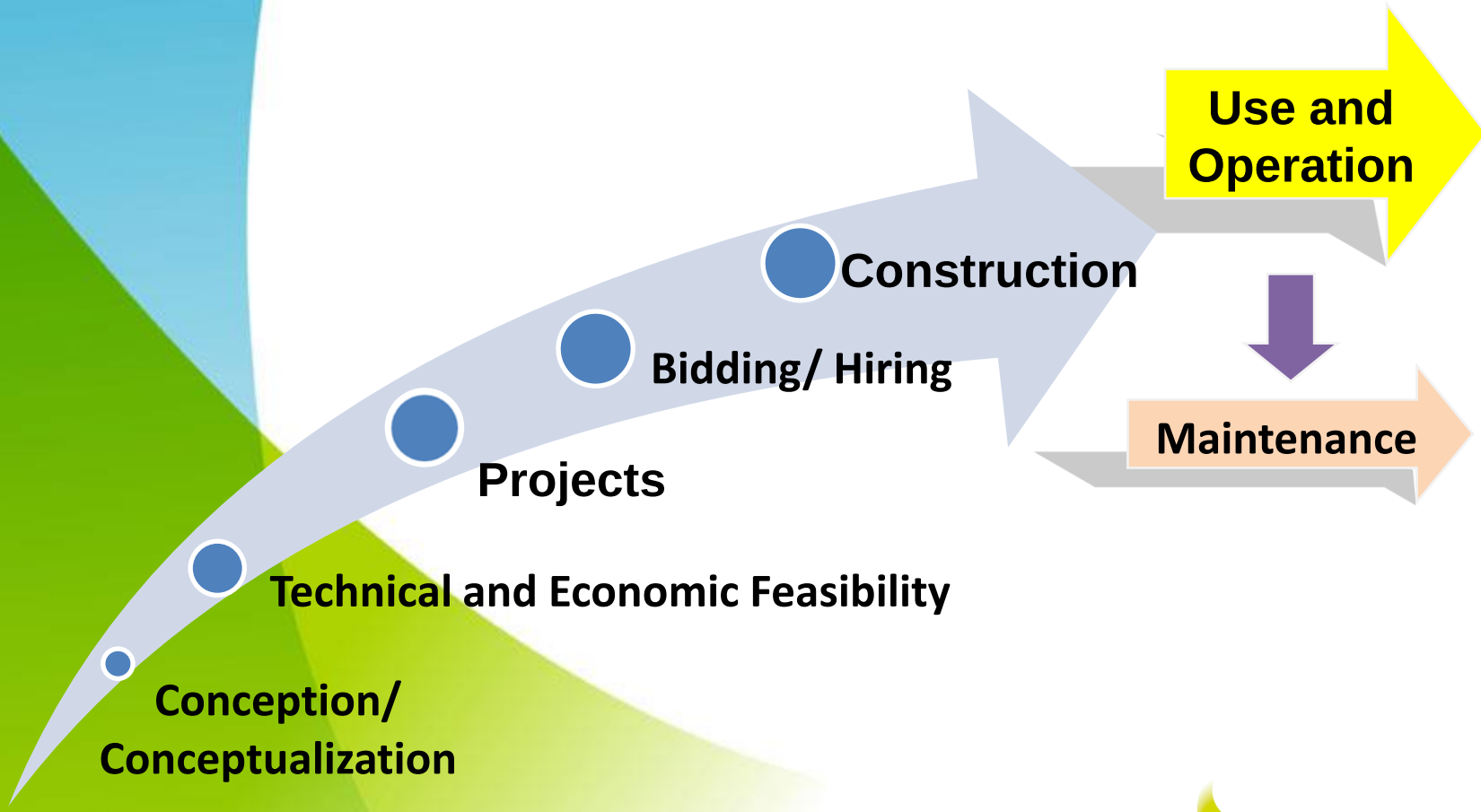
Stages of a Construction Project



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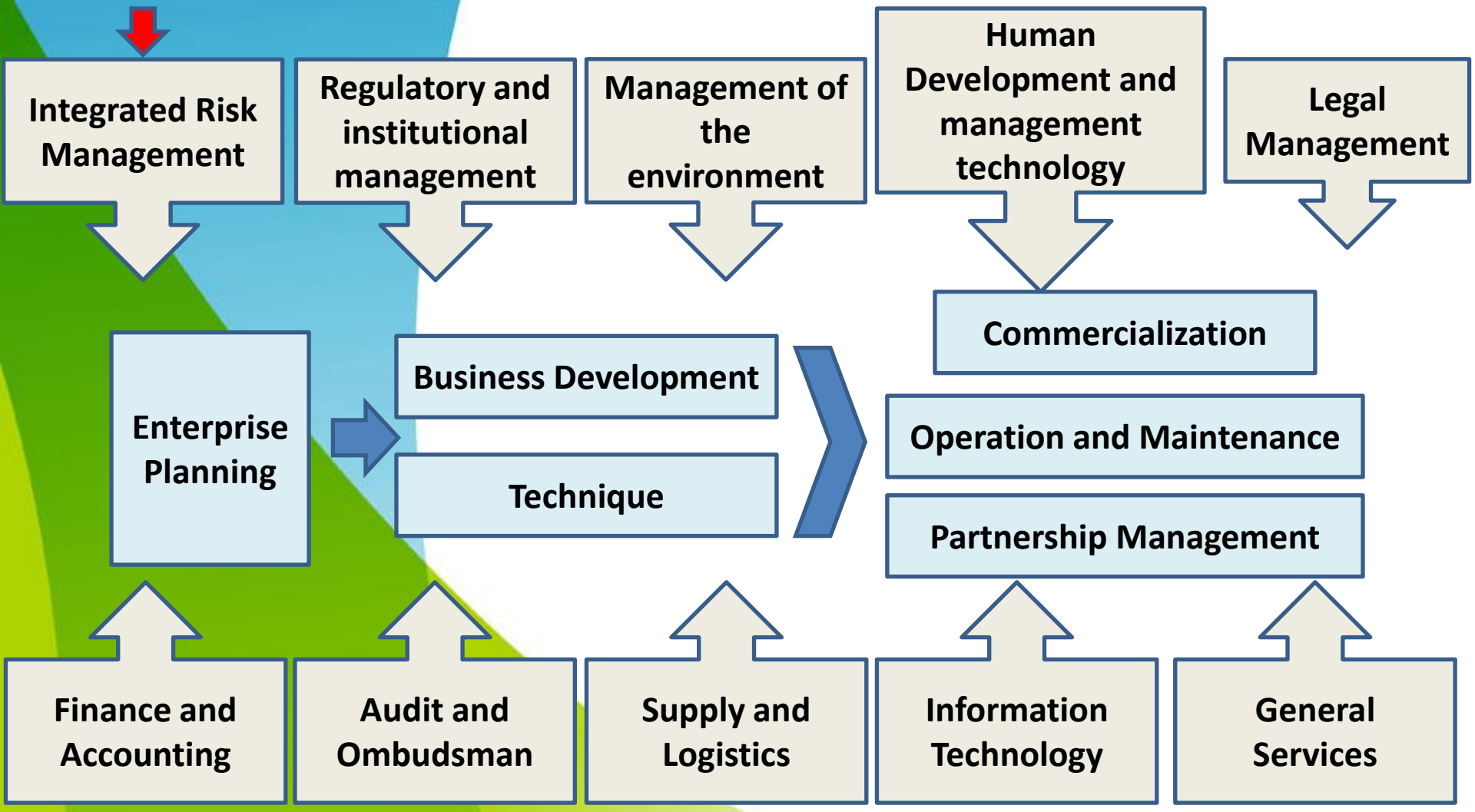
I. Corporate Risk Management Master Plan



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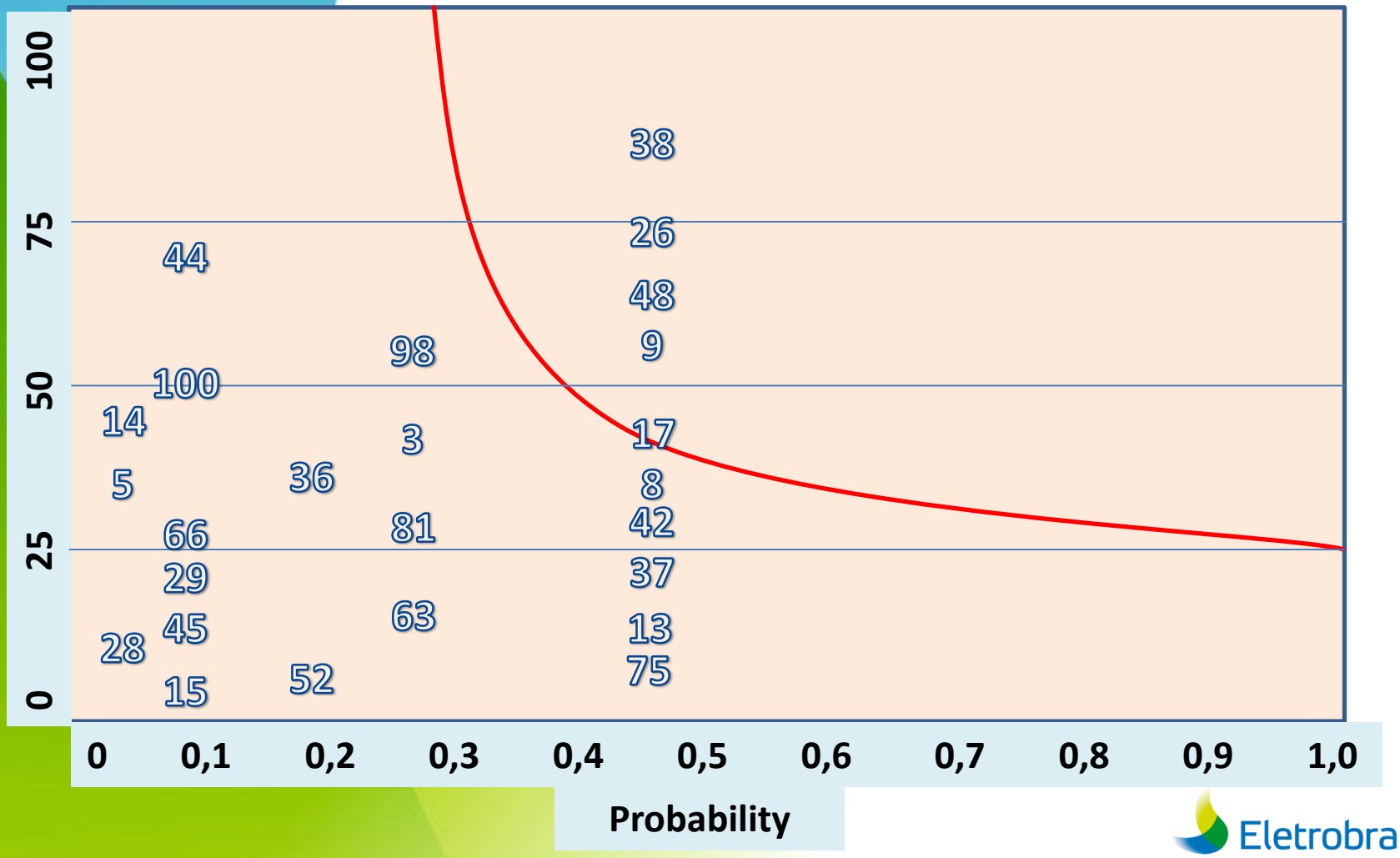

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I. Corporate Risk Management Master Plan

ADVANTAGES:

✓Created the basis for implementing the risk management culture in the company;

✓Prioritization of Risks (Expected Value).

DISADVANTAGES:

✓It focuses only on strategic risks and not on specific projects;

✓ It does not allow more specific risk analysis for costs and deadlines;

✓It does not address the uncertainties inherent in a subjective process.

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II. Risk Management System in Power Generation Projects

- ✓ **Objective: Creation of software to prioritize construction risks, using the FAHP-Fuzzy Analytic Hierarchy Process methodology, which addresses the uncertainties;**
- ✓ **FAHP => Multicriteria method of decision support, addressing the inherent inaccuracies of complex decisions;**
- ✓ **Case studies => 2 Dams, 1 Eolic Complex.**

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II. Risk Management System in Generation Projects

Result of the FAHP application

PRIORITY	SERVICE PACKAGE	IMPACT LEVELS
1	Socio-environmental	40,6%
2	Transmission civil works	17,5%
3	Complementary works	12,8%

PRIORITY	RISK EVENTS	IMPACT LEVELS
1	Project	33,5%
2	Contracts	22,2%
3	Geotechnical	21,9%

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II. Risk Management System in Generation Projects

FAHP application

ADVANTAGES:

- ✓ It takes into account the inherent inaccuracies of complex decisions;
- ✓ Prioritization of Risks;
- ✓ The result confirmed the expectations of the interviewees.

DISADVANTAGES:

- ✓ Difficulty in applying the method;
- ✓ Difficulty in in-depth interviews and content analysis;
- ✓ Subjectivity in the definition of service packets and risk events.

DIFFICULTY OF APPLICATION:

- ✓ Not understanding the method;
- ✓ Tiredness of the interviewee;
- ✓ Tendency to choose extreme degrees of preference.

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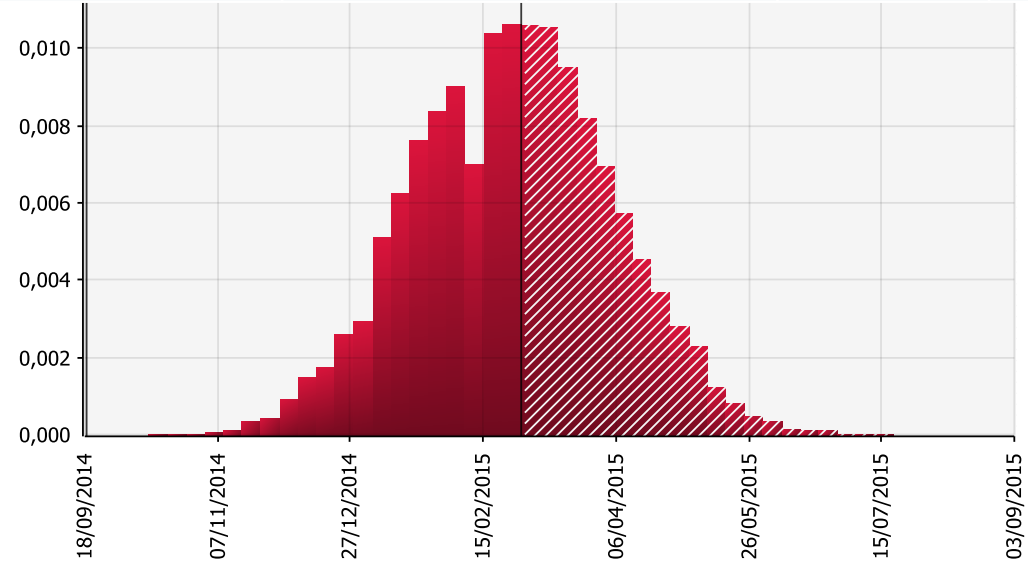
III. Risk Management System in Generation Projects

Impact on the Project End´s Date

	Average	Minimum	Maximum			
Duration	1263	1131	1402			
Delay	251	119	390			
	To Anticipate	Delay	Up to 3 months	3 to 6 months	6 to 12 months	More than 1 year
Probability	0,0%	100%	5,4%	74,2%	20,4%	0,0%



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III. Risk Management System in Generation Projects

ADVANTAGES:

- ✓ Analysis of complex models;
- ✓ Assists in the decision regarding deadlines and costs;
- ✓ If the model is well planned, there is a good level of precision.

DISADVANTAGES:

- ✓ Project schedule should be well planned and defined;
- ✓ Beware of using best practices for network of activities;
- ✓ Difficulty in interviewing to define the worst and best case;
- ✓ It does not take into account the uncertainties regarding the definition of durations by the specialists.

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IV. Risk Analysis for Dam Safety

PHASE I:
Selection of Dams

→ **Function of the Dam**
Size of the Dam
Age of the Dam

PHASE II:
Analysis of Risks in Individual Dams

→ **Score Impact / Confidence Index**
Risk Index
Risk Potential
Behavior Index
Risk class
Classification Matrices
Global Modified Risk Index

PHASE III:
Analysis of Failure Modes of Major Problems

→ **Methodology of Risk Analysis**
LCI/FMECA
ETA/FTA

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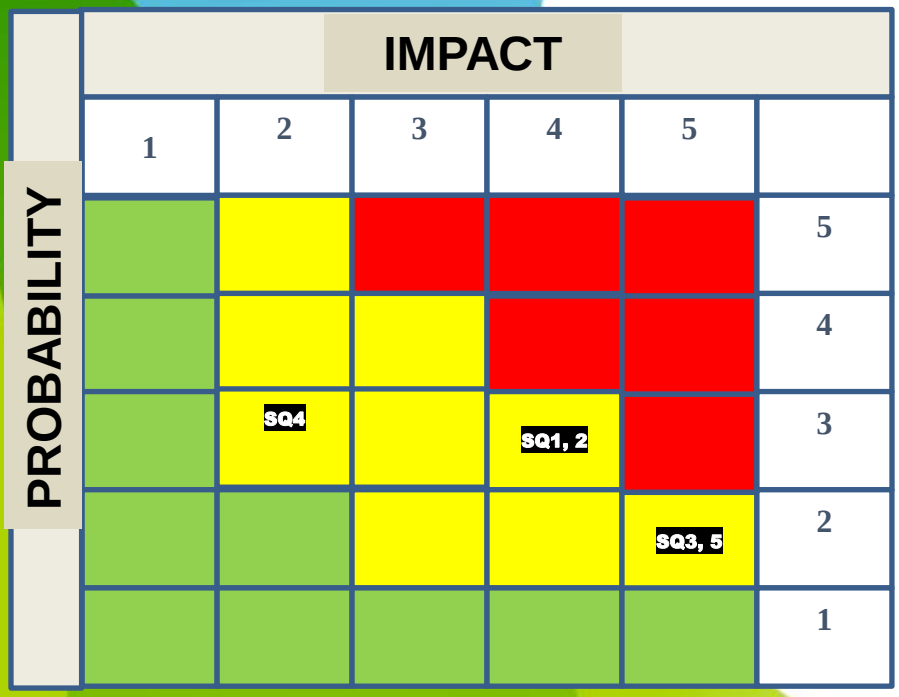
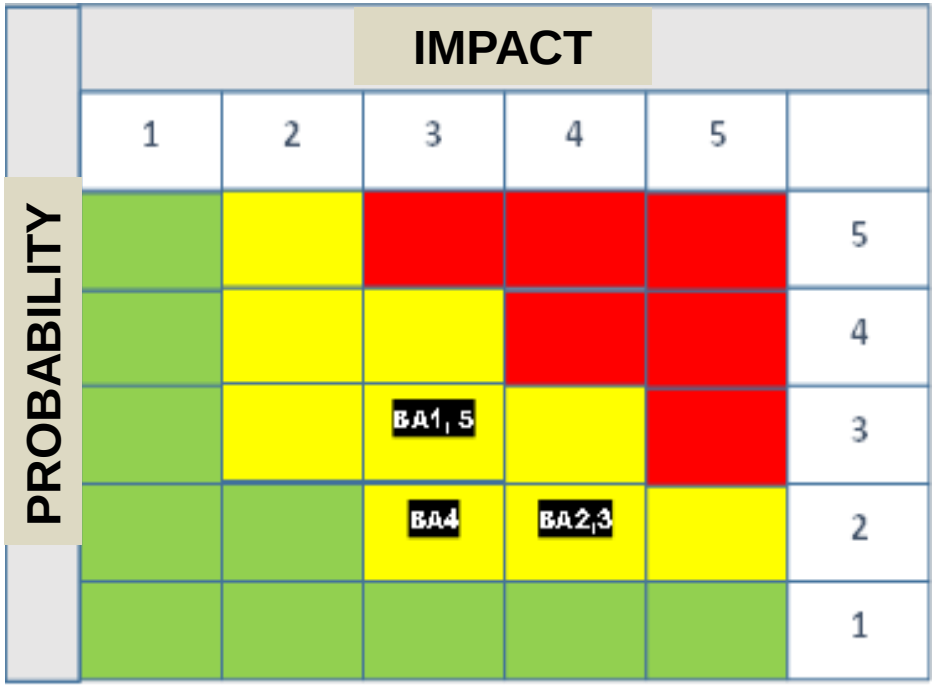
IV. Risk Analysis for Dam Safety

Risk Matrix of LCI Method





HIGH MEDIUM LOW

HIGH MEDIUM LOW

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IV. Risk Analysis for Dam Safety

FMECA (Failure Mode, Effect and Criticality Analysis)

FUNCTION	FAILURE MODE	CAUSE	EFFECT	P	I	ICR	DETECTION MODE (DM), PREVENTION (PR)	D	RPN
1.CONCRETE DAM									
CONTAIN RESERVOIR	1(1) OVERFLOW (HYDRAULIC FAULTS)	Exceptional water levels	External erosion with dam break	2	20	40	Reservoir lowering (PR) Level monitoring by telemetry system (DM)	2	80
	1(2) SLOPE SLIP	Exceptional uploads	Global instability with uncontrolled water release	1	20	20	Reservoir lowering (PR) Visual inspection and instrumentation (DM)	3	60
		Inadequate material properties		1	5	5	Geological mapping (PR) Instrumentation (DM) Consolidation Injection (DM), Installation of drains (PR)	2	10
		Inadequate foundation properties		2	8	16	Technological control (PR), Instrumentation (DM), Construction of stabilizer bats (DM), Compression (DM)	1	16

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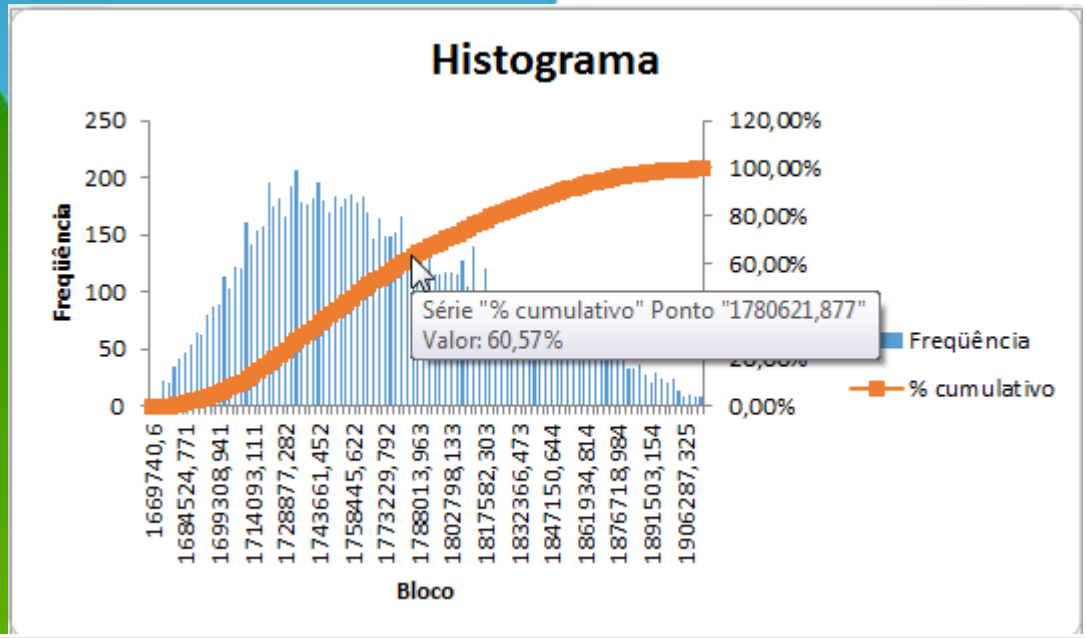
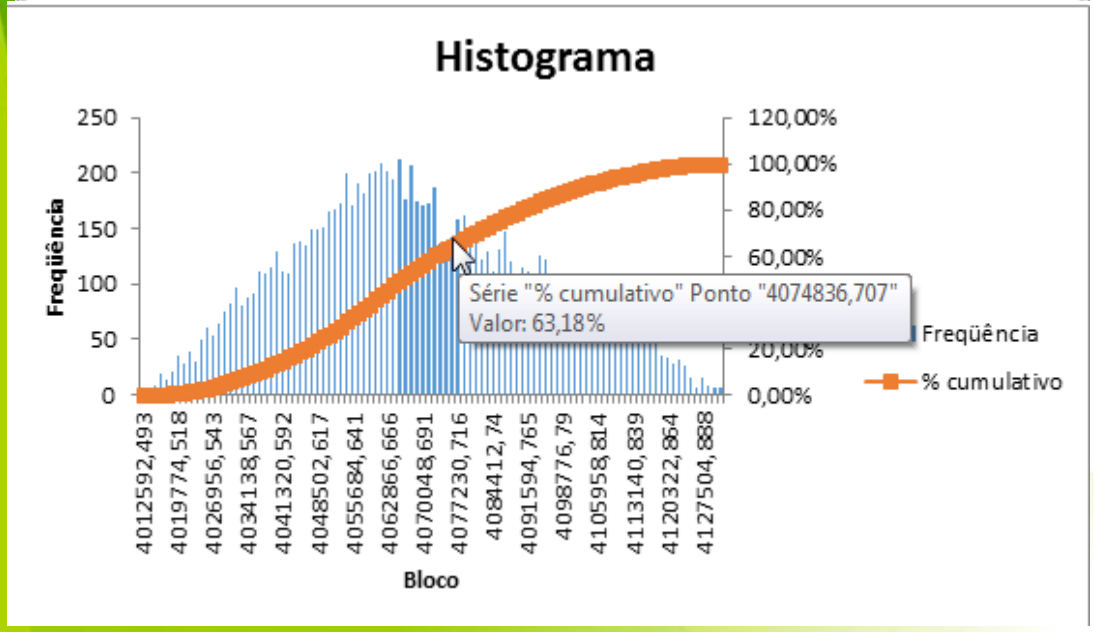
V. RISK ANALYSIS FOR COST CONTINGENCY



SUBSTATION 1
TOTAL COST = R$ 1.667.892,00
60,57% Probability of cost of the project does not exceed
R$ 1.780.621,88

EV = R$ 1.731.505,40 (1%)
(EURO 509.266,00)



SUBSTATION 2
TOTAL COST = R$ 4.011.674,00
63,18% Probability of cost of the project does not exceed
R$ 4.074.836,71

EV = R$ 4.059.814,09 (1%)
(EURO 1.194.062,00)

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CONCLUSIONS

- ✓ EACH OBJECTIVE HAS A RISK METHOD
- ✓ THERE IS NO METHOD THAT WORKS FOR EVERYTHING
- ✓ EACH METHOD HAS ADVANTAGES AND DISADVANTAGES
- ✓ THE IMPORTANT IS TO FIND THE BEST TOOL TO MEET THE SPECIFIC OBJECTIVE

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THANK YOU !

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