Ex-ante Evaluation / Prioritization Multicriteria Approaches - and the context -

Sergio Salles-Filho & Adriana Bin
04.07.2017
Outline

1. Fundamental concepts to RDI prioritization
2. How to select the most suitable approaches under different conditions of bounded uncertainty / partial knowledge?
3. Four cases
4. Agenda
1. Fundamental concepts to RDI prioritization
RDI Specificities

- Things that never happened before
- Things that depend on knowledge to be developed
- Things we do not know whether they will work
Fundamental concepts
Uncertainty

Risk

Intuition

Ambiguity

Rationality

Expectation
Two complementary definitions

• “...It is a world of change in which we live, and a world of uncertainty.

• (…)

• The essence of the situation is action according to opinion, of greater or less foundation and value, neither entire ignorance nor complete and perfect information, but partial knowledge.”

Risk, Uncertainty, and Profit
Frank Knight, 1921
Two complementary definitions

• “In a predestinate world, decision would be illusory
• In a world of perfect foresight, empty
• In a world without natural order, powerless
• (...)
• Since decision in this sense excludes both perfect foresight and anarchy in nature it must be defined as choice in face of bounded uncertainty”

Decision Order and Time in Human Affairs
George Shackle (1969)
1+2: The starting point

Partial Knowledge → Bounded Uncertainty → Ex-ante Evaluation
How prioritize under partial ignorance and bounded uncertainty?

Data & Opinion

↓

Data & Opinion’

Opinion

↓

Opinion’

Data

↓

Data’

Opinion & Data

↓

Opinion & Data’
Based on the Stacey Diagram
(Ralph Stacey prof. Hertfordshire)

Professor Robert Geyer of Lancaster University
Stacey Diagram
2. How to select the most suitable approaches under different conditions of bounded uncertainty / partial knowledge?

A general proposition
Foresight Tools and Means of Prioritization

- Data and Text mining
- Surveys and Delphi
- Scenarios
- Projections
- Panels
- Roadmapping
- Horizon scanning
- ...

Means of Prioritization

- Mathematical programming
- Multicriteria Methods MCDA
- Descriptive / multivariate Statistics
- Simple scoring
- Potential surprise
- Bayesian Statistics
- Real Options
- Genetic algorithms
- Artificial intelligence
- ...

...
Several classifications of methods

Verbano e Nosella (2010)
Iamratanakul et al. (2008)
Henriksen e Traynor (1999)
Heidenberger e Stummer (1999)
Mathematical Programming
Optimization

Economic Models
Utility, B/C, Real Options

Machine Learning
Modeling AI

AD HOC Models
Experts, Citizen

MCDA - Multicriteria Decision Analysis
MCDA: an interdisciplinary field

Slide kindly provided by Prof. Leonardo Tomazeli FCA/UNICAMP
MCDA: main categories

**AGGREGATION**
- Multi Atribute Utility (MAUT)
- Multi Atribute Value Theory (MAVT)

**OUTRANKING**
- Electre
- Promethee
MCDA: main categories

- Analytic hierarchy process (AHP)
- Analytic network process (ANP)
- ELECTRE (Outranking)
- Goal programming
- Inner product of vectors
- UTA, UTAII, UTADIS
- Nonstructural Fuzzy Decision Support Syst.
- PAPRIKA
- PROMETHEE (Outranking)
- Superiority and inferiority ranking met.
- TOPSIS
- Value engineering
- Fuzzy VIKOR method
- Weighted product model
- Weighted sum model
- Multi-attribute utility theory (MAUT)
- Multi-attribute value theory (MAVT)

Slide kindly provided by Prof. Anibal Azevedo FCA/UNICAMP
The process of MCDA

- Decision making authority
- Problem modeling
- MCDA method

1. Decision aiding
2. Information processing
3. Evaluation of the alternatives to the selected criteria
4. Attribution of a relative value or of a comparison structure

Agent 1, Agent 2, ..., Agent k

Goal
Alternatives
Criteria
Data

Slide of Prof. Leonardo Tomazeli FCA/UNICAMP – slightly modified
Objective and Subjective Elements

1. Data

1. Agents involved

1. Goals

2. Criteria

3. Alternatives

Subjective
Why outranking MCDA in RDI ex-ante evaluation?

• They are more suitable to deal with bounded uncertainty
• They are not based in one-off (best) choice
• They build a kind of fuzzy ranking comparing all criteria against each other
• They deal equally with objective and subjective information (DATA AND OPINION)
• They are suitable to combine with any other prioritizing method
## MCDA uses

**WoK: 2000 – 2017 → 109 papers (R&D project selection + different methods)**

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<th>Year</th>
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Massaguer, P. (2017, forthcoming)
### MCDA combinations

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Massaguer, P. (2017, forthcoming)
Priority setting and decision making in RDI using the Stacey Diagram (Slightly modified...)

- Agreement

+ Assertiveness of information
Priority setting and decision making in RDI using the Stacey Diagram (Slightly modified...)

- Ad hoc models
- Machine learning
- Mathematical Programming
- MCDA
3. Four cases
A proposal based on the diagram

- Agreement
- Assertiveness of information

Methods to emphasize convergence
Methods for both
Calculation
Methods to emphasize information
4 cases

- Materials for packaging
- perception of well-being in 10 years time
- projects to accomplish with an enforcement
- technologies in a “promising” area of knowledge
Case 1: selecting well-being concepts for cosmetics industry

The objective of the study:
• Identify relevant components to characterize and to measure individual well-being

The Challenge:
• highly subjective, non-structured, and variable information to be gathered and selected according to several criteria
• Horizon of 10 years
• Low level of agreement about what promotes well-being
• Low level of assertiveness of information

The Approach:
• First list: literature review + Interviews
• Internal validation
• Background document
• Multi-Expert Panel: collective scores
• Simple ranking (importance x context)
Case 1: selecting well-being concepts for cosmetics industry

Findings:

• Most adequate concepts to be exploited in different situations:

  Best ranked: happiness - self-esteem - physical health

  2nd Best: emotional stability - anxiety / distress (reduction) - love

  3rd Best: joy – optimism - discomfort (reduction)
Opinion Based

- Literature review
- Imagination and diversity
- Heterogeneous opinions
- Discussions

Case 1

+ Agreement
- Assertiveness of information

- future of thermoplastic resins in packaging
- projects in order to accomplish with an enforcement
- technologies in a “promising” area of knowledge
Case 2: Technologies for a promising area in the electricity sector: Grids

The objective of the study:
• Identify technologies to compose future R&D project portfolio with focus on grid/smart grid

The Challenge:
• Identify trends, strong and weak signals, and opportunities to develop “Grid” technologies
• High level of agreement about the importance of Grid
• Low level of assertiveness of information

The Approach:
• First list: Data and text mining
• Internal validation
• Background document
• Expert Panel
• ELECTRE (several scenarios)
• Classification of “robust” technologies
• Internal validation

Robust selection

• Smart meters (AMI)
• Meter data management systems (MDMS) integrated with information systems operating (AMI)
• Artificial intelligence systems (Adaptive Protection, Control Technologies and Dynamic Reconfiguration)
• Virtual and augmented reality platforms for simulation (Training Methods)
Search for expert opinions and new data

- As much data as possible
- Search for weak signals
- Expert opinion
- Popperian falseability (Karl Popper)

Case 2

- Agreement
- Assertiveness of information

- future of thermoplastic resins in packaging
- perception of well-being for new cosmetics company
- projects in order to accomplish with an enforcement
Case 3: Selecting projects to accomplish with regulatory framework

The objective of the study:

• Select the most suitable project proposals to accomplish with the Brazilian regulatory framework in the electrical sector which obliges firms to invest 1% or their revenues in R&D per year (under the threat of being finned by the regulatory Agency)

The Challenge:

• Selecting the proposals that fulfill the regulatory requirements and reduce the regulatory risk
• High level of agreement about the alternatives
• High level of assertiveness of information

The Approach:

• First list: Proposals received by the company
• Optimization + multicriteria method (knapsack + Promethee) + Monte Carlo
• Classification of the Best solution based on optimization and outranking
Maximization Approaches

- Optimization (knapsack) problem
- + Multicriteria
- + Monte Carlo
- Etc.

Case 3

Agreement

Assertiveness of information

future of thermoplastic resins in packaging
perception of well-being for new cosmetics company
technologies in a “promising” area of knowledge
Case 4: Applications of thermoplastics in packaging

The objective of the study:

- Identify new applications of different types of resins towards packaging

The Challenge:

- Identify new possibilities of using thermoplastic resins to develop new (or to replace existing) packaging materials
- Low level of agreement about the future (environmental and consumption trends)
- High level of assertiveness of information (known material properties)

The Approach:

- First list: market and technical available data
- Background document
- Expert Panel
- Multiple correspondence analysis
- Selection of new developments and potential replacements
Building convergence

- Monitoring (data and text mining)
- Trends and drivers constantly adjusted
- Search for convergence

Case 4

Agreement

Assertiveness of information

- perception of well-being for new cosmetics company
- projects in order to accomplish with an enforcement
- technologies in a “promising” area of knowledge
4 cases

- Agreement
  - Assertiveness of information

- Packaging
  - “convergence”

- Regulatory constraints
  - Optimization

- Well-being
  - Knowledge + convergence

- Grid knowledge
4. Agenda
Agenda on means of calculation

• Work more on possibilities than in probabilities
  • Shacklean approach
  • Horizon scanning and monitoring

• Work on methods of constant recalculation
  • Bayesian approaches

• Work on methods related to evolution
  • Genetic algorithms approaches

• Work on Artificial Intelligence approaches
  • Big Data Driven approach – Watson and beyond
Thank you

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