Portfolio decision analysis (PDA) with M-MACBETH

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PDA case-study selection

Real-world applications of a multicriteria socio-technical approach for PDA using the M-MACBETH DSS in decision conferences

CASE-STUDY I
Model to select a R&D portfolio of robotic innovations for minimal invasive surgical interventions... ...under a limited budget
(Hummel, Oliveira et al. 2017)

CASE-STUDY II
Model to prioritize community care programmes... ... in view of allocating human resources... ... to assist the Head of the GHCC of Northern Lisbon
(Oliveira, Rodrigues et al. 2012)

CASE-STUDY III
Model to prioritize health and competing non-health programmes... ... considering their value-for-effort... ... to assist the Head of the SEDSDH (Brazil)
(Bana e Costa, Lourenço et al. 2014)
Prioritizing Health Care Interventions: A Multicriteria Resource Allocation Model to Inform the Choice of Community Care Programmes

Several benefit (and risk) criteria:

- Overall benefit
  - Quality of care and users satisfaction
    - Effective health gains
    - Equity
  - Productivity, economic and financial targets
    - Achievement of GHC goals
    - Agreement with the portfolio of services and with the community

‘Cost’ constraint:
Limited number of nursing hours

12 Programmes

- P1 - Social integration income
- P2 - Domiciliary visits: healthy lives
- P3 - Physical exercise for the elderly
- P4 - Prevention of domestic accidents for the elderly
- P5 - Reproductive health and family planning
- P6 - Group support for teenagers
- P7 - Support to the child and youth vulnerable groups
- P8 - Preparation for maternity/paternity
- P9 - Preparation for post-delivery
- P10 - Integrated long-term care
- P11 - Health at home
- P12 - Promoting family parenting for vulnerable families

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Valuing programme benefits and risks on a common basis

$V_j = \nu_j(x_{1j}, \ldots, x_{nj}) = \sum_{i=1}^{n} k_i \nu_i(x_{ij})$

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‘Cost’ constraint: Limited number of nursing hours
Which PDA approach?


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Resource allocation managers’ common critical mistake in prioritizing projects:

Projects prioritized by decreasing benefit, until the budget is exhausted

how do they do it in practice? Many different methods seem to be employed, but most are some variant of the following five steps: (1) List the projects (investments); (2) Determine the benefit that each project is expected to create; (3) Order the projects from most to least benefit; (4) Associate a forward cost for each project; (5) Go down the list, choosing projects until the budget is exceeded. In short, projects are prioritised on the basis of benefits only.
Under some conditions a simple alternative prioritization approach applies:

Projects prioritized by decreasing benefit/cost ratio, until the budget is exhausted

(The Health Foundation 2012)
Alternatively, the portfolio selected by the optimization approach is the optimal solution of the following binary integer programming problem (known as the “0–1 knapsack problem” [47]):

\[
\begin{align*}
\text{maximize} & \quad \sum_{j=1}^{m} v_j x_j, \\
\text{subject to} & \quad \sum_{j=1}^{m} c_j x_j \leq B, \\
& \quad x_j \in \{0, 1\}, j = 1, \ldots, m,
\end{align*}
\] (8)
PDA: Ratio prioritization or knapsack optimization...? M-MACETH answer: Both!

Justification for new software: Existing commercial DSS for multicriteria resource allocation do not combine interactively benefit /cost prioritization and optimization and, therefore, do not allow an on-the-spot discussion of the advantages of both approaches.

Adding other constraints:

- Force in/out
- Mutually inclusion/exclusion
- Dependency between projects
- Group constraints

Additional features:
Addressing the baseline problem...

Mathematically, it is easy to reformulate the optimization problem (1) to allow nonzero values for not doing a project. If we let \( v_i^a \) represent the value of not doing project \( i \), the optimization problem can be rewritten as

\[
\max_{x_i \in [0, 1]} \sum_{i} x_i v_i + (1 - x_i) v_i^a
\]

subject to \( \sum x_i d_i \leq 2,500 \).
Addressing the baseline problem...