The Limitations of Current Decision-Making Techniques in the Procurement of COTS Software Components

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Overview

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- Principles of Decision-Making
- General Difficulties with Current Decision-Making Techniques
- Current Proposed Decision-Making Techniques
- Limitations of the Current Decision-Making Techniques
- An Alternative Approach
- Conclusion

Principles of Decision-Making

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- To select or recommend a suitable product, the evaluated alternatives must be ranked according to their perceived relative importance to meet customer requirements.
- Making a decision that does not help achieve this goal can lead to long lasting user disappointments.
- Decision-making process combines judgements that may be affected by the evaluator's beliefs and their underlying preferences.

Principles of a Decision-Making Problem

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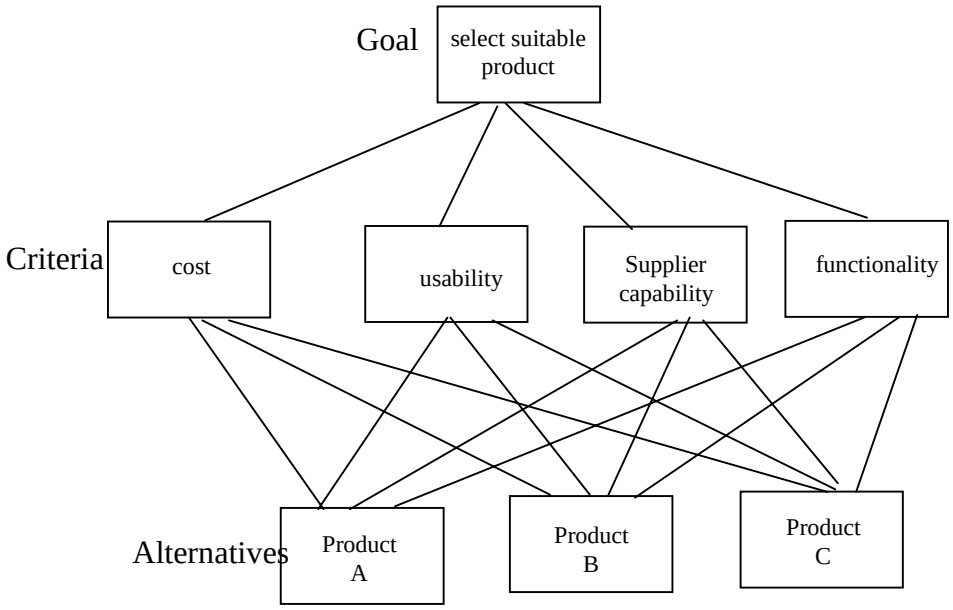
- **Presented as a hierarchy of three levels (Saaty '90).**



- **Level 1: the main goal for the decision-making process e.g.select a suitable COTS product among competing alternatives.**
- **Level 2: criteria for judging and selecting the product.**
- **Level 3: actual alternative candidate COTS products in which the criteria is applied to achieve the main goal.**

General Difficulties with Current Decision-Making Techniques

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- Problems in evaluation and selecting COTS software arise from many factors:
  - A large number of component attributes or features that have to be considered;
  - Various combinations of hardware platforms, OS, and application software need to considered;
  - Rapid technological changes in all aspects of computing, the business environment and user needs;
  - Most users lack the technical expertise or time to develop criteria, measurements and testing procedures for performance assessments and to conduct the actual evaluations;
  - There are considerable variations in performance between the attributes of each component and across the components of each attribute

Characteristics of Decisions for Selecting COTS Software

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- Decisions for selecting COTS software are governed by characteristics such as:
  - Selection decisions are multilevel and multidimensional;
  - Decisions involve information that comes from different sources;
  - All the required information to make a decision may not be available;
  - Some of the information used in making a decision may be hard, that is, based on scientific principles;
  - Some of the information used in making a decision may be soft, that is, based on the selectors judgement and experience;
  - The decisions are less than optimal and represent *satisfactory* solutions, that is, not the 'best' but 'good enough'.

Current Decision-Making Techniques

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- A number of decision-making techniques that can be used in COTS selection currently exist.
- Most of these techniques rely on compensatory models:
  - E.g. the linear weighted score model that sums the weighted ratings to arrive at a single score for each product.
- These models are problematic:
  - very good performance on one attribute can offset poor performance on another.
- Most of these techniques are not suitable for software evaluation:
  - due to their fundamental underlying assumptions in their judgement value system.
- Examples of such techniques are:
  - MAUT, MCDA, WSM/WAS, AHP.

Multi-Attribute Utility Theory (MAUT)

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- MAUT is a decision-making model that deals with choosing among a set of alternatives that are described in terms of their attributes.
- MAUT requires information about:
  - The decision-makers preference among values of a given attribute, i.e. how much does the decision-maker prefer a commercial database over a proprietary database;
  - The decision-maker's preference across attributes, i.e. how much more important is the database than cost.
- A marginal value function is associated with each criterion and a global value function is computed in an additive or multiplicative form.

The Multi-Criteria Decision Aid (MCDA)

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- With MCDA, a list of criteria that a software component should meet is established first.
- Scores are then assigned to each criterion based on its relative importance in the decision.
- Each alternative is then given a number of scores according to how it fully meets the criterion.

Criteria	Possible Points	Component A	Component B	Component C
Cost	30	25	20	15
Functionality	40	35	10	20
Supplier	20	15	5	10
Usability	10	5	3	2
Total	100	80	38	47

- The main weakness of the MCDA is that if criteria set is large, it quickly becomes very complicated.

Weighted Score Method (WSM) or Weighted Average Sum (WAS)

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- WSM/WAS is an aggregation technique that is most commonly used in many decision-making situations:
  - Defines criteria and each criterion is assigned a weight or a score, then overall score is calculated using a summation function.

Criteria	Weight Score	Component A	Component B	Component C
Ease of use	2	3	3	3
Compatibility	4	1	5	2
Cost	3	3	5	1
Functionality	5	4	4	3
Security	4	1	2	5
Supplier	5	2	5	3
Score		53	94	67

- The problem with WSM is in assigning the scores:
  - In the above example, security and compatibility could be interpreted is twice as important as ease of use, whereas in reality this might not be the case.

Analytical Hierarchy Process (AHP)

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- AHP is a MCDM technique based on the idea of decomposing a multi-criteria decision making problem into a hierarchy.
- At each level of the hierarchy, the relative importance of each component attribute is assessed by comparing them in pairs, i.e. pair-wise comparisons.

			Level 1 Priority Vector				
	Cost	Functionality	Usability	Technical	Supplier	Total Scores	Priority Vector
Cost	1	4	5	4	6	20	0.339
Functionality	0.25	1	7	7	7	22.25	0.377
Usability	0.2	0.143	1	5	3	9.343	0.158
Technical	0.25	0.143	0.2	1	4	5.593	0.095
Supplier	0.167	0.143	0.333	0.25	1	1.893	0.032
						59.079	1

- The main drawback of the AHP is that it assumes total independence between component attributes and this is rarely the case with software requirements.

Gap Analysis
an alternative approach

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- A requirements-driven technique adapted from environmental science.
- Gap Analysis assesses the COTS products' capabilities against customer requirements.
- The gap is determined by identifying required capabilities that are not fulfilled, or unneeded capabilities provided, by the product under consideration.
- A 2-dimensional matrix of requirements vs. product capabilities is constructed.
- The cells of the matrix contain information about the gap.

Principles of Gap Analysis

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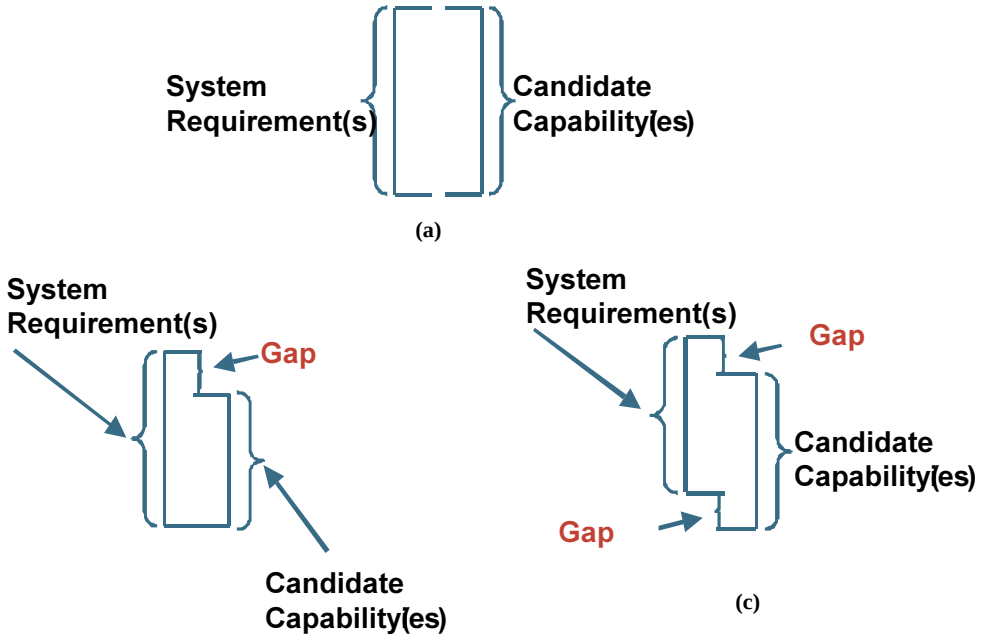

- Three potential results:
  - Figure (a) - trivial case in which product capabilities and requirements exactly match;
  - Figure (b) – product partially fulfills the requirements;
  - Figure (c) – product fulfills some or all requirements BUT also has more capabilities that are not presently needed.

Fulfillment Cost Calculations

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- Once gap has been determined, calculate the cost of reducing the gap to an acceptable solution.
- Many strategies can be used:
  - trivial case – cost of gap reduction is zero;
  - product partially fulfils requirements BUT requirement can not relaxed – determine the cost of adding functionality to the product to meet requirement;
  - product partially fulfils requirement BUT requirement can be relaxed – negotiate a change in requirement to closely match product capabilities;
  - Excess product capabilities – either accept excess capabilities, or provide excess capabilities as part of the system, or inhibit excess capabilities within the system.

Aggregating Cost Fulfillment Calculations

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- Gap Analysis creates multiple matrices depending on the number of evaluations performed:
  - Each matrix is transformed into a fulfillment cost determination;
  - For each matrix, a preferred product is selected;
  - The optimal combination of preferred products for constructing the system is chosen.
- **The goal is to find the optimal path through the matrix series based on selecting the most suitable product from each matrix!**

Summary

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- Most current decision-making techniques are not adequate for COTS software evaluation and selection.
- The fundamental problem of these techniques is their underlying assumptions and their judgement value system.
- There is a need for new requirement-driven decision-making techniques for the COTS-based development paradigm.
- Gap Analysis provides an alternative technique that emphasizes relationship between requirements and product capabilities.
- However more research work is needed and is being done develop the Gap Analysis technique.