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An Approach to Construct Criteria for Evaluating Alternatives in Decision-Making

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***Abstract*—**This paper introduces an approach to construct a set of criteria for evaluating alternative options. Content analysis was used to collect criterion elements. Then the elements were classified and organized yielding to hierarchic structure. The reliability of the constructed criteria was evaluated in an experiment. Finally the criteria were used to evaluate alternative options indecision-making.

***Keywords*—**Conceptual analysis, Content Analysis, Criteria, Decision-Making, Evaluation of Candidates

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I. Introduction

A decision problem arises when there are several alternatives available among which to choose. An objective of a decision-making process is to evaluate alternatives and eliminate them until the most potential candidate is left. The more candidates are available, the more variables exist, and more complexity is added to decision-making. A human's cognitive capacity is limited, and a short-term memory can sustain only about seven blocks of information simultaneously [5], [9]. If this capacity is exceeded, important information might be lost [6].

It can be challenging to evaluate benefits and deficiencies of different candidates. Each one has usually a range of possible outcomes that an actor or a group of actors have to evaluate before their final decision [1]. Candidates are usually planned for various environments and various conditions, which might cause significant differences on them. That, in turn, can violate evaluation premises because the alternative candidates are usually not directly comparable.

To manage the chaos caused by information overflow a supervised decision-making process is suggested. Actors have to be informed continuously because the judgments shall be based on known facts. Actors have to be aware of advantages and disadvantages of every candidate, and they also have to be able to evaluate the consequences their decisions may result. If a decision problem is trivial in nature, a selection can be made directly based on an actor's experience and knowledge. In more complex cases it may be appropriate to divide the decision problem into phases and develop criteria against which to evaluate the candidates.

Decision problems, however, vary in different phases of the process, and decision-making situations can arise somewhat unexpectedly. The decision-makers might not be able to recognize their objectives in early phases of a project and thus the identification of key objectives is inadequate [2]. At simplest, criteria are only a rough sketch but due to uncertainty caused by lack of information, defining reliable criteria sets can be challenging. Still criteria should be adaptable and preferably available continually.

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II. Constructing Criteria

A. Content Analysis

Content analysis is a method that is applied to identify certain words or patterns of words among texts. The basic idea of the method is to classify a predefined set of texts into content categories that consist of one or many words with similar meanings [10]. There are six questions that have to be considered when utilizing content analysis [7]. They are

1) Which data are analyzed?
2) How are they defined?
3) What is the population from which they are drawn?
4) What is the context relative to which the data are analyzed?
5) What are the boundaries of the analysis?
6) What is the target of the inferences?

Two main categories of content analysis exist. They are conceptual (thematic) and relational (semantic) analysis. Conceptual analysis examines a presence and a frequency of certain concepts in texts whereas relational analysis studies if there are relations among concepts in a text [3]. In this study, the former is applied to find criteria appropriate for evaluating candidates during decision-making process.

To perform conceptual analysis, there are eight steps to accomplish [3]. These steps are adapted to create rules and limitations for this research. The whole framework for this study including the research question is shown in Table I.

TABLE I
Applied Rules for Criteria Collection [3]

	Step	Explanation
1	The Research Question	To define a criteria set that can be used to evaluate alternatives.
2	Material	A set of texts, defined by a facilitator. Some additions, suggested by a researcher.
3	The Level of Analysis	Single words and patterns of words.
4	Amount of Concepts	All concepts that refer to a theme of the research question.
5	Existence or Frequency	Existence
6	Level of Generalization	Similarity of concepts.
7	Translation Rules	Knowledge of the facts.
8	Irrelevant Information	Ignored.

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B. Collecting Criterion Candidates

Although there are several content analysis tools available (see e.g. [8]), this study was performed manually. First the selected texts were read through. Phrases that met the predefined rules were underlined and then added to a spreadsheet. The texts were read through again to verify that all relevant concepts were collected. Then the phrases were classified according to the similarity of key concepts they included. Equivalent phrases were aggregated and excess information was removed so that only the key concepts i.e. single criterion elements remain.

The remaining data was classified as to the meaning of criterion elements. Formed criteria classes were given a common denominator. The resulting main criteria classes each included 4-6 single criterions. Then 3-4 hyponyms were defined for each single criterion to enable the evaluation of candidates. Hyponyms were needed to detail an actual criterion. Finally, a constructed "raw" criteria set was introduced to a few specialists who refined it during a workshop before an actual experiment.

C. Piloting the Criteria

The usability of developed criteria set was piloted in an experiment intended to choose the most applicable alternative among candidates. The amount of candidates decreases as the process progresses. There were 25 actors with similar backgrounds that participated in the experiment. Both direct and indirect evaluations were used. First candidates were introduced to actors in order to achieve informed decisions. After each presentation actors evaluated how well each hyponym was fulfilled by a candidate. Scores were given using an even-point scale (or a "forced choice" method [4]). The middlemost value was neglected because there was a need to force the result to either negative or positive.

D. Evaluating the Criteria

The reliability of the criteria set was explored by asking superiority of the candidates directly ("Which of the candidates is the most applicable for the future needs?"). Also simple pairwise –comparisons were used as another control method. Mean value and standard deviation was used to derive values for each criterion. Also the mean of means was used to find latent anomalies from the data. There was minor but possible influential exceptions in participants' backgrounds so by comparing the votes of these "unequal by size -subgroups" to all votes, the exceptions were observable.

III. Results

As a result a rough criteria set was developed. It consists of three main criteria classes. Each of these classes includes 4 to 6 criterions. Every criterion is further defined by 3 to 4 hyponyms yielding to hierarchic structure. The principle of the criteria set is shown in Fig. 1.

The usability and reliability of the criteria were tested in an experiment where alternative candidates were evaluated by utilizing the developed criteria. The results from the evaluations are visualized in Fig. 2. Candidates are presented in columns and evaluation methods (developed criteria, pairwise comparisons and superiority) are shown in rows. Purple shows which candidate is least applicable whereas green indicates the most developable candidate.

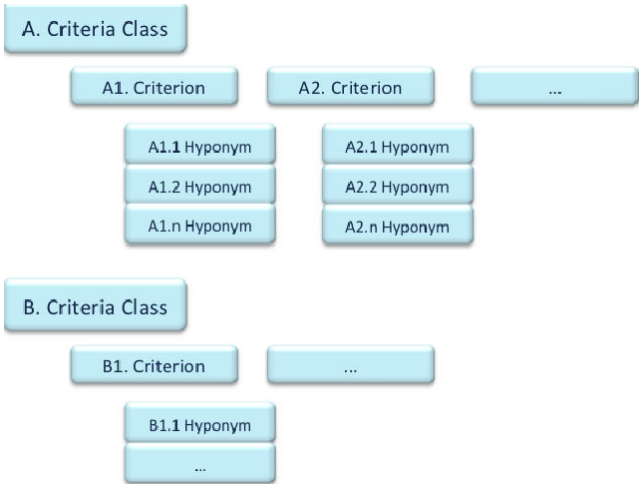


Fig. 1 A hierarchy of criteria

The results from all evaluation methods are somewhat unanimous that C2 and C5 are the most applicable candidates for further development whereas C1 and C4 should probably be discarded. The results for C3 vary in turn. According to the criteria, C3 would be the most prominent candidate for future needs. When asking superiority, it was ranked in the middle – and in pair-wise comparisons it was in the negative side of the scale.

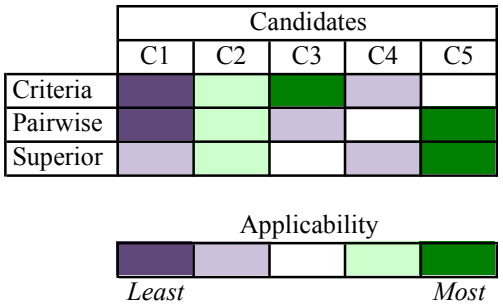


Fig. 2 Results from the evaluation

IV. Discussion

When constructing a criteria set, some considerations are needed. If a decision-maker cannot articulate why the criteria are needed and what objectives it should fulfill, it can be challenging to construct reliable and usable criteria. Requirements for this study were somewhat vague. There were no explicit guidelines to follow. The objectives of experiment were also insufficient. Only the schedule was definite, resulting an idea of a rough criteria sketch that would not only be available when needed, but also modifiable.

Applied conceptual analysis was an effective method to collect criterion elements. Predefined rules for criteria collection are essential as well as a selection of reference texts. Because there were not very specific guidelines available, all sentences concerning the topic were collected. A framework for this study was so wide that a small criteria workshop was necessary before the actual experiment. Facilitators refined the criteria sketch in the workshop.

In the experiment the candidates were evaluated by developed criteria set. Forced-choice method was used yielding negative or positive responses. No-choice option was not available. Mean values were chosen to analyze data. Arithmetic mean is an understandable and fast way to derive total scores to candidates although it hides the strongest disagreements. Therefore standard deviation and mean of means were used as control methods to find possible anomalies from data.

The reliability of the criteria set was estimated by asking directly superiority of candidates, and by pair-wise comparisons. The results show that there were not significant deviations among evaluation methods when rating candidates. Though there was not a clear agreement of superiority of candidates either. Despite of this as indicators they show that certain candidates are more applicable than others.

Experiences from an experiment indicate that the criteria are needed when evaluating alternatives. Because the criteria set is a rough plan, the results are more directional than explicit but satisfactory enough to support decision-making in this research. In future the criteria set should be adjusted more. Weighting criteria according to their importance is also under consideration.

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