Multi-Criteria Decision Making Software Products - A Comparison and Ranking in Terms of Usability and Functionality

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ABSTRACT
A large number of multi criteria decision making (MCDM) software products have been developed in academia and business. The selection of the appropriate MCDM software product to solve a given decision problem is a difficult task. Users need adequate MCDM software that meets quality standards regarding usability and functionality, utility, reliability and computer efficiency. In this paper we make a comparison of six MCDM software products regarding usability and functional suitability. Then we rank the MCDM software products included in comparison, first for criteria of usability and functionality and second only for criteria of usability. Ranking the six MCDM software products is a multi-criteria problem itself.

Author Keywords
Multi criteria decision making; Usability; Software Quality; Functional Suitability; Alternatives; Criteria.

ACM Classification Keywords
H.4. Information Systems Applications: Types of Systems: Decision support.

INTRODUCTION
Choosing an appropriate decision problem structure, an appropriate decision method and a decision software product in order to solve a given decision problem are important steps in achieving good decisions.

A MCDM problem consists in selecting an alternative from a set of several available alternatives. The alternatives are characterized by several criteria which are usually in conflict. MCDM offer various advantages: they allow the consideration of conflicting criteria, provide a structure and an organization that guide a transparent analysis process and can handle both qualitative and quantitative criteria [4].

With the advance of modern computing technology, a great number of software products that support multi-criteria decision were realized. Various software products have been developed based on MCDM methods. In OR/MS Today' October 2014 for Decision Analysis Software Survey (http://www.orms-today.org/surveys/das/das.html) 38 software packages were listed. Selection of an appropriate MCDM software product for solving a given decision problem is a difficult task. Users often seek adequate MCDM software that satisfies some minimal quality standards in terms of usability, utility, reliability and computer efficiency.

In recent years, the research on standards for software quality has begun to gain great importance. The quality is determined not only by the software product, but also by the context in which it is used: the particular users, tasks and environments. The usability attributes which contribute to software quality will include the style and properties of the user interface, the dialogue structure, and the nature of the functionality.

The paper is organized as follows. In the next section we present short considerations to ISO Standards for Software Quality. Then, we present the common input data involved in general MCDM decision problems and criteria for selection a MCDM method.

We make a comparison of six MCDM software products regarding usability and functional suitability. Finally we rank MCDM software products included in comparison, first for criteria of usability and functionality and second only for criteria of usability. Ranking the six MCDM software products is a multi-criteria problem itself. Our aim is to help (a) potential users to select a suitable MCDM software product that is more compatible with their needs and (b) software developers to improve the MCDM interactive software products.

THE ISO STANDARDS ON SOFTWARE QUALITY
According to series ISO/IEC 25000 [8], a quality model is a "defined set of characteristics and of relationships between them, which provides a framework for specifying quality requirements and evaluating quality". The software quality models have been analyzed for many years. The ISO/IEC 9126 is the best known reference in this area [2]. This standard provides a very general quality model for software products, based on a set of 6 quality characteristics (Functionality, Reliability, Usability, Efficiency, Maintainability, Portability) and 27 sub-characteristics. This standard has been replaced by ISO/IEC 25010 [9], which updates the previous quality model in various ways.

An important characteristic for selection of a software product is usability. There are many researches that aim to measure usability. Usability is the effectiveness, efficiency, and satisfaction with which specified users achieve

specified goals in particular environments. There is no consensus agreement on this definition; it might refer to the user interface, ease of use or user friendliness [1, 3, 5].

The ISO standards provide a general conceptual framework for defining the quality model for complex systems with a substantial software component. To be of practical use, these standards must be tailored to the specific class of software systems under consideration. This may not be a simple task, especially when these software systems do not fit well with the systems considered in the classical software products, such as ERP, command & control, embedded systems. This is the case of MCDM software products, which possess a number of characteristics that greatly differentiate them from the above systems.

MULTI-CRITERIA DECISION PROBLEMS

Multi-criteria decision problems share the following common input data:

- A set of decision makers (individual or team decision makers / analysts / experts) assessing and finally selecting the most appropriate solution in relation to requirements.

- A set of alternatives to be evaluated and from which the most suitable alternative will be selected.

- A set of criteria. Each alternative is evaluated with the help of criteria taking into account the preferences of the decision maker and a rating scale (quantitative or qualitative). To each criterion can be associated a coefficient of importance (weight).

After setting the input data, the MCDM method to solve the decision problem is chosen. Literature is rich with different types of MCDM methods [6, 7, 10]. There is no single MCDM method which can be a superior method for solving all decision-making problems. Different researchers have different point of views on this issue. The selection of a MCDM method must take into account: (a) the type of the decision problem, (b) the number of the alternatives considered, (c) the criteria features, (d) the easiness of use and (e) the decision maker skills.

COMPARATIVE ANALYSIS OF MCDM SOFTWARE PRODUCTS

Various MCDM software products or decision support systems (DSS) have been developed to support the use of MCDM in practice. Besides computational support for implementing the methods and the calculation of the results, the software usually provide various ways to also support other phases of the process, such as construction of the model and analysis of the results. Especially, the graphical user interfaces can provide various possibilities to view the process and the results, and consequently make the understanding of the results more transparent.

From the set of MCDM decision software products we selected six MCDM software products in order to perform our analysis, mainly based on the availability of some demo or trial versions of the software product.

The MCDM software products considered in this paper are following:

1. **1000Minds** (Free for academic purposes) – The software product supports decision-making, prioritization and the discovery of decision makers' preferences. 1000Minds is based on PAPRIKA (Potentially All Pairwise Rankings of All Possible Alternatives) method and is Web-based software with a tab-based interface.

2. **Analytica** (Lumina Decision Systems, Inc.). It helps in building business models or policy analysis. Has intuitive influence diagrams for creating models and allows communicating clearly with colleagues and clients. Analytica has Object-oriented visual interface, with which one can implement practically any method. Analytica has various graph-building and pre-defined modules available, for example, for MAUT, optimization, and risk analysis.

3. **Criterium Decision Plus 3.0** (InfoHarvest). It can be used for managing the entire decision process. Criterium Decision Plus includes Direct Tradeoffs, basic MAVT software with AHP functionality, larger models, powerful graphics and extensive options for supporting decision making.

4. **V.I.S.A. Decisions** (SIMUL8 Corporation Ltd) - It allows weighing up all the factors using a considered and sound process and documents how decision was made and why it was the right outcome for future reference. V.I.S.A. Decisions is based on MAVT method.

5. **Multicrit** (ICI Bucharest) - Multicrit assists decision-makers in structuring and analyzing complex problems, following which decisions can be made as close to the purpose. Multicrit is based on a set of multi-criteria decision-making methods: TOPSIS, ONICESCU and WSM held in a methods base.

6. **Logical Decisions** (Logical Decisions). It allows evaluating choices by considering many variables at once, separating facts from value judgments and explaining choices to others. Provides a variety of methods for assessing attribute weights and has many results displays. Logical Decisions is based on the MAVT software with the AHP functionality.

We make a comparison between these six MCDM software products in term of the interfaces and functions which they have in user interaction (usability and functional suitability). Comparative analysis of the MCDM software products is presented in Table 1.

Ranking the six MCDM software products is a multi-criteria problem itself. We rank the six MCDM software products considered, based on the nine criteria defined, using the PAPRIKA method.

Table 1. Comparative analysis of the MCDM software products

Criteria	Alternatives					
	1000Minds	Analytica	Criterium Decision Plus	Logical Decisions	Multicrit	V.I.S.A
Usability						
1. Language of the user interface	English	English	English	English	Romanian	English
2. Decision Process interface support	Yes	No	No	NO	No	No
3. Visual scoring	No	Yes	Yes	Yes	No	Yes
4. Visual weighting	No	Yes	Yes	Yes	Yes	Yes
5. Level of user expertise	2	3	3	3	2	3
Functional suitability						
1. Supported MCDM methods	PAPRIKA, MAUT/MAVT	MAUT/MAVT	MAVT, AHP, SMART	AHP, MAUT	TOPSIS, ONICESCU,SAW	MAVT
2. Hierarchical method	No	Yes	Yes	Yes	No	Yes
3. AHP/Pair wise comparison	Yes	No	Yes	Yes	No	No
4. Modeling by uncertainties	No	Yes	No	No	No	No

The preference weights (determined by pairwise comparisons in the PAPRIKA method) are:
1. Language of user interface: 0.019,
2. Decision Process interface support: 0.278,
3. Visual scoring: 0.093,
4. Visual weighting: 0.130,
5. Level of user expertise: 0.074,
6. Supported MCDM methods: 0.259,
7. Hierarchical method: 0.037,
8. AHP/Pair wise comparison: 0.037,
9. Modeling by uncertainties: 0.074.

The Radar Chart of criteria weights is presented in Figure 1.

In Table 2 the evaluation matrix and the alternatives ranking are presented. The optimal MCDM software product for this criteria (usability and functionality) and defined preference weights is Criterium Decision Plus.

For criteria considered only for Usability the evaluation matrix and the alternatives ranking are presented in Table 3. The optimal MCDM software product for the usability criteria and the defined preference weights is 1000Minds. Analytica, Criterium Decision Plus, Logical Decisions and V.I.S.A have equal ranks.

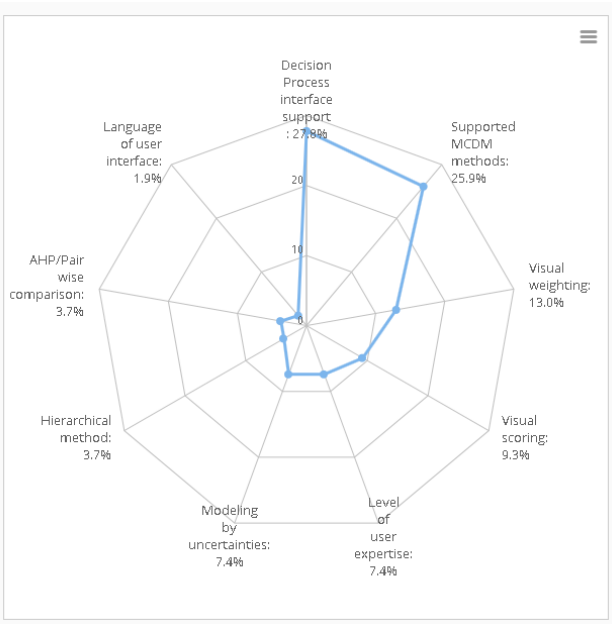

Figure 1. Radar Chart of criteria weights

Table 2. The ranked alternatives for 9 criteria (usability and functionality)

Alternatives	Criteria										
	Language of user interface	Decision Process interface support	Visual scoring	Visual weighting	Level of user expertise	Nr. of supported MCDM methods	Hierar-chical method	AHP/ Pair wise comparison	Modeling by uncert-ainties	Rank	Total score
Criterium Decision Plus	English	No	Yes	Yes	3	3 methods	Yes	Yes	No	1st	0.57
1000Minds	English	Yes	No	No	2	2 methods	No	Yes	No	2nd	0.54
Logical Decisions	English	No	Yes	Yes	3	2 methods	Yes	Yes	No	3rd	0.46
Multicrit	Romanian	No	No	Yes	2	3 methods	No	No	No	4th	0.44
Analytica	English	No	Yes	Yes	3	1 method	Yes	No	Yes	5th	0.35
V.I.S.A	English	No	Yes	Yes	3	1 method	Yes	No	No	6th	0.28

Table 3. The ranked alternatives for 5 criteria (usability)

Alternatives	Criteria						
	Language of user interface	Decision Process interface support	Visual scoring	Visual weighting	Level of user expertise	Rank	Total score
1000Minds	English	Yes	No	No	2	1st	0.55
Analytica	English	No	Yes	Yes	3	2nd=	0.45
Criterium Decision Plus	English	No	Yes	Yes	3	2nd=	0.45
Logical Decisions	English	No	Yes	Yes	3	2nd=	0.45
V.I.S.A	English	No	Yes	Yes	3	2nd=	0.45
Multicrit	Romanian	No	No	Yes	2	6th	0.18

CONCLUSION

In this paper, we have compared six MCDM software products on the terms of the usability (interfaces) they provide and functionality. For these six MCDM software products we considered two ranking problems. The first ranking problem is to rank the six MCDM software products for criteria of usability and functionality. For this type of software product the interface for definition of the decision problem is very important. The second ranking problem is to rank the six MCDM software products only for criteria of usability.

The conclusion from analysis is that all of these MCDM software products provide excellent support for the decision process beginning with problem formulation and continuing through to evaluation, results and sensitivity analysis. Nonetheless, there are distinctions in particular methods used, the interfaces and in results presentation.

The analysis shows that characteristics of the selected MCDM software products are similar to each other. This can be explained by standardized multiple-criteria process implemented in such software. Common trend in the analyzed MCDM software products seems to be multi-purpose software providing several methods for various decision problems. This flexibility requires certain expertise from the user to use such software.

Analysis and ranking obtained may be considered by software developers such as recommendations for developing this type of interactive software products. This research addresses also to decision makers who wish to purchase a MCDM software product.

Future research directions will consider a greater number of usability criteria as well as reliability and computer efficiency criteria.

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