Verbal decision analysis foundations and trends accounting essay

Business, Accounting



The decision maker is the central figure in decision making based on multiple criteria. Elicitation of the decision makers' preferences should take into account peculiarities of human behavior in the decision processes. This is the central goal of Verbal Decision Analysis or VDA (Larichev and Moshkovich, 1997; Moshkovich et al., 2005.)The Verbal Decision Analysis is a framework for designing methods of MCDA by using preferential information from the decision makers in the ordinal form, a type of judgment known to be stable and consistent. VDA is based on the same principles as multi-attribute utility theory – MAUT (Keeney and Raiffa, 1976), but is oriented on using the verbal form of preference elicitation and on evaluation of alternative decisions without resorting to numbers. Traditional methods of VDA were oriented on problems with a rather large number of alternatives but a relatively small number of criteria. They were designed to elicit a sound preference relationship that could be applied to future sets of possible alternatives, while many other methods (e.g., outranking methods (Roy, 1996) or AHP

(Saaty, 1980) tended to compare a given set of alternatives. New developments in the area of VDA illustrate some changes in the goals and ways of verbal analysis. The paper reviews the main principles of Verbal Decision Analysis, describes classical methods associated with this framework, and then analyzes new trends in the development and application of new methods.

2. Basic Principles of Verbal Decision Analysis (VDA)

Term " Verbal Decision Analysis" was introduced in 1997 by Larichev and Moshkovich (1997) though research in this area originated in earlier publications (see, for example, Larichev and Moshkovich, 1994, 1995). The

main idea behind the term is that there is a need for decision aids which allow the decision maker to express his/her evaluations and preferences in a verbal form and this verbal form should not be transformed into a quantitative form in any arbitrary way. In the area of MCDA, the decision maker is usually the central person in the decision process and tries to maximize utility or value function that depends on the criteria or attributes. Verbal Decision Analysis acknowledges that known constraints of human information processing system as well as the psychological validity of input data in decision analysis should be taken into account while designing decision aiding methods. Thus, VDA is oriented on construction and application of methods that: Use language for problem description that is natural to the decision maker. This requirement means that if the decision maker takes into account gualitative characteristics of the alternatives (e.g., car in a good condition) or uses generalized notions while conducting analysis (e. g., " good credit", " high risk", etc.), the decision aids should use them for alternatives' evaluations. Here comes the notion of " verbal scales." Implement psychologically valid measurements and preference elicitation procedures. Larichev (1992) carried out the initial analysis of literature to differentiate between elicitation of different types of evaluations from the decision maker. Some types of information lacked corresponding research. Additional types of admissible information elicitation types were introduced later (see, e. g., Furems et al., 2003; Larichev et al., 1995)In aggregate these major admissible groups of preferential information include: Rank ordering of criteria importance, Qualitative comparison of attribute values against one, two or three criteria, Qualitative evaluation of probabilities, Direct

classification of an alternative. Incorporate procedures for consistency check of decision maker's preferences. This requirement means that all or part of the elicited information should provide auxiliary preferences which may be used to check for consistency of preferences as well as for verification of the

used to check for consistency of preferences as well as for verification of the underlying axioms. For example, many MAUT methods assume preferential independence of criteria and/or transitivity of preferences. Procedures should be " transparent" to the decision maker and provide explanations of the results. The last requirement assumes that the information elicited from the decision maker will be used in an easily understandable way to provide the solution and as such the result may be easily explained to the decision maker. Within this framework majority of the VDA methods are based on the rules of dominance (Pareto Principle) as a result of ordinal scales and transitivity of preferences.

3. Classical Methods of VDA

In 1997 three methods were introduced as a VDA toolkit for three major types of decision problems. Method ZAPROS (based on Larichev and Moshkovich, 1995) is used for rank ordering alternatives, ORCLASS (based on Larichev and Moshkovich, 1994) is used for an ordinal classification of alternatives, and method PACOM (based on Berkeley et al., 1990) is used for the selection of the best alternative. All methods assume that discrete alternatives are evaluated against a set of Q criteria with finite number of possible verbal values Xq q= 1, 2,..., Q where |Xq|= nq. Thus, we can form Y= X1 * X2 * ...* XQ - a set of all possible vectors in the space of Q criteria |

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Y|= nq. We also have a set A={ai} ■ Y of vectors, describing realalternatives. All methods elicit order of criterion values within each scale.

3. 1Method ZAPROS

Method ZAPROS is intended for problems in which we need to rank order a rather large number of alternatives and the set of the alternatives may change while decision rules stay in place. For example, we need to distribute limited resources among research projects submitted to a government agency (Larichev and Moshkovich, 1997). If there is a system for projects' evaluation and comparison (ranking) it is possible to apply them for any set of projects. Method ZAPROS elicits the decision maker's preferences through pairwise comparisons of hypothetical alternatives near the so called reference points (all the best or all the worst possible values). These alternatives differ against only two criteria, and the decision maker has to state preference for one on them or indifference between them. Elicited information is checked for consistency through transitivity of preferences and comparison of the same criterion values at two reference points (for criterion independency check.) As a result the so called joint Ordinal Scale (JOS) in the criterion space is formed. It rank orders different criterion values and this ranking is not connected to a specific set of alternatives. JOS allows partial pairwise comparison of real alternatives. These comparisons form the basis for partial rank ordering of real alternatives. For more on the procedure see (Larichev and Moshkovich, 1997)

3. 2. Method ORCLASS

Method ORCLASS is used when we need to define appropriate class for each real alternative out of K classes C1, C2, ..., Ck. We assume that the classes are ordinal in the sense that all alternatives in class C1 are preferred to alternatives in class C2, and so on. For example, ORCLASS application may classify papers submitted to the journal where classes are: " accept", " accept with minor changes", " re-write and re-submit", and " reject". Another example is connected to a loan application where each application has to be classified as " good," " acceptable", and " poor". As ZAPROS, ORCLASS aims at constructing the classification rule in the criterion space and then applying it to any submitted alternative(s). The decision maker is presented with hypothetical alternatives (vectors from Y) to classify them. Based on the dominance principle, possible classes for other alternatives from Y are reduced based on the ordinal nature of classes. The process stops when all vectors from Y are classified. The process allows for classification consistency check. If the decision maker assigns class outside of the ones possible for this vector (based on previous classifications), there is a contradiction which may be explained to the decision maker and resolved through some re-classification. For easier classification of real alternatives, the notion of class boundaries is introduced. Lower border for each class is presented by least preferable vectors from the class on the basis of dominance, while upper border is formed by the most preferable vectors of the class. These two borders accurately represent each class and may be used to determine if another vector belongs or does not belong to it.

3. 3Method PACOM

Method PACOM, called in Russian publications as PARK and in earlier version as ASTRIDA (Berkeley et al., 1990), is oriented on the selection of the best alternative out of their small number. This is the only method where the process is oriented on the pairwise comparison of the real alternatives based on the compensation principle - disadvantages of one alternative are counterbalanced by disadvantages of the other alternative. Let assume we have two real alternatives: a and b. Alternative a has better values for the first m criteria, while alternative b has better values against all other criteria. Comparison of these two alternatives is based on eliciting information about the relative preference for different alternatives' values, and is carried out as the comparison of basic (hypothetical) alternatives, differing in values upon only two criterialnformation about comparison of basic alternatives may be used to compare real alternatives. It is proposed to form hypothetical alternatives for comparison in an iterative goal-seeking mode, quickly establishing the principal possibility for comparison for two real alternatives. When all pairs of real alternatives from the initial list are analyzed using the proposed procedure the general analysis of the results is carried out. As the aim of the analysis is to select the best alternative when two alternatives are compared, the least preferable one is excluded from the list and is not used in further analysis (as it cannot be a candidate for the final choice). The more preferable alternative is then compared with the next alternative, and so on. If there is only one alternative left in the initial list, the problem is solved. If incomparable alternatives are still in the list, it is concluded that likely there is no satisfactory alternative among those in the initial list to make real

choice. The decision maker is proposed to analyze the list of adjusted alternatives that has been formed in the process of the analysis (evaluating the possibility to obtain a real alternative with such characteristics). In this part we described the " classical methods" of VDA. All presented methods are theoretically sound, elicit preference information in a qualitative form, provide opportunities to check this information for consistency, and apply only easily explainable rules of dominance and transitivity to reach the solution. Proposed methods do not guarantee complete rank ordering of alternatives or selection of the best one. Those working within VDA framework believe that if it is not possible to select the best alternative based on the qualitative analysis, the solution should not be forced by assigning arbitrary numbers to different evaluations. In this case VDA approach recommends the re-design of the problem through new criteria, modified scales and modified set of alternatives.

4. New Methods within the VDA Framework.

During last decades there have been many publications about new approaches in VDA as well as modifications of the classical VDA methods. Figure 1 illustrates the connection between the older and the newer VDA methods we review in this paper.

Figure 1. Verbal Decision Analysis Methods

4. 1ZAPROS based methods

ZAPROS III (Larichev, 2001) as well as STEP-ZAPROS (Moshkovich et al.,

2002) increases Joint Ordinal Scale (JOS) to a Joint Scale for Quality

Variations (JSQV) to allow comparison not only individual values of different

criteria but also pairs of criterion values. The advancement is achieved through additional questions to the decision maker on the pairwise comparison of hypothetical alternatives differing in values against two criteria. The main difference between ZAPROS III and STEP-ZAPROS is in the completeness of the process. In ZAPROS III all above mentioned hypothetical alternatives should be compared. After that the JSVQ is formed and applied to comparison of real alternatives. As the number of comparisons is large, this approach is mostly appropriate for a relatively small number of criteria and small number of possible criterion values. STEP-ZAPROS uses additional comparisons only after the JOS is used to compare real alternatives. The method proposes an iterative procedure of identifying a minimal set of comparisons necessary to compare small number of real alternatives left incomparable on the basis of JOS. UniCombos (Ashikmin and Furems, 2005) is a computerized system which is based on the ideas of ZAPROS but it has three major differences: the approach assumes that we need to rank order only a small number of real alternatives; a decision maker can consistently compare alternatives' values upon more than two criteria (in general, upon three criteria); the ability of the decision maker to compare complex combinations of alternatives' values is enhanced by special ways of visualization of those values. As an interactive system, the UniCombos checks the comparability of the real alternatives after each additional piece of preferential information is obtained. It will stop as soon as all alternatives are compared and/or the best alternative is found. Once all possible pairs of alternatives' values are compared but there are still incomparable alternatives in the set, the system will present thedecision maker with the

so-called " tryads" of alternatives' values – values different against three criteria.

4. 2ORCLASS based methods

Main improvements in ORCLASS approach were oriented on making the process of information elicitation more efficient. As the decision maker has to classify many hypothetical alternatives from Y, any procedures that can minimize their number is an improvement to the process. Methods CYCLE (Larichev et al., 2002a) and DIFCLASS (Larichev and Bolotov, 2000) differ from ORCLASS only in how they find hypothetical alternatives from Y to be presented to the decision maker for classification. DIFCLASS is applicable only in cases with two decision classes where indirect classification of alternatives is quick and always consistent. CYCLE proposes the construction of " chains" of vectors between vectors a and b from Y which are known to belong to different classes. Then the most " informative" vector is searched in the chain, thus essentially lowering the computational complexity of the algorithm. The process is dynamic and searches for the "longest" chain between two vectors. The effectiveness of the approach was compared to the algorithms of monotone function decoding and appeared much more effective for smaller problems. Methods SAC - Subset of Alternatives Classification (Larichev et al., 2002b) and CLARA - Classification of Real Alternatives - (Ustinovichius et al., 2008) are designed for problems with a relatively small number of alternatives needed to be classified only once (avoiding construction of a classification rule in the criterion space.) In this case a modified approach may be used to decrease the number of vectors

the decision maker has to classify. In SAC method the principle of evaluating " informativeness" of vectors from Y is the same as in ORCLASS but in SAC only the indirectly classified real alternatives are taken into account. This makes the process less complex. Method CLARA is also oriented on classification of real alternatives but selection of alternatives to be presented to the decision maker for classification is based on method CYCLE. Again only real alternatives are taken into account when constructing and analyzing chains.

4. 3Method SNOD based on PACOM

As PACOM, method SNOD - Scale of Normalized and Ordinal Differences -(Ustinovichius and Kochin, 2004) is oriented on the selection of the best alternative out of few. The goal of SNOD is to make the process proposed in PACOM more efficient. This is achieved by computerized preliminary analysis of potential quality of real alternatives. First, normalized scales are used to " quantify" criterion values. Then these values are used for pairwise comparison of real alternatives to define the " potentially best alternative." All alternatives dominated by this one are eliminated from the analysis. All other alternatives are ordered in accordance to the total scoring difference between the " potentially best alternative" and this one. The order is used in the dialog with the decision maker in assumption that it will lead to the solution quicker than in the traditional way of PACOM. Though use of quantified scales for alternatives evaluation and/or comparison is outside the framework of VDA, this method does not influence the outcome of the decision process, only its efficiency. At no time, any final decisions are made on the basis of the preliminary analysis. If the best alternative is not found quickly, previously discarded alternatives will be returned into the process, and " normalized and ordinal differences" may be revised. The analysis of new VDA methods shows the tendency to concentrate on problems with relatively small number of real alternatives and carry out goal oriented solution process rather than constructing possible decision rules in the criterion space.

5. Verbal Decision Analysis Applications

VDA has positive features of using psychologically valid preference input, providing checks for input consistency, and Implementing mathematically sound rules. VDA was used in a number of applications starting with earlier applications of ZAPROS in R&D planning (Larichev and Moshkovich, 1997), ORCLASS for job applicants' selection (Moshkovich et al., 2002b) and PACOM for pipeline selection (Flanders, et al., 1998; Larichev and Brown, 2000; Larichev et al., 1995). Tamanini et al., (2009) applied ZAPROS III to rank order tools in of Alzheimer's disease diagnosis. In this work, preferences were obtained through guestionnaires from experts and postmortem patient diagnosis. The study enabled identification of tests that would more quickly detect patients with Alzheimer's disease. Ustinovichius et al., (2009) used UniCombos to compare construction contracts using seven criteria for three real alternatives. ZAPROS was used in rank ordering real retailer commercialization decisions in Brazil based on discussions and analysis with key managers (Rodrigues and Cohen, 2008). Mendes et al. (2010) demonstrated use of VDA in the design of mobile television application,

applying ZAPROS to the characteristics of prototypes based on user experience and intentions. The ordinal classification approach was used for R&D planning and journals' evaluation, as well as for job selection (Larichev and Moshkovich, 1997; Mechitov et al., 1994). Yevseyeva et al. (2008) applied a SAC like method for neuropsychology patient diagnosis. CLARA was used in several decision making applications in the area of construction. Ordinal classification approach was successfully applied in modifying tasks with many criteria into subtasks of smaller sizes. In criterion hierarchy scales for higher level criteria presented ordinal decision classes for the combination of lower level criteria. This approach was successfully used in evaluating investment risk in construction projects. Gomes et al. (2010) applied ORCLASS to marketing decisions for a small business in Brazil engaged in the distribution of dental products.

6. Conclusion

The primary goal of research in MCDA is to develop tools to help people to make more reasonable decisions. In many cases the development of such tools requires combination of knowledge derived from such areas as applied mathematics, cognitive psychology, and organizational behavior. Verbal Decision Analysis is an example of such a combination. It is based on valid mathematical principles, takes into account peculiarities of human information processing system, and fits the decision process into existing organizational environments. The basic underpinnings of Verbal Decision Analysis were demonstrated by early VDA methods, such as ZAPROS and ORCLASS, and their later modifications, such as ZAPROS III, UniCombos, CLARA, and others. A substantial number of published applications based on VDA demonstrate the maturity of VDA methodology.