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IMPLEMENTATIONS OF INTERACTIVE MULTICRITERIA DECISION SUPPORT METHODS IN CONDITIONS OF RISK

This paper presents programs which implement the tools for interactive methods of decision support under risk proposed by M. Nowak, as a complementary way to disseminate research results. It also presents a discussion of the appropriateness of implementing quantitative method tools in the form of add-ins to MS Excel.

Key words: decision support, multicriteria decision making, operations research software tools

1. Introduction

Scientific research is inherently linked with sharing the results of studies. Each field of knowledge has its own special way of disseminating results. The most widely used method is publishing results in books, technical journals, or popular science publications. It is also common to present results in the form of a presentation during conferences. In quantitative research which results in some new algorithms, it is possible to implement the methods developed in the form of computer programs.

This work was created as a result of activities carried out during the implementation of the algorithms for interactive multi-criteria decision support under risk proposed by Nowak [5]. The algorithms are presented in the form of an MS Excel add-in. Section 2 presents the type of issues associated with decision-making processes. Section 3 contains a description of the implementation of the algorithms. Section 4 provides an example of using the software. The article ends with the conclusions of the discussion on the implementation of operations research tools in the form of add-ins to MS Excel.

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2. Statement of the problem

Decision-making problems have been the focus of economics for a long time ([5], p. 9). The quantitative approach to facilitating the process of decision-making is based on a defined set of actions and selection criteria. Most often, one considers situations involving more than one criterion. In this case, we are talking about problems of multi-criteria decision-making. Sometimes the evaluation of actions can only be precisely defined or described by random variables, probability distributions or characterized by a collection of assessments. When we are able to obtain a probability distribution of ratings, even on the basis of a set of assessments, we are talking about decision-making under conditions of risk.

In order to find the best option which considers the decision-making preferences of the decision maker in terms of risk, Nowak used an interactive method, already known for solving multi-criteria problems under conditions of certainty. Two methods, among others, were proposed:

- STEM-DPR [3] – a method based on the STEM method, originally proposed by Benayoun et al. [1]. The idea is to present a trial solution for each iteration which is compared with the ideal one. Through relaxation and loosening the requirements of the assessment criteria, this method seeks a satisfactory solution that meets these relaxed criteria.

- INSDECM [4] based on the principles of multi-criteria goal programming, originally proposed for interactive methods by Spronk [6]. Based on the parameters of distributions, sets of actions that meet certain additional conditions defined by the decision maker are determined. By defining these additional conditions, the set of actions is restricted, which allows for easier selection of a satisfactory solution.

These methods use the following classes of stochastic dominance ([7], p. 75):

- FSD – first stochastic dominance,
- SSD – second stochastic dominance,
- TSD – third stochastic dominance,
- SISD – second inverse stochastic dominance,
- TISD1 – third inverse stochastic dominance 1, proposed by Zaraś [11],
- TISD2 – third inverse stochastic dominance 2.

During the discussion on how to implement the methods, several possible software solutions were considered. We chose an implementation in the form of an add-in to MS Excel. Strong reasons for this choice were:

- widespread knowledge of the user interface environment of MS Excel,
- opportunity to prepare the input data in a spreadsheet,
- ease of carrying out further analysis, which can also be stored in spreadsheets.

The choice of this environment was also accompanied by some concerns. As noted at the beginning, the algorithms considered use interactive methods. In such a situation, there are two important aspects of the problem:

- communication with the user via an interface that enables dialogue,
- documenting the resulting dialogue.

The universality of MS Excel, which could potentially enable wider dissemination of the programs generated, determined the decision to implement the methods as an MS Excel Add-in.

3. Implementation

The discussion presented in the previous section results in the system architecture presented in Fig. 1. The program is available, together with all the necessary documentation, on the CD attached to the book [8].

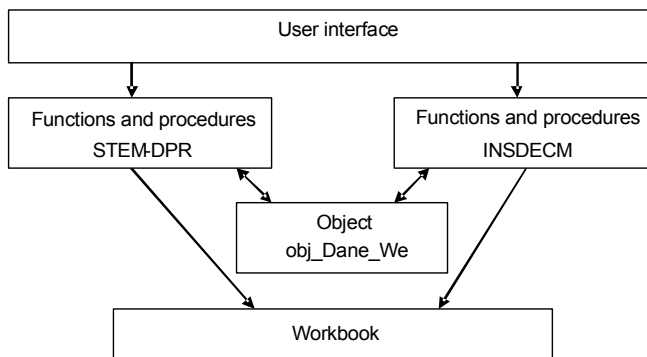


Fig. 1. System architecture; source: Author's work

The user interface is implemented by a sequence of userforms, which channel the dialogue between the decision-maker and the program into the framework set by the methods implemented, STEM-DPR and INSDECM. During the startup of the add-in, an `obj_Dane_We` object is created, containing a description of the decision problem under consideration. The user does not have direct access to this object. Downloading data and saving information takes place through a set of functions and procedures using the STEM-DPR and INSDECM methods. Simultaneously, the information is stored in a workbook so that it is available for analysis at the end of the dialogue.

Programs are written in an extended version of Visual Basic for Applications, using a standard MS Excel userforms toolbox. The software developed has been thoroughly tested using MS Excel 2003, although it also works in later versions of MS

Excel. At the moment, only a Polish language version exists, but in the case of interest, an English version will be developed.

The current version of the program has the following limitations:

- maximum number of criteria – 10,
- maximum number of values in the support of a distribution – 10,
- maximum number of distribution parameters – 11,
- accuracy of the comparison – 10^{-6} .

These limitations are mainly due to the fact that the system has not been tested for larger values. Use of the program has been enriched with context-sensitive help, that explains each step in the interactive method.

Installing the add-in is very simple; it consists of copying two files to the MS Excel add-ins folder, which can be easily located using the add-ins manager. After copying these files, a new MCDM add-in appears in the main window of the add-ins manager (Fig. 2).

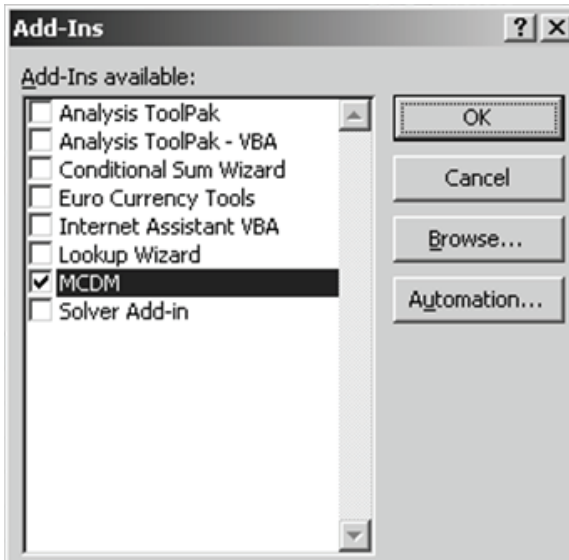


Fig. 2. Add-ins manager;
source: MS Excel 2003 interface

After selecting the MCDM add-in, there is a new position on the MS Excel menu. The option MCDM appears on the Tools menu. The main menu of the program created is shown in Fig. 3.

The MCDM add-in allows one to enter data describing a decision-making problem (actions, evaluation criteria) and then, save them in a file with a specific format. The evaluation of a criterion may be introduced in the form of an observation or a probability distribution. The main menu allows one to select the method used to solve the problem. Selecting one of them introduces a dialogue mode and a sequence of dialogue userforms implementing the method selected is displayed.

The dialogue process is documented in a newly opened workbook that, at the end of the dialogue, can be saved under any name and used for further analysis. Each iteration is stored in a new sheet of this workbook. A mathematical description of the problem being solved and stochastic dominance relations based on the criteria are also stored on separate sheets.

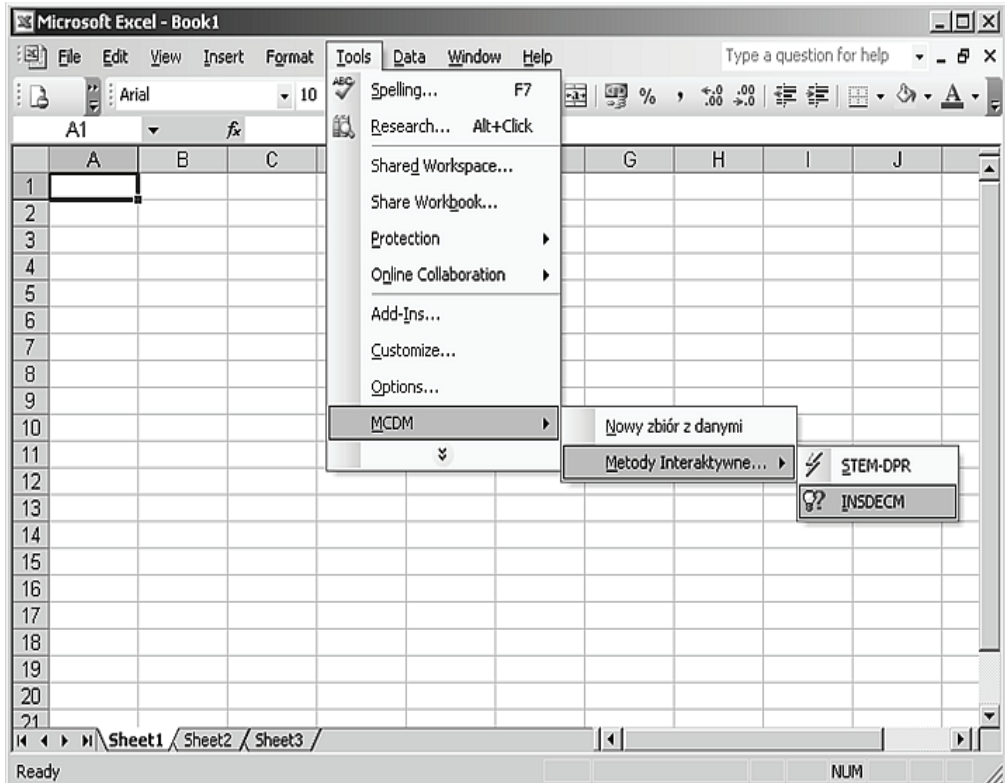


Fig. 3. New options in the MS Excel menu; source: MS Excel 2003 interface

4. Use of the software

The program can be used both to solve trivial problems, which this paper illustrates, as well as serious problems, such as those presented in [5], which were used to test the program.

We will consider the problem of choosing between three actions $\{V_1, V_2, V_3\}$, which are evaluated according to two criteria $\{A, B\}$. The evaluations by experts, who

assess according to the first criterion using a scale of 2 to 5 and according to the second criterion by giving 0 or 100 points, are shown in Table 1.

Table 1. Expert assessment

Expert No.	V1		V2		V3	
	A	B	A	B	A	B
1	2	100	5	0	5	0
2	5	100	5	100	5	100
3	5	0	5	0	5	0
4	5	100	5	100	5	100
5	5	0	5	0	5	0
6	2	0	5	100	5	100
7	5	100	2	100	2	100
8	5	0	2	0	2	0
9	5	100	2	100	2	100
10	5	0	2	0	2	0

Source: Author’s work.

In this case, the assessments are observations. It is also possible to introduce direct assessments in the form of probability distributions. Internally, the program contains processed and stored distributions. After entering the problem, it can be resolved using each of the methods implemented. The solution obtained using STEM-DPR is shown in Fig. 4. Due to a lack of space, the dialogue cannot be presented here.

STEM-DPR Report

Iteration: 2

Candidate Action:

V1

Considered Actions:

V1

Criterion	Mean	d	Ideal value	Active
A	4,1	0,00	4,1	No
B	0	0,00	0	Yes

Final Solution

Fig. 4. The results obtained using STEM-DPR (translated into English); source: Author’s work in MS Excel

In a similar way, by carrying out a dialogue, we can obtain a solution to the problem using the INSDECM method, which is shown in Fig. 5.

INSDECM Report

Possibilities Matrix P(1):

Criterion	A			B		
	Mean	Std. Dev.	uMsD	Mean	Std. Dev.	uMsD
Worst Action	3,8	1,5492	3,5	0	0	0
Best Action	4,1	1,2550	3	0	0	0

Worst values accepted

Considered Actions:

V1
V2
V3

Solutions Matrix R(1):

Criterion	A			B		
	Mean	Std. Dev.	uMsD	Mean	Std. Dev.	uMsD
Actions:						
V1	4,1	1,2550	3,5	0	0	0
V2	3,8	1,5492	3	0	0	0
V3	3,8	1,5492	3	0	0	0

One of the solutions accepted as the final solution

Fig. 5. The results obtained using INSDECM (translated into English);
source: Author's work in MS Excel

5. Conclusions

The paper presents a computer implementation of interactive multi-criteria decision-making methods under conditions of risk proposed by Nowak, implemented as an add-in to MS Excel. Initial concerns, regarding the possibility of creating a dialogue with the decision-maker in a spreadsheet, have been allayed by successful implementation. Thanks to this solution, it is possible for any MS Excel user to use the STEM-DPR and INSDECM methods. The program is available in Polish, but if there is interest, an English version will be developed.

Implementing methods from operations research as an add-in to MS Excel seems to be a promising way to disseminate the results of research. Thanks to the well-known Excel environment, the methods developed can reach a wide range of potential users.

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References

- [1] BENAYOUN R., DE MONTGOLFIER J., TERGNY J. AND LARICHEV C., *Linear Programming with Multiple Objective Functions: Step Method (STEM)*, Mathematical Programming, 1971, 1, 366–375.
- [2] KIMMEL P., BULLEN S., GREEN J., BOVEY B., ROSENBERG R., *Excel 2003 VBA Programmer's Reference*, Wiley, Crosspoint Boulevard, Indianapolis, 2004.
- [3] NOWAK M., *Interactive Approach in Multicriteria Analysis Based on Stochastic Dominance*, Control & Cybernetics, 2004, 4, 463–476.
- [4] NOWAK M., *INSDECM – an Interactive Procedure for Stochastic Multicriteria Decision Problems*. European Journal of Operational Research, 2006, 175, 1413–1430.
- [5] NOWAK M., *Interaktywne wielokryterialne metody wspomagania decyzji w warunkach ryzyka. Metody i zastosowania*, Wydawnictwo Akademii Ekonomicznej im. Karola Adamieckiego w Katowicach, Katowice, 2008.
- [6] SPRONK J., *Interactive Multiple Goal Programming*, Martinus Nijhoff, The Hague, 1981
- [7] *Metody wielokryterialne na polskim rynku finansowym*, T. Trzaskalik (Ed.), PWE, Warszawa, 2006.
- [8] *Wielokryterialne wspomaganie decyzji. Metody i zastosowania*, T. Trzaskalik (Ed.), PWE, Warszawa, w druku.
- [9] TRZPIOT G., *Odwrotne dominacje stochastyczne*, [in:] T. Trzaskalik (Ed.), *Zastosowania badań operacyjnych*, Absolwent, Łódź, 1997, 435–447.
- [10] TRZPIOT G., ZARAŚ K., *Algorytm wyznaczania dominacji stochastycznych stopnia trzeciego*, *Badania Operacyjne i Decyzje*, 1999, No. 2, 75–85.
- [11] ZARAS K., *Les dominances stochastique pour deux classes de fonction d'utilite: concaves et convexes*, RAIRO/RO, 1989, 23 (1), 57–65.
- [12] ZAWISZA M., TRZASKALIK T., TRZPIOT G., *Implementacja komputerowa dominacji stochastycznych*, *Studia Ekonomiczne*, No. 12. Wydawnictwo Akademii Ekonomicznej w Katowicach, Katowice, 2000, 233–251.