MANAGERIAL DECISION SUPPORT TOOLS – DIFFERENT PERSPECTIVE

Hana Kopáčková
Ústav systémového inženýrství a informatiky, FES, Univerzita Pardubice

Abstract
Manager who is adjusted to think about decision process in the terms of intuitive process, rational model, and model of bounded rationality is usually confused with many technical details describing something he does not understand. To take more advantage of decision support tools managers need IT professionals to speak with the same language. This article represents an attempt how to use managerial language in order to describe decision support tools.

Keywords
Decision, decision support tools, gathering information, model of bounded rationality, rational model.

1. Introduction

Decision-making process represents undoubtedly an essential and indispensable part of human life. Every day brings new problems that must be solved, accompanied by decisions having different impact. Some these problems need fast solution whence act of decision-making is done by individual, mostly using intuition and previous experience.

- Intuitive decision-making, according to Thagard [12], has three main advantages:
- Speed – an emotional reaction can be immediate and lead directly to a decision.
- Interest – basing decision on emotions helps to ensure that the decisions take into account what decision maker really care about.
- Action – the positive feeling toward an option will lead directly to action.

Nevertheless emotion based intuitive decision-making can also have some serious disadvantages. An option may seem emotionally appealing because of failure to consider other available options. Another problem with intuition is that it may be based on inaccurate or irrelevant information. Finally, intuitive reasoning is problematic in group situations where decisions need to be made collectively.

Intuitive decision-making is purely based on real person who acts as decision-maker. Due to this fact no ICT tools can be used to make such process easier and it is also reason why I will not cover this branch in more detail. Moreover managerial decision-making should not be so dependent on one person.

Theory of decision-making has taken, as its subject matters how individuals and groups make decisions [2], [4], [5]. The goal for much of this work has been the production of a model of decision making - a model general enough to describe individual cases of decision making while drawing out important generalities across different individuals and situations.

One example of decision-making model, that can be described and supported by information and communication technologies, represents rational model. It assume that a decision maker

posses a utility function (an ordering by preference among all the possible outcomes of choice), that all the alternatives among which choice could be made were known, and that the consequences of choosing each alternative could be ascertained [9], [11].

Unlike intuitive decision-making, this type of decision-making process can be described and divided into steps, for example according to Bazerman [1]:

- Define the problem, characterizing the general purpose of your decision.
- Identify the criteria, specifying the goals or objectives that you want to be able to accomplish.
- Weight the criteria, deciding the relative importance of the goals.
- Generate alternatives, identifying possible courses of action that might accomplish your various goals.
- Rate each alternative on each criterion, assessing the extent to which each action would accomplish each goal.
- Compute the optimal decision, evaluating each alternative by multiplying the expected effectiveness of each alternative with respect to a criterion times the weight of the criterion, then adding up the expected value of the alternative with respect to all criteria.

Although the assumptions of rational model (results and alternatives are ascertained, information are complete and so on) cannot be satisfied even remotely for most complex situations in the real world, they may be satisfied approximately in some isolated problem situations without uncertainty.

The computational tool of linear programming, which is a powerful method for maximizing goal achievement or minimizing costs while satisfying all kinds of side conditions, can find optimal result within the limits of approximation of such model to real world conditions.

Problem of scheduling, time tabling and routing can be also covered in the rational model of decision-making due to certainty of results. Methods used to solve these problems range from pure statistical methods to artificial intelligence methods (genetic algorithms, neural networks...). All these methods are now applied by computers reducing complexity and time requirements.

Although examples of rational decision-making process are not rare, limits of incomplete information, inconsistency, and institutional constraints on alternatives brings us to the models of limited (bounded) rationality. These models retain the same process of decision-making but incorporate many additional limitations. Simon [10] describes ‘satisfying’ behavior - a decision making process which searches for ‘good enough’ options, rather than an optimum solution. With satisfying decision making becomes something which is carried out in a limited time, and with some limits on the individuals concerned.

Theories of bounded rationality have been developed to incorporate the importance of rules and identities in decision making. Rules and identities are important logics which are used in deciding what to do - the so called ‘institutional’ aspects of activity.

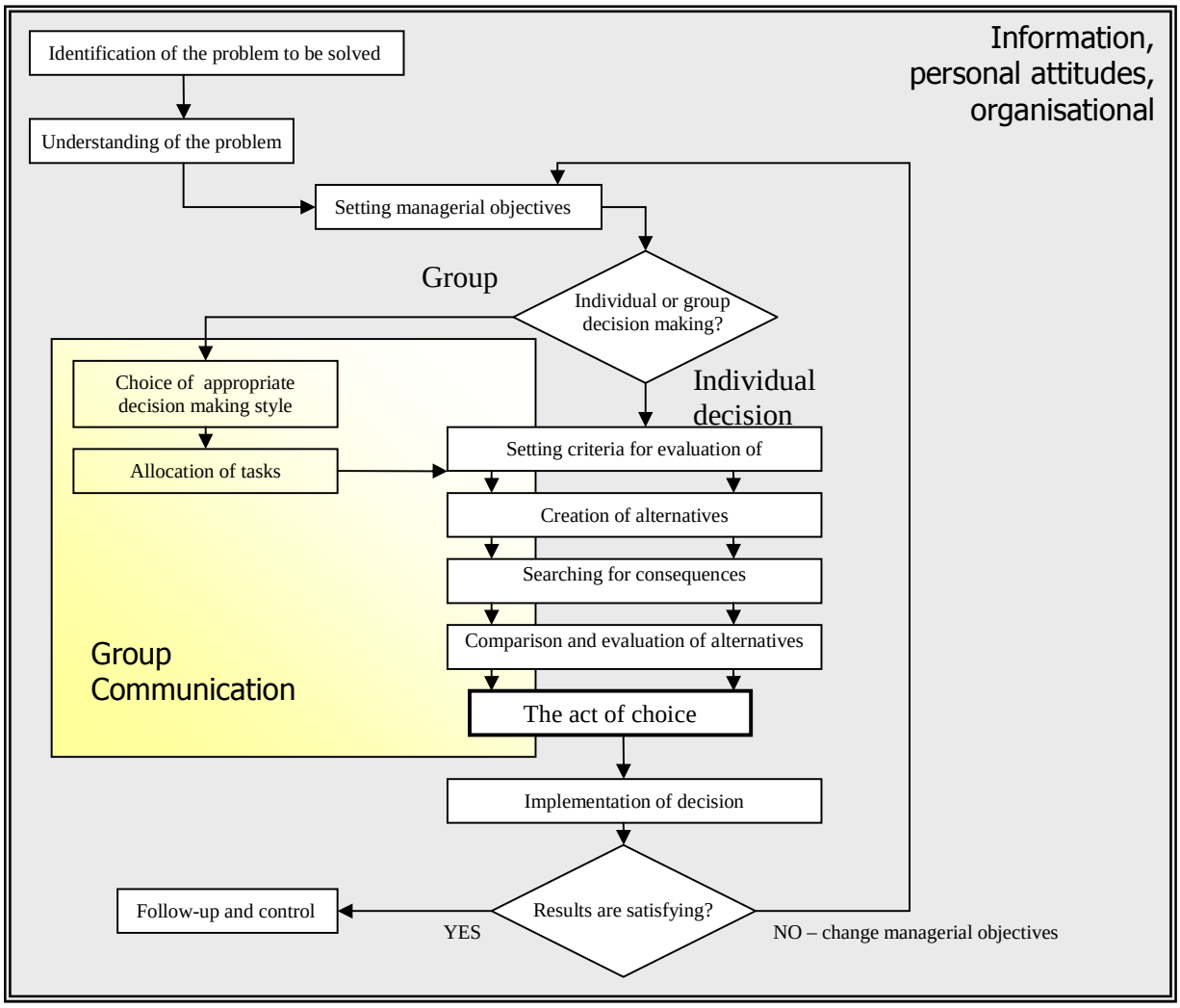

Figure 1: Steps of decision making in bounded reality. Freely adapted from [3]

2. Problem formulation

Model of bounded reality covers the most frequent decision making situations in the real world. Taking this model as a basic framework, now I want to introduce great amount of tools from the range of information and communication tools that can be useful in decision making process.

Fig. 1 gives a pictorial summary of necessary steps of the individual and group decision making. It also depicts the inclusion and integration of personal and institutional aspects of such activity. The sections that follow describe each step of individually looking for possible ICT tools.

Identification of the problem to be solved can be very simple in the case of allocation of tasks. If the problem is allocated to manager's responsibility, he/she can continue with the step two without usage of any tool. But the situation doesn't have to be so clear. Managers are supposed to be proactive and look for sources of possible future dangers. In this situation ICT tools can be used in their diversity, starting from text documents, spreadsheets, databases to methods of

machine learning. Especially methods of unsupervised learning can be used to find something new. Unsupervised learning is a method of machine learning where a model is fit to observations. It is distinguished from supervised learning by the fact that there is no apriori output. Such techniques are adopted in data mining tools enabling even managers without previous IT education to use them. This is very important presumption for all ICT tools that can be used in decision making. Working with these tools must be clear and user friendly otherwise they remain as the nice technical gadgets staying on the shelf.

Understanding of the problem is composed of detailed description of the problem, separation of unique features of the problem, specification of changes and testing of causes. This step of decision making is very important. Even small mistake in setting of causes can overthrow the whole process of decision making. Results that would be found would not lead to satisfying solution of the problem and the whole process would have to necessary start again. Due to these facts, managers should not pass this step without usage of any tools. For example modeling tools normally employed for business process modeling can be used in this step if companies have them. If it is not possible, any drawing program can serve in the similar way. In the case of very important and sensitive problem, expert systems provide managers with best information. An expert system is regarded as the embodiment within a computer of a knowledge-based component from an expert skill in such a form that the system can offer intelligent advice or take an intelligent decision about a processing function. A desirable additional characteristic, which many would consider fundamental, is the capability of the system, on demand, to justify its own line of reasoning in a manner directly intelligible to the enquirer [13]. Main problems with expert system rise from their advantage. Due to their complexity, creation of the expert system is very lengthy and demanding which is adequate to its price. Application of such tool is therefore evincible only in the case where claims committed by wrong decision are too high.

Setting of managerial objectives is one of the steps which are predisposed to personal attitudes and organizational rules. Rational model of decision making assume maximizing of utility function but organization may prefer alternative objectives or manager as a decision maker may prefer different strategy according to previous practice. Influence of these institutional aspects is in the most cases necessary and it does not have to have negative impact. Unfortunately in this step managers can not use any ICT tool to support decision making.

Afterwards setting managerial objectives, decision maker has to select one from two ways. Either he can choose to continue in decision making process alone or involve other persons into this process. Both alternatives have their pros and cons. Great advantage of individual decision making is time point of view. Individual decisions take less time but on the other hand amount of information used is determined only by manager's knowledge. Another disadvantage can be seen in the influence of personal attitudes that can excessively narrow process of decision making (too few alternatives, simplified comparison and evaluation of alternatives...). Group decision is on the other hand much more time-demanding, requiring communication in group. Nevertheless ICT tools can be very helpful in supporting group communication (instant messaging, video conference, sms communication, e-mail, and other tools can make communication faster and easier).

Decision about individual or group solution of problems should not be supported by ICT tools since the amount of decisive facts is too huge and not stable.

In the event of choosing group decision making, another step represent selection of

appropriate decision making style. According to [14] manager can choose one out of five styles. The way of selection can be represented as a decision tree but with some restrictions (model does not give explicit recommendation, differentiation among styles is insufficient, and so on). New version of their model can be described mathematically by seven equations, giving great space to ICT usage. Manual calculation of such model is very demanding in comparison with computer application that takes only minimum time and computational capacity.

Allocation of tasks is purely dependant on decision makers, how they distribute tasks, roles and responsibility. I suggest no usage of ICT in this step.

Following five steps are common for both; group and individual decision. Differences can be found in the way of seeking solution, gathering information and so on.

Setting criteria for evaluation of alternatives represent such activity where only criteria with defined qualities are selected. Those requirements are: completeness, lucidity, null redundancy, and minimal range. Seeking for appropriate criteria should always start with managerial objectives, considering the fact that these criteria will serve as an indicator of fulfillment of managerial objectives. For each partial objective should be set minimally one criterion, nevertheless criteria set in this way are insufficient and must be completed by other ones. Identification of subjects whose interest can be touched shows us other important criteria which must be applied in order to make decision acceptable; compatibility with personal interests. Second thing that must be accepted during the process of setting criteria is possibility of negative impact of final decision. Such impact is usually not covered in managerial objectives but it is necessary to formulate it in this stage. From the point of view of ICT tools, we can find only databases with possible criteria prepared during previous decision making to be used.

Next step in decision making is creation of alternatives. It is a case of demanding creative process covering systematic and analytical methods and methods giving much space to creative inspiration. Examples of particular methods are as following: brainstorming, brainwriting, Delft method, bionics, morphological analysis, decision trees, matrix of hypothesis and so forth. Except from brainstorming, other methods can be applied by ICT preparing the environment for straightforward interpretation. If the problem is based on quantitative data (value of sales, number of claims, results of statistical measurements...) it is possible to engage management information system (MIS) as indirect tool using preprocessed data or data mining tools that can discover hidden dependences. Due to this new information, manager is able to change original alternative or to create new one. The last but not least is possibility of using expert systems, which is the most expensive but in some cases indispensable. Main problem in this step represent the fact that all the process is highly dependent upon institutional constraints. The situation is affected by the same elements as it was described in the step of setting managerial objectives. For the most part of situations, rational model is then broken. Nevertheless number and quality of alternatives is very important for the whole decision process.

Searching for consequences is closely connected with creation of alternatives and sometimes it is mixed together. Process of searching depends on the type of solved problem but in all cases it must be done according to required criteria. Quantitative problems can be easily solved using mathematical modeling. In this case we can find many ICT tools which can be used directly for finding consequences, either these tools are special, only for selected problems, or general. Ill structured qualitative problems are more dependent on decision maker or other expert.

Comparison of alternatives and the act of choice is subject to influence of institutional constraints.

Following steps are not part of decision making process but I mentioned them here just to see that even good decision that is poorly implemented can spoil the whole process.

3. Gathering of information

Rational model and model of bounded rationality define steps of decision process without emphasis on data gathering. It is given as an activity that will be done somehow. I would like to stress necessity of textual data and to show which methods appears to be effective.

Automated processing of text documents can prevent simplifications and generalisation, which allow us to decide on the base of small amount of cases and widen this decision on all cases. Unfortunately, this approach is commonly used having too much text documents and only little time to read them. Usage of text categorization methods can also significantly lower manager workload.

Methods suitable to support managerial decision-making process must fulfil these criteria:

- easy to implement,
- fast to process categorization,
- cheap,
- stable for differences in length of document,
- learning model build from small number of documents,
- high precision.

Three methods which are easy to apply were tested for being used in managerial decision-making. These methods are K-nearest neighbour, Rocchio algorithm and Naive Bayes algorithm. In the testing environment I used 50 documents in Czech language; 25 of them were focused directly on the branch of waste management and the rest 25 documents were not specialised – only covered problem of the environment. The shortest document had only 98 words and the longest had 1400 words. For feature selection were used three different methods: Chi-square, Mutual information, and Information gain [7], [6] for the weighting of words was used TFIDF weighting [8]. After the pre-processing stage database was filled with 10571 words.

The result can be seen in Table 1 (CCI means correctly classified instances and K means Kappa statistics).

Table 1: Effectiveness of classificators

	Naive Bayes		K-NN		Rocchio algorithm	
	CCI [%]	K [%]	CCI [%]	K [%]	CCI [%]	K [%]
Chi-square	96,00	92,00	66,00	32,00	100,00	100,00
Mutual information	96,00	92,00	68,00	36,00	100,00	100,00
Information gain	92,00	84,00	50,00	0,00	100,00	100,00

K nearest neighbour algorithm is very sensitive to length differences (documents using same words have long Euclidean distance between them if they differ in length) so it is not suitable to support managerial decision-making as it was described here. On the other hand Rocchio algorithm and Naive Bayes can serve as very helpful tool.

4. Acknowledgment

This research and paper was created with a kind support of the Grant Agency of the Czech Republic, grant number GACR 402/05/P155.

5. References

[1] Bazerman M. H. *Judgment in managerial decision making*. New York: John Wiley, 1994.

[2] Eppen G., Gould F. *Introductory Management Science*. New Jersey: Prentice-Hall, p. 164-165, 1984.

[3] Fotr J., Dědina J., Hrůzová H. Manažerské rozhodování. Praha: Ekopress, 2003

[4] Golub A. L. *Decision Analysis: An Integrated Approach*. New York: John Wiley & Sons, 1997.

[5] Leiw A., Sundaram D. Complex Decision Making Process: Their Modelling and Support. In: *Proceedings of the 38th Hawaii International Conference on System Sciences*, IEEE, 2005.

[6] Li Y. H., Jain A. K. Clasification of text documents. In: *The Computer Journal*, vol. 41, no. 8, 1998.

[7] Quinlan J. R. Induction of Decision Trees. In: *Machine Learning*, vol. 1, no.1, 1986.

[8] Salton G. Developments in Automatic Text Retrieval, In: *Science*, Vol. 253, 1991.

[9] Simon H. A. A Behavioral Model of Rational Choice. Cowle: Foundation Paper 98. In: *The Quarterly Journal of Economics*, vol. LXIX, February 1955.

[10] Simon H. A. *Models of Bounded Rationality*., Cambridge, M.A.: Harper and Row, 1983.

[11] Simon H. A. *Report of the Research Briefing Panel on Decision Making and Problem Solving*. National Academy of Sciences. Washington, DC: National Academy Press, 1986

[12] Thagard P. How to make decisions: Coherence, emotion, and practical inference. In: *Varieties of practical inference*. Cambridge, MA: MIT Press, 2001, pp. 355-371.

[13] The British Computer Society's Specialist Group on Expert Systems (BCS SGES)[online] URL: http://www.chrisnaylor.co.uk/Definition.html

[14] Vroom V. H, Jago A. G. *The New Leadership*. Englewood Cliffs: Prentice Hall, 1988.

Kontaktní adresa:

Ing. Hana Kopáčková, Ph.D.
USII/FES Univerzita Pardubice
Studentská 84, Pardubice, 53210
e-mail: hana.kopackova@upce.cz
telefon: 466036245