An Approach to Intelligent Web-Based Multi-attribute Decision Support System

Milan Randjelović, Dragan Randjelović, Milija Suknović

Abstract — **Intelligent methods in technology of web-based e-government help citizens in many areas of theirs life. The construction and subsequent use of such systems is in the status of low-level accumulation of experiential knowledge which is contrary to the requesttopic time and many documents that establish the strategy of development in this area, like EU i2010 strategy. Model for Web-based multi-attribute decision support with the appropriate algorithm is the subject of discussing of this paper.**
Keywords — **DSS, Intelligence, Data warehousing, Multiple criteria analysis, E-Government**

I. INTRODUCTION

EXTRAORDINARY situations were, is, and will be parts of our lives, regardless if they appear in local, wider environments or planet-wide. They may appear in various areas of social, biological, economic life, etc. Examples include but not limited to: fires, floods, storms, earthquakes, various biological risks such as epidemic or terrorist's attack by biological weapons, financial crisis, market unstable, etc. All of the above have their own sources and consequences, but they have several things in common. All are dangerous and a community must be able to foresee such situations and must be prepared to act on time and in proper ways. Also, citizenry demand to participate and collaborate in local and state governments by means of suggestions and complaints submissions and they are very disturbed if are not satisfied with received answers and if they haven't received answers.

To take care and act about above mentioned situations is under responsibility of the local of state government. In many situation they are exchanged information with other authorities either using direct communication and/or via some common global body, for example World Health Organization, in case of well known bird flu. Since the early days of computers various government and scientific organizations collected relevant data, analyzed them and tried to predict what may happen and how to protect particular community. Thinking about that now, we have in mind a lot of available technological opportunities. They are, but not limited, to: Internet and Web that lead to build the efficient and cheaper government systems (known as E-Government), power of new hardware technologies that are able to store PBs of data (regardless of their nature, pure text, figures, tables, pictures, code, etc.) exchange them via very reliable and high speed channels, and make complex calculations over that data either on source or destination computer, etc.

The purpose of this paper is to explain motivation, goals for, and overview of, a intelligent Decision Support System (DSS) based on Web technologies, and key algorithms that will be used as mechanism for helping decision processes in described situations which we propose to be divided in two basic groups:

- to the first group belong those in which a decisions can be used for reasoning based on known cases(in which group belong a, for example, applications which support suggestions and complaints from citizens),
- second group that would be carried out using an inference from the known groups of algorithms of machine learning (which group includes all applications in which is present a choice of one from the group of possible or available options).

II. SYSTEM OVERVIEW

Because of the complexity of the problem it is difficult to find a papers which examine a DSS for reviewing applications all together on one place, but is possibly to find a works that are separately engaged in intelligent web-based multi-attribute decision support systems for individual applications such as advisors. in business, education to health care and so on.

The framework of such DSS for e-government can be in three layers, consisting of data warehousing subsystem, human-computer interaction subsystem, based on Internet and Web technologies, and applications subsystem and this paper analyzes such DSS.

Therefore the paper discuss the intelligent web-based DSS for e-government to help a citizens with necessary consultants i.e. services from social, economic and biological focus, especially in emergency situations in the field of social (fires, natural disasters, security risks ...), biological (emergencies, self ,...) and economic life (financial crisis, the instability of various ,...) and present fact of effectively and continuously caideveloping of application with permanent o (DW) authors cur propose three-layers architecture of DSS, according to Figure 1, as is given and explained in more detail in [7].

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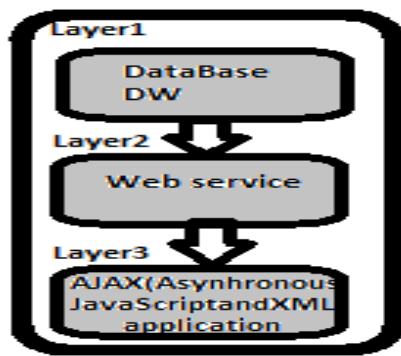
Figure 1 Web-oriented architecture solutions

DW follows DSS chosen architecture which is given with Figure 1:
• DW approach to building bottom-up
• developing its architecture with more storage groups according to the possible applications and that Social (data of Ministry of inferior, Ministry of Justice, Ministry of Education,...), Biological (data of Ministries of Health, Ministry of Social Insurance ,...) and Economic (information of Ministry of Economy, Ministry of Agriculture and Trade, ...), leaving the possibility of later construction, and one common stock in accordance with architecture that is specifically determined by each application from one table over star and snowflakes warehouse, see [28] - [30]. On-Line Analytical Processing (OLAP), as a process analyst for fast, interactive approach regarding the information that is transformed from "raw" transaction data stored in the database, must be used at place of each warehouse.

III. RELATED WORK ON MULTI-ATTRIBUTE ANALYSIS LIKE AN MODEL SOLUTIONS FOR WEB BASED DSS

One of the most important goals of e-government, clearly defined in the last EU i2010 strategy is the interaction of state,regional and local administration with the citizens, distributed primarily at the local level, in order to use the growing number of services such as:
- sociological consultant with such services as choice for future career through choice of education and collaborative complaints and suggestions procedures to the administration,...;
- security consultant primarily in emergency situations from different areas of daily life manifestations (fires, natural disasters, security risks ...);
- biological consultant in fields of medicine and agriculture (emergency squad, first aid,...);
- economic consultant in different economic areas of life (investment, financial crisis, instability in markets,...).
Development of such systems is difficult because of little experience in the existence of adequate and examples of scientific- research results. Implementation of the system that would incorporate a many fields of application of such services for citizens is a very complicated thing, but it is possibly to find papers dealing with web-based intelligent support systems, which are supported with multi-attributive decision system for single or any number of such applications, ie. such as in business, health care...
So, for example in [1] authors have reviewed the DSS and found that they help in decision making in small and medium uncertain data and poorly structured or unstructured problems at all levels of government, but they are the most significant to it's higher levels and as such are complex and have many different implementations. This paper describes the concept, definition and classification of Web-based DSS. On this topic can be found in [2] - [7] and in particular with the application of group decision making,authors are dealing in the papers [8] - [9]
• In [10] authors recognize that, five of them 1992. were signed in paper [17], where have discussed about more criterion decision making (MCDM) and multi attribute theory (MAUT) in the next decade and in this paper discuss meanwhile what has been done and what is situation in these areas:
1st Using the Internet as the computing power in the tumultuous development is very oft which resulted that MCDM - Tools offer increasing possibilities for the future. There is a Web-based software to assist users in applying MCDM -Access.
2nd There has been a significant increase in the application of MCDM -Tolls what can be seen, for example, on the site for an expert Choice: http://vvv.ekpertchoice.com2.
3rd The importance of MCDM / MAUT is recognized in the professional management journals.
4th The importance of behavioral aspects of decision making is growing, and that is recognized and the awarding of 2002. Nobel Prize in Economics to Daniel Kahneman.
5th Data envelopment analysis (DEA) has become an important area as neighboring discipline.
6th Evolutionary multi objective optimization (EMO), has emerged as a new field associated with MCDM / MAUT.
7th Heuristics in MCDM / MAUT have become more important role.
8th MCDM - Toll has begun to penetrate many new areas of research and application.
• MCDM -Tools have more adjacent fields like EMO and DEA.Theirs concepts and methods are developed and used in these disciplines and it is difficult to draw a sharp boundary between them ([11] - [18]).
In the papers [19] - [20] are described the support systems for interactive communication e-government with citizenry in the field of suggestions and complaints to the administration.
• The paper [21] describes how a multi-attribute decision theory is combined with adaptive techniques to enhance individualized instruction in intelligent learning environment (ILE), which aims are to help new users to master the skills of computer use. Teaching dynamically adapts to each student because learning depends on factors such as habits, prior knowledge and skills, which are used as criteria for the application of MAUT and as a result tools of adaptive technique provide a way for the best possible advice to be presented to users.
• In the articles [22] - [23] is described the application of intelligent web-based e-government in the health sector and to respectively, the Republic of Serbia and a doctor-client applications, in [24] - [25] application in the economy and to respectively investment and planning of agricultural development, in the work [26] is given the

application security service to the citizens within them all the possible methods of implementation multi-attribute decision based on evolutionary algorithms integration.

• Web accessible paper [27] gives general discussion and respectively complex perception of DSS.

• The papers [36] and [37] give in two different way possible solution for the univariate case which can be used for Web based multi-attribute DSS for application in solving an choice one from the set of given alternatives .

IV. AN ALGORITHM FOR MULTI-ATTRIBUTE DECISION

It is known from decision theory to the DSS algorithms that construct the model solutions can be roughly divided into two groups appear. Tentatively to the first group belong those in which decisions can be used for reasoning based on known cases(in which group belong a applications which consider suggestions and complaints from citizens) and another group that would be carried out using an inference from the known groups of algorithms of machine learning, such as. neural network, reduction algorithms and an associative type of decision tree algorithms (which group includes all applications in which is present a choice of one from the group of possible or available options).

Model solutions for the type of reasoning based on known cases and is not subject of this work and more can be seen in the example. [28]. The subject of this paper are algorithms for systems solutions that reduce the system to select the optimum from the set of possible decisions at one per data collected from real-world or through the experiment, univariate or multivariate type, or what more can be found in [32] - [35].

1. We can write for dependent variable y_i which is called the response surface $y_i=F(x_{1i},x_{2i},x_{3i},\ldots,x_{pi})+e_i$ where $i=1,2,\ldots,n$ represents the n observation in the multi factorial experiment and x_{pi} represents the level of p-th factor in the i-th observation and residual e_i measures the experimental error of the i-th observation . In the case when the mathematical form of function F isn't known, this function can be approximated satisfactorily, for example by a polynomial different degree in the independent variables x_{pi}. This considering is the basis of multiple regression analysis in the case of univ ariate, or canonical analysis in multivarite case besides obligatory using variance analysis and all three methods belong to the group of the methods of dependance .

2. Theory of multi attribute decision methods gives possibility that we can make also the analysis of results of one multifactor and multivariate experiments just in the case of the choice of optimal factor combination ,see [32]. Application of multi attribute decision methods in the optimal factor combination choice of one experiments is possible therefore exist necessary parameters:

• More criteria – functions of aim for decision which are defined with defined explicit attributes

• More and that finite number of discreet alternatives

• One finite solution

Therefore the solving a problem of the optimal factor configuration choice in one multifactor experiment with repetition understood application a very complex apparatus of multiple regression analysis or in multivariate experiments with repetition more complex canonical

analysis the author of this paper have proposed an integration of method analysis of variance in the multi attribute methods. An application of ELECTRA method, which is one from the group of multi attribute method, is described in [36] in the univariate case.
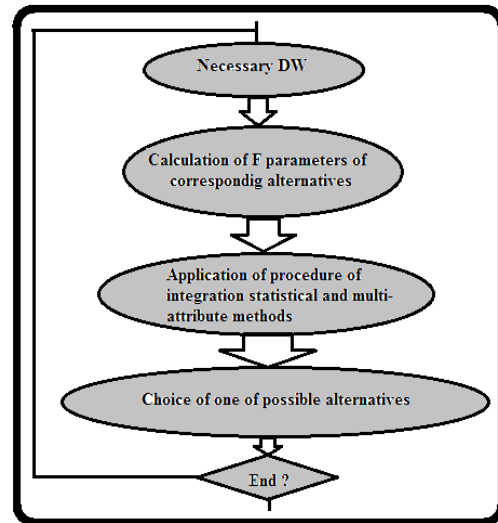

Figure 2. Model for Web based multi-attribute DSS

• Namely, like result one application of one multifactor experiment with repetition we have results organized in one table with rows which are factor combination and columns which are repetition of this factor combination.

• In the ELECTRA method we make the beginning matrix which is given like table of criteria which are in columns of this table and alternatives, i.e combination of factors, which are rows in this table with values from obtained results from executed experiments which take the middle value of one factor combination and for all that last row take values of heaviness coefficients of this criteria. Sum of values this heaviness coefficients is normalized on value 1.

• It is known that exist a methods for exact determining the heaviness coefficients of applied criteria, which are unfortunately also very difficult therefore , without generalization we understood that the heaviness coefficients for applied criteria are equal for a group of output and a group of input criteria.

• For the group of input criteria authors proposes using of F parameters computed using the method of analysis of variance, which are obviously used to consider the results of one experiment in the sense of affirmation supposed hypothesis, in the way that the values of heaviness coefficients of criteria can take whichever values, which sum is obviously identical one, if this F parameters have not a significant values for each input criteria.

In this way with connection the methods analysis of variance and multi-attribute decision method we obtain the new procedure which enables an easier i.e. efficacious way for considering a results of one experiment.

This procedure enables one construction of the model for Web based multi-attribute DSS for the group which chooses one from possible options, given with the Fig. 2. The first step in the model involves defining the problem to be solved by defining the alternatives and selected on the basis of a means of storing data from existing

transactional database administration, ie. its organizational units (ministries, agencies, public companies ...) as the time for its innovation.

The second step is based on classical statistical methods of analysis of variance and Wilks lambda for univariate and multivariate case to determine the F parameters.

The third step is a direct implementation of the described procedure and the integration of classical statistic and multi-attribute methods.

The fourth step is the one which determines the choice of solution alternatives and went to the first step.

V. CONCLUSION

In this paper is demonstrated an algorithm which integrates classical statistical F-test and ELECTRA method from MAUT and which is broadest examined in [36]. It is good attempt for exact determining the heaviness coefficients of applied attributes in chosen method of MAUT together with the method proposed in [37] which integrates data envelopment analysis with the methods from MAUT. Both are the better solution in comparison with very known but very complex method of entropy. This two methods, with proposed for example in [38] in which is discussed comparison of methods and processes related techniques in determining the weight coefficients and evaluation criteria, enable possibly construction of fault tolerant Web based multi-attribute DSS for the group which chooses one from possible options. This possibility is consequence because simultaneous and joint application of this methods on same task allows their integration in one fault tolerant method which enables choice with relation of, for example 2:1, what is the subject of authors work in future.

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