

Framework and Implementation of A Web-based Multi-objective Decision Support System: WMODSS

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Abstract

This paper presents a web-based general decision support system for solving multi-objective decision problems. This is referred to WMODSS. The system provides three decision-making methods in its method base. They deal with a wide range of linear multi-objective decision-making problems and different user requirements for the solution process. In particular, the WMODSS provides an intelligent guide to help users select a most suitable method from the method base by evaluating the relevant problems and user requirements. A satisfactory solution can thus be obtained in an interactive and flexible manner.

Key words: Decision support systems, Web-based systems, Multi-objective decision-making, Multi-objective decision support systems

1. Introduction

Various decision support systems (DSS) have, over the years, been successfully implemented in many organizations at different organizational levels. DSS always concern with information and how to make effective use of it in decision-making scenarios [8]. To deal with multi-objective decision-making (MODM) problems by using DSS, one or more MODM methods must be embedded into the DSS to form multi-objective decision support systems (MODSS). MODSS have been considered as a 'specific' type of systems within the broad family of DSS.

Traditionally, DSS had to be installed in a specified location, such as a decision room, supported by a specified operating system. Web technology allows organizations to make decisions in a distributed environment that supports remote data access and communication. Since the advance of web technology, which allows users fast and inexpensive access to an unprecedented amount of information provided by websites, digital libraries and other sources, web-based DSS have been proposed to extend the applications of traditional DSS to a global environment with a unified web platform. The computer facilities for utilizing DSS have been moving towards a more widespread use of

the Internet with its graphical user interface, the web [14].

More recently, both E-business and E-government are increasing their demands for more online data analysis and decision support. The web platform, which is also a platform for E-business and E-government development, lends itself to widespread use and adoption of DSS in organizations [6, 2]. From the web platform, managers who have not used DSS will find the new decision support tools powerful and convenient. New managers who have not been exposed to client-server tools or other DSS tools in the 1980s and 1990s find that web-based DSS are what they needed: easy to use and available from their office, home and client locations. The organizations where decision makers are distributed in different locations can use web-based DSS to assist them in making organizational strategic decisions by way of the Internet [13].

This paper presents a web-based multi-objective decision support system, called WMODSS, and describes its framework, design and implementation.

2. Multi-objective decision support and web technology

In a MODM problem the objectives usually conflict with each other and any improvement in one objective can be achieved only at the expense of another. With this observation, decisions on optimality are not determined uniquely. A final satisficing solution must be selected from among a set of possible close to optimal solutions. Consequently, the main task in solving MODM problems is to derive a satisficing solution based on subjective judgments and preferences for alternatives [9]. A number of MODM methods have been reported to provide solutions and lead to better decision outcomes for MODM problems [16].

As a specific type of the DSS family, MODSS have special characteristics that distinguish them from other DSS. The main characteristics are that they allow analysis of multiple objectives; they use a variety of

MODM methods to compute efficient solutions; and they incorporate user input in the various phases of modeling and solving a problem. While it has been customary to consider algorithms as the focal point of decision support, emphasis is shifting to database and modeling activities [7].

Traditionally, users needed proper training to learn how to use a DSS. Because the Internet is easily accessible, web-based DSS are automatically available to large number of decision makers [10]. Web-based DSS don not require any special software on a user's computer. This means that the operating system used, or compilers available, are not important to users. Further, the web enables a convenient and graphical user interface with visualization possibilities. The main issue for web-based DSS users is that the only requirement for using the DSS is a connection to the Internet, and a web browser.

Web-based DSS have reduced technological barriers and made it easier and less costly to make decision-relevant information and model-driven DSS available to decision makers in geographically distributed organizations [1, 12]. Because of the Internet infrastructure, enterprise-wide DSS can now be implemented in geographically dispersed companies at a relatively low cost. Using web-based DSS, organizations can provide DSS capability to managers over a proprietary Intranet, to customers and suppliers over an Extranet, or to any stakeholder over the global Internet. The web has increased access to information and thus should increase the use of DSS in organizations. Several web-based DSS have been developed in the last few years. These systems mainly focus on criteria-driven decision support, except for WWW-NIMBUS. WWW-NIMBUS is a web-based multi-objective DSS, in which NIMBUS is a MODM method [10]. As some MODM methods are more suitable than others for particular users and particular decision problems, our study proposes the WMODSS which contains three typical linear MODM methods. Also, in order to help users to choose the most suitable methods for their decision problems, the WMODSS provides an intelligent guide as a front-end. These methods have different characteristics when dealing with multi-objective decision problems. Therefore, WMODSS has more advantages than existing systems as it can be used for a more wide range of decision-making problems and decision makers.

3. Framework of WMODSS

This research proposes a conceptual framework of web-based DSS for solving multi-objective decision problems using interactive modules. This is shown in Figure 1. Key issues involved in this framework

include system integrity, communication, shared information space, method management and data management. The framework integrates a database, a method base and intelligent user interface. In the framework, data used for decision making is mainly obtained from internal database and user input, but can also be obtained from web resources. All MODM methods in the method base can be accessed and executed locally or remotely by users. The method base has an appropriate linkage with the database. Users can be distributed in different locations using the system through web browsers.

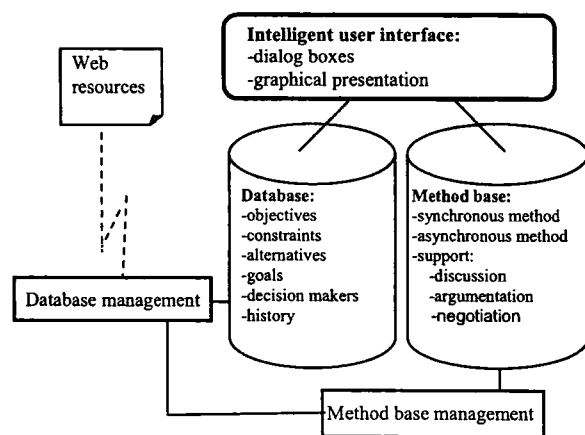


Figure 1. A conceptual framework of WMODSS

4. Implementation of WMODSS

4.1 Web sever

A web server manages all the web pages of the WMODSS, traces user information and provides simultaneously services to multiple users through sessions, applications and coking facilities. All the web pages displayed dynamically to users are created on the fly by the web server. Using the server side application program, the web server can manage and implement client tasks. For example, when a user wants to access WMODSS using existing problem data, the process is described as follows. (1) The user submits a task to the web server. (2) The web sever asks the database sever to confirm the user, and fetches a stored MODM decision problem. (3) The web then sends the decision problems to the user. (4) The system guide will help the user select a suitable MODM method. (5) After a decision problem is chosen (or given) and a MODM method is selected, the web server gives this information to the method base management component. (6) When the web server gets a solution by running the MODM method, it will let the database sever store the solution together with the user's

information. (7) Finally, the web server constructs a solution page displaying the solution to the user.

4.2 Method base

It has been found that there are many differences between different MODM methods in their applications. Some MODM methods are easy to use but require pre-data, such as goals of objective functions. Some methods encourage decision makers to explore other alternative solutions in an interactive fashion with the aim of finding a satisficing solution but users have to have such ability to do relaxation. The ultimate success of MODSS lies in its ability to help decision makers produce the most satisfactory solution through providing pre-data or directly interacting with analytical models. This is why the WMODSS builds a MODM method base which contains different kinds of methods. Three popular MODM methods are selected in the method base of WMODSS: the Efficient Solution via Goal Programming (ESGP) method [3], Linear Goal Programming (LGP) method [4], and STEUER method [15]. These methods are developed as independent executables to facilitate the flexibility required of the system. Figure 2 shows a set of alternative solutions for a product planning problem using STEUER method. Figure 3 shows the algorithm of STEUER method.

4.3 Database

The WMODSS database is designed to share problem data and solution data among users. Relational data mode technology is used in the database design. There are three main entities in the WMODSS database: user, problem and solution data.

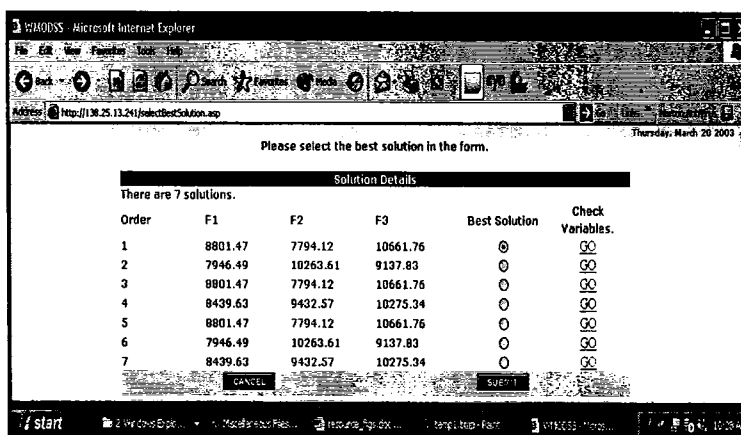
4.4 Method selection guide

The system builds a method selection guide for users selecting a suitable MODM method from the method base. Based on research results of Poh [11] and Lu & Quaddus [9], the various characteristics of MODM methods are classified into four classes: user-related, method-related, problem-related and solution-related. Each class has a group of special characteristics. For example, the user-related characteristics concern user preference for selecting a method. Such characteristics include users' desire to interact with the system, and users' ability to provide pre-data for a specific MODM method. For example, LGP needs pre-data of weights, goals and priorities for its objectives, but STEUER and ESGP do not.

When a user chooses the guide, a set of questions are shown firstly. The system uses a response-characteristic-method match algorithm to get a recommendation of a suitable method to the user based on their responses. Figure 4 shows the question page of the guide.

4.5 Web page connection

Web pages of the WMODSS are designed and implemented to support users accessing the system. Figure 5 shows possible web pages involved when using STEUER method and their connections. Basically there are two ways to get a decision problem. One is to set a new problem by inputting its objectives and constraints. Another is to use an existing decision problem which has been set before and solutions may have been obtained by other users. Figure 5 shows two groups of pages to handle the two ways respectively.



Please select the best solution in the form.

There are 7 solutions.

Order	F1	F2	F3	Best Solution	Check Variables.
1	8801.47	7794.12	10661.76	<input type="radio"/>	<input type="checkbox"/>
2	7946.49	10263.61	9137.83	<input type="radio"/>	<input type="checkbox"/>
3	8801.47	7794.12	10661.76	<input type="radio"/>	<input type="checkbox"/>
4	8439.63	9432.57	10275.34	<input type="radio"/>	<input type="checkbox"/>
5	8801.47	7794.12	10661.76	<input type="radio"/>	<input type="checkbox"/>
6	7946.49	10263.61	9137.83	<input type="radio"/>	<input type="checkbox"/>
7	8439.63	9432.57	10275.34	<input type="radio"/>	<input type="checkbox"/>

CANCEL SUBMIT

Figure 2. A number of alternative solutions

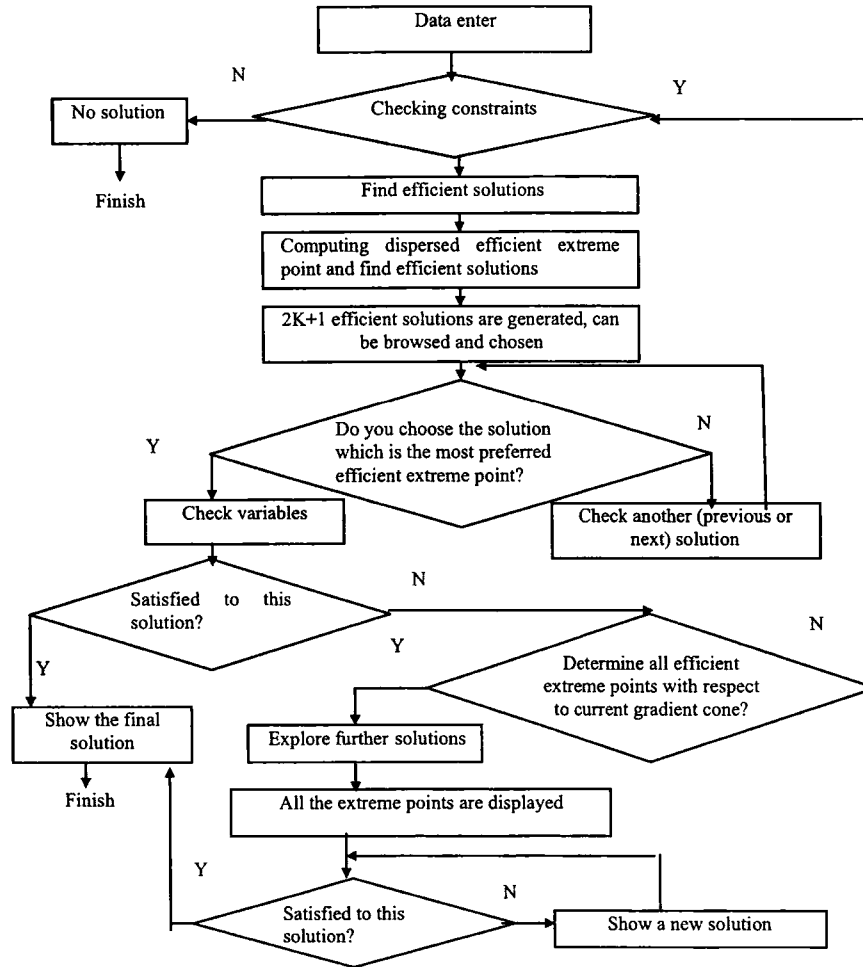


Figure 3. Algorithm and execution of STEUER method

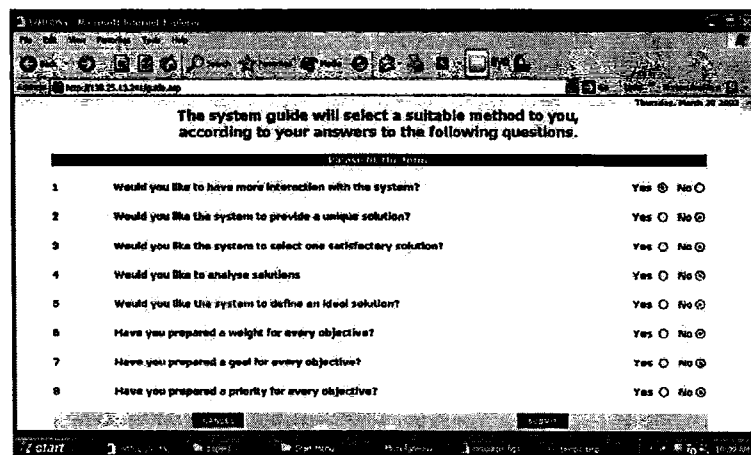


Figure 4. Question page of the guide in WMODSS

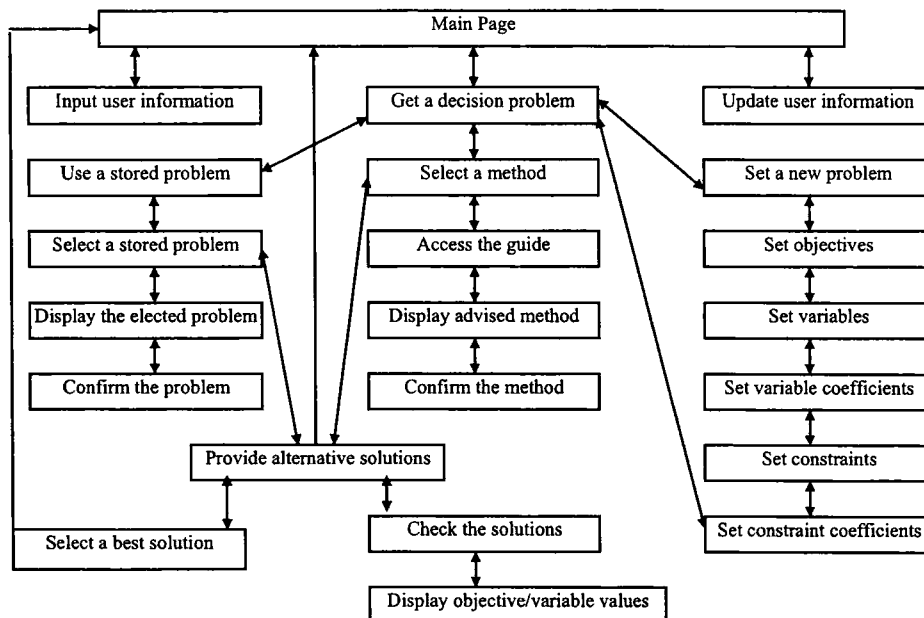


Figure 5. Page connections when using STEUER method

5. Future study

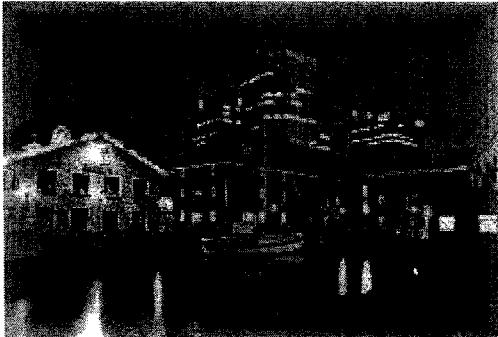
The WMODSS is interactive, flexible and easy to use for various linear multi-objective decision problems. It is expected to be applied to practical multi-objective decision problems such as product planning, resource management, research project funding, and the determination of optimal price changes. We hope to get feedback from our users and to make the system widely available. We are planning to enhance the systems to support group decision-making involving multi-objective decision problems.

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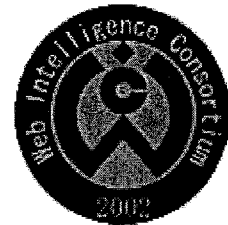
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