MULTICRITERIA GROUP DECISION MAKING BASED EXPERT SYSTEM: FRAMEWORK

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ABSTRACT

This paper presents a framework of a decision support system (DSS) with multicriteria group decision making (MCGDM) using both mathematical programming and expert system (ES). The study indicates the implementation of multicriteria techniques through group decision making in DSS. The main advantage of this framework is the combination of both the mathematical programming and expert system in a hybrid approach to achieve the interaction between the solution procedure and decision maker through group decision making.

KEY WORDS:

Decision support system, group decision making, multicriteria, expert system.

1. INTRODUCTION

Few years ago, the terminology decision support system (DSS) attracted researchers who are working in decision making field to organize and implement the information about mathematical models and the required techniques to solve them. DSS is defined as a computer program consists of three different modules. The first is data base management module, the second is model base management module, and the third is the user interface module [1]. Bennet [2] classified DSS into two categories, data oriented and model oriented systems. the first class interested in providing the required data, analysis and presentation. The second class performs simulation, or

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provides models of optimization for decision makers. This classification indicates the main contribution of DSS in decision making field, whatever in data retrivial or model building. From the study of DSS, one can conclude that it increases the effectiveness of the decision making process not the efficiency.

Group decision support system (GDSS) is an advanced generation of DSS and its foundation is given by Gallupe [3]. With the increasing of complexity in different problems, it becomes necessary to feed back with group who are responsable for making a decision in order to improve the decision results. Multicriteria decision making (MCDM) concerns with the problems which have certain number of conflict objectives. the solutions of MCDM problem are refered to as noninferior, efficient, Pareto optimal, or nondominated solutions. The most common approach in MCDM is to characterize the set of all noninferior solutions in terms of the optimal solution of appropriate scalar optimization problem. There are many scalarization techniques for MCDM problems. The main techniques are the weighted sum and $\in$ -constraints methods. In [4], a modified hybrid approach for solving MCDM problem done using the characterization of both the generalized Techebycheff norm and the method of constraints.

This paper focuses on introducing a framework of multicritera group decision support system (MCGDSS) based on both mathematical programming and expert system to explore the decision makes experiences and interact with the solution procedure in order to get the best satisfactory solution.

The foundation of GDSS and an expert procedure for ranking criteria in the presence of multi-experts is introduced in the second section. The third section discusses the solution porcedure of MCDM problems using a modified hybrid approach. the last one gives the suggested framework of MCGDSS and its features.

2. GDSS AND ES.

2.1. GDSS

A GDSS supports the decision making process rather than the solution of a specific problem. It is defined as an interactive, computer based system that facilitates the solution of unstructured problems by a set of decision makers working together as a group [1].

The characteristics of GDSS can be summarized as follows:-

i) A GDSS is designed with the goal of supporting groups of decision makers in their work.
ii) A GDSS should improve the decision making process and its outcomes.
iii) A GDSS is easy to learn and easy to use.
iv) A GDSS may be specific or general.

Gallupe [3] defines the GDSS components as follows:-

i- Hardware, ii- Software, iii- People, and iv- Procedures.

From the leterature, it is clear that GDSS technology has made enumorous theoretical advances. These technology has been studied from both conceptual and design perspectives. The technology development leads to create the following four possible scenarios:

i) Decision Room,
ii) Local decision network,
iii) Teleconferencing, and
iv) Remote decision making.

Our paper introduces a framework for building GDSS to solve multicriteria problem using specific powerful approach and an expert system for ranking criteria.

2.2. Expert Procedure for Ranking Criteria

In 1994, Abd El-Wahed [5] presented an expert procedure for ranking different criteria in MCDM problems. The given procedure has the following characteristics:

i) It is easy to use.
ii) It invokes the openion of multi-experts in one satisfactory openion using statistical analysis,
iii) It is a general system, i.e. it can be used for ranking objects, elements, alternatives, ... etc.
iv) It is coded on a personal computer using both PROLOG language and VP-expert system shell, to be more applicable.

The procedure steps can be summarized as follows:-

i) Construct the comparison matrix by asking the expert of the poblem domain about the preferences between the criteria.
ii) Repeaet step one with each expert.

iii) Treat each matrix statistically as mentioned in [6].
iv) Combine the matrices of all experts in one matrix to get the final ranking of criteria.

In the following section, we shall discuss one of the powerful methods for generating the set of noninferior solutions of MCDM.

3. A MODIFIED HYBRID APPROACH

This approach is used to solve MCDM problems. it combines the characteristics of both the generalized Tchebycheff norm and the method of $\in$-constraints. This approach is rather simpler than hybrid since the parameters in the corresponding scalar problem included only in the constraints instead of being included in both the objective function and the constraints.

Let us consider MCDM problem as follows:-

$$P_1: \quad \begin{array}{l} \min \quad F(x) \\ \text{Subject to} \\ M = \{x \in R^n / G(x) \le 0\} \end{array}$$

where $F : R^n \to R^m$, $G : R^n \to R^r$ are convex functions on R^n

Using the generalized Tchebycheff norm which is defined in [6] and the method of $\in$-constraints a corresponding problem with scalar objective takes the form

$$P_2: \quad \begin{array}{l} \min\limits_{M} \; \max\limits_{i} \beta_i \left| F_i(x) - u^*_i \right| \\ \text{Subject to} \\ F_i(x) \le \varepsilon_i , \qquad i = 2, \ldots\ldots, m \end{array}$$

where $\beta \in R^m{+}$, $u^* \in R^m$ is an ideal target. It was shown in [7], that x^- is an efficient solution of P_1 if it is only the solution to P_2 for some $\beta = \beta^-$.

The problem P2 can take the following equivalent form:

$$P_3: \quad \begin{array}{l} \min \quad z \\ \text{Subject to} \\ N(\beta, \varepsilon) = \{(z,x) \in R^{n+1} / \beta_i [F_i(x) - u_i^*]\} - z \le 0 , \\ i = 1,2, \ldots, m, \; \{F_i(x) - \in_i \le 0, \text{ and } G(x) \le 0\} \end{array}$$

From [4] if (z,x) is an optimal solution to problem P_3, then x is an efficient solution to P_1. For some (β, ε) and the set of all nondominated solutions can be obtained from the solution of P_3 for (β, ε).

4. FRAMEWORK OF A GDSS PROCEDURE

The components of the suggested framework of MCGDSS can be described through the following organized steps:

Step 1: Define objectives of the problem and determine its relative importance using the expert procedure in [5].

Step 2: Generate the set of nondominated solutions using modified hybrid approach.

Step 3: Determine the relative imprtance of the alternatives in step 2 for each decision maker and get the final ranking of the alternatives [5].

Step 4: Combine the relative importance of the alternatives with the relative importance of the objectives via pairwise comparison matrices.

Step 5: Give the set of solutions with their ranking priorities to the decision makers for group decision.

Step 6: Are they agree on the solution ? If yes go to step 8. If no, go to step 7.

Step 7: is there no decision ? If yes go to step 8. If no go to step 1.

Step 8: Stop.

The above algorithm can be summarized in a flow diagram shown in Fig.(1).

5. CONCLUSION AND POINT FOR FURTHER RESEARCH

This paper suggests a framework for group decision making in the presence of multicriteria decision making problem. the tools of the framework based on the modified hybrid approach for getting the set of all nondominated solutions and an expert system for ranking the alternatives to decide the satisfactory solution.

The main contribution of this paper is introducing the effect of expert system on the work of group decision making to increase its efficiency and effectiveness.

The future work should be concentrated on the code of the suggested procedure and adding another features to the model as fuzziness and stochastic analysis to support the group decision.

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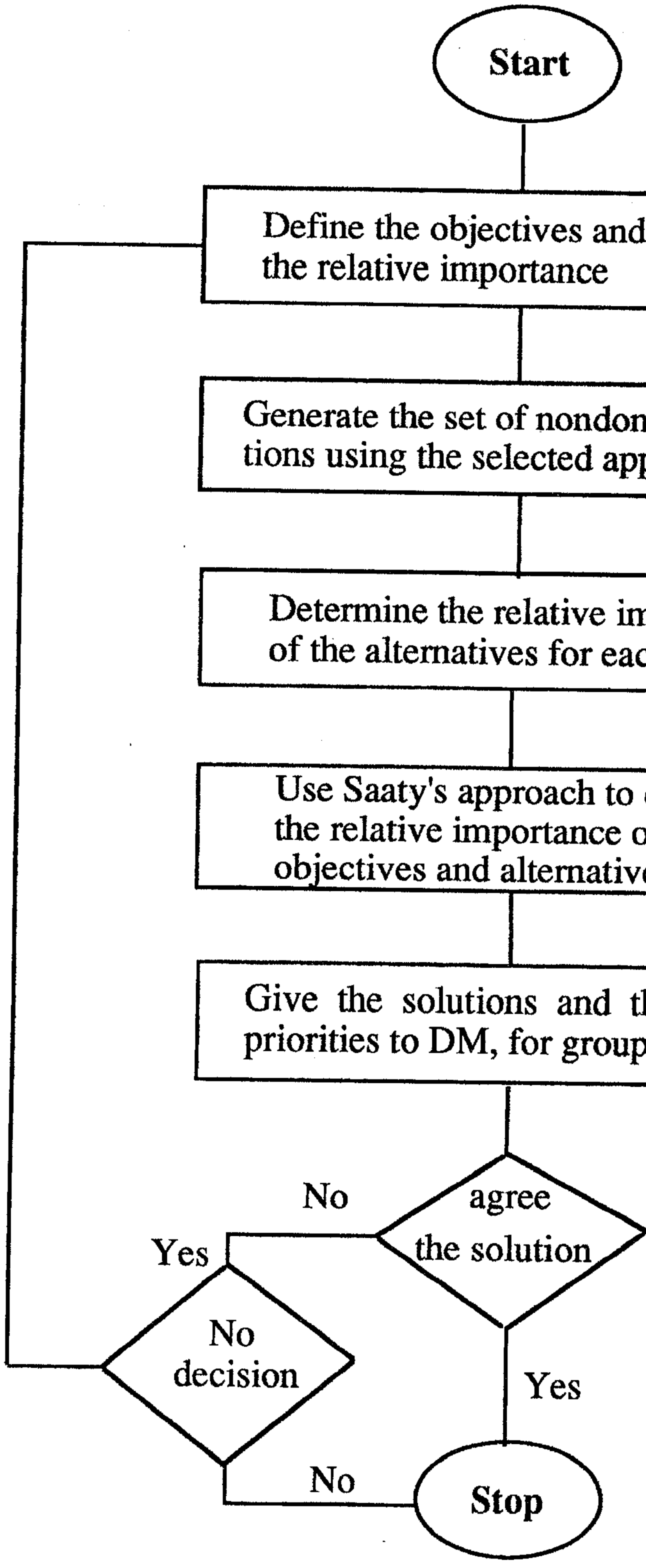
Start
Define the objectives and determine the relative importance
Generate the set of nondominated solu-tions using the selected approach
Determine the relative importance of the alternatives for each DM
Use Saaty's approach to combine the relative importance of both objectives and alternatives
Give the solutions and their rank priorities to DM, for group decision
agree the solution
No
Yes
No decision
Yes
No
Stop

FIG.(1)

صناعة القرار متعدد الأهداف في نظام مجموعات بإستخدام نظام خبير(إطار عمل)

د./ أحمد أحمد الصاوى   د./وائل فتحى عبد الواحد

قسم العلوم الأساسية الهندسية -كلية الهندسة -جامعة المنوفية

يعرض هذا البحث إطار عمل لنظام دعم وأتخاذ القرار بإستخدام مفهوم المجموعات مبنيا على كل من النظم الخبيرة والبرمجة الرياضية فى نفس الوقت.وأهم ما توضحة هذة الدراسة هو توظيف طرق معالجة إتخاذ القرار المتعدد الاهداف لخدمة نظم دعم وأتخاذ القرار . ولهذا البحث ميزة هامة جداً وهي تأصيل التفاعل بين مجموعات متخذى القرار وطرق الحل فى منظومة واحدة بما يضمن إتخاذ قرارات سليمة ودقيقة وتعبر عن واقع المشكلة الفعلية المطلوب حلها.