A STUDY OF MULTIPLE CRITERIA DECISION MAKING (MCDM) PROGRAMMING IN CURRENT SCENARIO

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ABSTRACT

MCDM is a sub-discipline of Decision Analysis and a general class of OR that tends to consider several criteria in inconsistent decision-making. Where a best choice must be selected, sorted, and graded from a collection of suitable alternatives based on two or more competing criteria, the MCDM approach is used. Multi-Criteria Decision Analysis (MCDA) techniques were created to aid DMs in their individual decision-making process. Stepping stones and methods for negotiating a trade-off are among the MCDA strategies. They have the ability to make the DM the focal point of the operation. They aren't automatable techniques that produce the same answer for every DM; rather, they combine subjective data, also known as preference data, given by the DM, to arrive at a consensus arrangement.

KEY WORDS: multi-criteria decision analysis (MCDM), Operations Research (OR), decision maker (DM),

INTRODUCTION

MULTIPLE CRITERIA DECISION MAKING (MCDM)

Multi-objective optimization gave birth to GP. This is in line with the multi-criteria decision analysis (MCDA) division, which is also known as multi-criteria decision making (MCDM). As a result, we may define GP as an optimization program that is used to manage a large number of incompatible target procedures. These techniques have a specific aim or target importance that they are intended to achieve. It is often assumed to be an extension to the LP concept, which is used to exclude unacceptable nonconformities from a set of target values.

MCDM is a field devoted to perfecting ideas and methods to aid decision-makers in making informed decisions while confronted with several conflicting and opposing steps. The process of decision-making is the selection of an action or alternative of action from a collection of alternate actions or schedules that will yield the best results according to certain optimization principles. A good option (solution) in a multifaceted system is only feasible when several priorities are considered simultaneously. Each human being, as a living structure, has a collection of goals or consistency facts to follow and maintain. The portion of the difficult problem that the current approach would overcome is the multi-criteria decision problem. Management scientists and system analysts are completely aware of the multi-criteria complexities of decision problems in the real world.

Over the last 30 years, there has been a growing significance in the advancement of techniques and presentation of MCDM problems. MCDM is quickly becoming a popular branch of Operations Research (OR). This responsiveness in MCDM problems stems from the rapidly evolving realization that human inclinations are diverse and not reducible to simple objective purposes of cost minimization or net benefit maximization in the lowest level operational problems. In reality, it's debatable if words like cost or net benefit are even definable in the most precise problematic situations.

If 'OR' is to have an impact on tactical scheduling and decision-making, we must address the MCDM issue.

MCDM CLASSIFICATIONS

The issues with MCDM can be divided into two categories:

- **Making Decisions Based on Multiple Attributes (MADM)**

MADM (multiple attribute decision making) is an essential aspect of today's decision science. It uses the existing collection of options to analyze and evaluate many issues that a decision maker (DM) should consider. The primary goal of MADM is to identify and rate the most necessary alternates for associate decision-making. MADM issues, as a diverse research field, must be addressed using some traditional approaches such as the simple additive weighting method (SAW), the analytic hierarchy process (AHP), and the method in order preference by similarity ideal solution (TOPSIS). It is commonly used in a variety of fields, including economics, management, engineering, and technology. Characteristic values and characteristic weights are required decision-making information in MADM problems. The attribute values describe the substitutes' attributes, skills, and results. The meaning of the characteristics is quantified using characteristic weights. Both characteristic values and attribute weights are indefinite due to the difficulty of the natural world and human beings' limited knowledge and discernment abilities. The policy makers are unable to articulate their desires or values in a clear and unambiguous manner. Many researchers have attempted to precisely designate characteristic values and characteristic weights in inexact conditions in order to cope with the difficulties. The research in this field is usually divided into three sections, as follows.

Initially, the unknown set definition, which first appeared in 1965, has gradually become the norm in the field of advocating for and dealing with unclear characteristic values. Numerous extensions to the uncertain set theory have been predicted since its inception, including interval-valued uncertain sets, unsure multi sets, intuitionistic fuzzy sets (IFS), linguistic fuzzy sets, and reluctant fuzzy sets (HFS).

Second, a variety of methods have been proposed to control characteristic weights. Subjective, goal, and hybrid approaches are the three most common types. The subjective approaches use a decision maker's partialities to select characteristic weights, while the target techniques use goal knowledge to control attribute weights. To control characteristic weights, hybrid strategies connected to decision maker and target information are used.

Third, data envelopment analysis (DEA) needs virtually less additional knowledge as a nonparametric programming efficiency-rating tool for evaluating a collection of decision making units (DMUs) with multiple inputs and outputs. Without knowing the weights, DEA has been considered an important method for solving MADM problems. Doyle, for example, proposes a method based on the DEA method, which derives a collection of attribute weights from the data. Bernroider and Stix proposed a system for responsible and understandable MADM based on DEA with constrained multipliers. Wu and Liang propose a new multi-attribute ranking system based on the DEA game cross-efficiency model, in which each alternative is viewed as a player attempting to optimize its own success.

- **Making multiple-objective decisions (MODM)**

Multiple goal decision making, on the other hand, has little to do with the issue of determining substitutions. The models' main objective is to plan the best replacement by taking into account a variety of communications as well as plan limitations that change decision-making by achieving some satisfactory levels of set from some measurable goals. MODM approaches have the following characteristics in common:

• A method for determining certain trade-off facts, implied or unequivocal, among the specified measureable target and also among stated or unstated non-measureable goals. As a result, MODM is linked to a design problem (in contract to selection problems for the MADM).

RELATIONSHIP BETWEEN GP AND MCDM

The word "multiple criteria decision making" (MCDM) refers to a branch of operations research and management science. MCDM was described by Zionts (2020) as a method for resolving decision problems involving multiple (sometimes conflicting) objectives. Although that term applies to GP as well, MCDM is a much wider collection of methodologies, of which GP is just a small part. GP may also serve as a unifying foundation for most MCDM models and methods. Extensive lexicographic objective programming has recently been proposed for this reason.

Romero (2020) and Ringuest (2020) are two publications that characterize the phenomenon. The relationship between MCDM and GP can be seen on a conceptual level in what Zionts (2020) refers to as the four subareas that make up MCDM. The subfield of multiple criteria mathematical programming, according to Zionts [2020,] entails solving mainly deterministic mathematical programming problems with multiple objectives. One of the several methodologies that is considered a major contributor to this subarea of MCDM is linear target programming. Indeed, according to Zoints and Wallenius [2020], the development of GP served as a springboard for the development of MCDM, especially this subarea. How can a GP model be distinguished from other mathematical programming models with multiple criteria? In most cases, decision variables are included in the objective function of MCDM models in this subarea, whereas GP models do not.

MULTI-OBJECTIVE DECISION ANALYSIS GOAL PROGRAMMING

Goal programming is one of the most promising methods for multiple objective decision analysis. Goal programming is a powerful method that uses the well-established and well-tested methodology of linear programming to solve a complex system of competing goals simultaneously. With a single objective and several sub goals, goal programming can manage decision problems. Charnes and Cooper were the first to implement the technique, and it was further improved by Jaaskelainen, Lee and Bird, Lee, and Ignizio. Many researchers, including Kwak and Schniederjans, Ignizio, Hallefjord and Jornsten, Reaves and Hedin, Hemaida and Kwak, Bryson, Easton and Rossin, surveyed, case study and applications of goal programming and multiple criteria decision making (MCDM), and concentrated their views for an overview of techniques for solving multiple object problems However, it is common practice to differentiate methods based on problem classifications, as described by Zanakis and Gupta, Steuer, Romero, Tamiz and Jones, and others. MCDM is an extremely significant discipline that deals with multiple-objective decision-making problems. Management priorities often compete for limited resources. Furthermore, these objectives could be incompatible.

As a result, a hierarchy of priority must be established among these competing priorities, so that low-order goals are met or have reached a point where more changes are no longer desirable. Goal programming can solve the problem if the decision maker can provide an ordinal ranking of goals in terms of their contributions or value to the organization, and if all of the model's relationships are linear.

Instead of trying to increase or reduce the target criterion directly, as in linear programming, goal programming focuses on minimizing the deviations between objectives and what can be accomplished within a specified set of constraints. Slack variables are used in the simplex algorithm of linear programming to describe such deviations. In target programming, these variables take on a whole new meaning. Positive and negative deviations from each sub goal or goal are expressed in two dimensions by the deviational variable. The objective function then shifts to the minimization of these exceptions depending on their relative value or priority.

The cardinal value, such as benefit or cost, is used to solve every linear programming problem. Goal programming is distinguished by the fact that it allows for an ordinal solution. While the decision maker may not be able to acquire information about the worth or expense of an objective or sub goal, he or she may often decide its upper and lower limits.

RESEARCH METHODOLOGY

MCDM is a sub-discipline of Decision Analysis and a general class of OR that tends to consider several criteria in inconsistent decision-making. Where a best choice must be selected, sorted, and graded from a collection of suitable alternatives based on two or more competing criteria, the MCDM approach is used. Due to their simple nature of being able to judge different alternatives based on various selection attributes with different units of measurement while choosing the most suitable alternatives, MCDM models are gaining popularity in management sciences as potential methods for evaluating complex real-time decision-making problems. The key feature of these paradigms is that a DM aims to fulfill all levels of the goals and seeks the most desirable balance between many, often conflicting goals, rather than optimizing a single defined target. MCDM's ultimate aim is to aid in decision-making rather than make the decision. Successful decisions in the manufacturing sector, for example, are intended to achieve lower manufacturing costs, higher performance, and proper production planning and scheduling processes. The procedure is difficult because it requires assessing and determining manufacturing strategies in light of a variety of requirements and implementation measures, including trade-offs between central components such as desired properties, working conditions, manufacturing process, and cost. As a result of these factors, decision analysis techniques have become well known as a fundamental and critical module in an organization's success. In its most simple form, MCDM assumes that a DM must choose the best options from a large number of options based on defined target work esteems or traits to be certain MCDM methods are well adapted to working with a variety of goal issues that include both ordinal and cardinal goals.

RESULTS AND DISCUSSION

Multi-Criteria Decision Analysis (MCDA) techniques were created to aid DMs in their individual decision-making process. Stepping stones and methods for negotiating a trade-off are among the MCDA strategies. They have the ability to make the DM the focal point of the operation. They aren't automatable techniques that produce the same answer for every DM; rather, they combine subjective data, also known as preference data, given by the DM, to arrive at a consensus arrangement.

QM for Windows was used to solve the model. The 42nd version yields the remedy for staff scheduling in the emergency room, radiology department, and nuclear medicine department.

TABLE- DISTRIBUTION ON THE BASIS OF OBJECTIVE FUNCTION'S ANALYSIS

Deviational Variable		Goal Priority	Goal Achievement
$d1^+$ (= 0)	$d1^-$ (= 210.000)	N1=0.0000	Fully Achieved
$d2^+$ (= 0)	$d2^-$ (= 0)	N2=0.0000	Fully Achieved
$d3^+$ (= 2.210)	$d3^-$ (= 0)	N3=2.210	Partially Achieved
$d4^+$ (= 0)	$d4^-$ (= 139.250)	N4=139.250	Partially Achieved
$d5^+$ (= 35.150)	$d5^-$ (= 0)	N5=35.150	Partially Achieved

TABLE- DISTRIBUTION ON THE BASIS OF DECISION VARIABLES ANALYSIS

Time Period (Shifts)	Available Personnel (Persons)					
	Emergency		Radiology		Nuclear Med.	
	Nurse(Y1)	Physician(X1)	Tech. (Z2)	Physician (X2)	Tech. (Z3)	Physician (X3)
6am-10am	05	02	20	07	08	04
10am-2pm	09	02	21	09	07	04
2pm-6pm	06	03	12	02	05	04
6pm-10pm	05	03	07	01	04	02
10pm-2am	05	02	05	01	04	02
2am-6am	06	02	06	01	02	02

The first two goals (P1=0.000 in d+ and P2=0.000 in both d 2- and d 2+) are met, but the remaining goals are not. The negative deviational variable d1- =210.000 indicates that the current staff scheduling developed by this GP model saves Rs. 2, 10,000. The decision variables and their values are shown. In each department (emergency, radiology, and nuclear medicine), the solution for staff assignment (nurses, physicians, and technologists) indicates optimum outcomes. Since fractional values are proportional to doctors, the original solution has fractional values in nurse and technician scheduling. But for the radiology section, none of the three departments have a physician on staff. In fact, health-care organizations handle these types of situations by using an on-call system, even if some types of employees are not required to be present at all times.

CONCLUSION

Multi-Criteria Decision Analysis (MCDA) techniques were developed to assist the DM in their unique and individual decision-making phase. MCDA tactics include stepping stones and tools for negotiating a trade-off. They are capable of positioning the DM as the procedure's focal point. They aren't automatable techniques that provide the same response for every DM; instead, they combine subjective data, also known as preference data, provided by the DM and leading to the compromise arrangement.

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