FUZZY MULTI CRITERIAL SELECTION FOR PROMETHEUS DECISIONS IN MILITARY APPLICATIONS

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Abstract: *This paper formulates the selection of solid information as a multi-criterion decision-making issue and presents a fuzzy intuitionist multicriterial decision modeling model for the efficient resolution of the problem. The subjectivity and imprecision of the decision-making process is adequately addressed using fuzzy intuitionist numbers. The concept of ideal solutions for determining the overall performance of each solid waste disposal alternative is adopted in all selection criteria. As a result, effective decisions can be made as to the choice of the most appropriate information on the specifics of the mission. An example is shown that shows that the proposed decision model is simple and effective to solve the problem of selection in real world settings.*

Keywords: *UAV, CSR, ISTAR,CAA, anti-drone system*

CAA	*- Civil Aviation Authority*	*ISM*	*- Industrial, Scientific, Medical*
RSSI	*- Received Signal Strength Indicator*	*UCAV*	*- Unmanned Combat Aerial Vehicle*
FMCW	*- Frequency Modulated Continuous Wave*	*ISTAR*	*-Information, Surveillance, target acquisition, and Reconnaissance*
SIGINT	*- Signal Intelligence*	*IR*	*- InfraRed*

1. INTRODUCTION

1.1 History

In the last decade, there has been a rapid growth on the unmanned aerial vehicles (UAVs) market. Around 80 countries possess UAVs, from which less than a dozen can be armed, according to the Ministry of Defense. According to the US General Accounting Office e the number of countries with UAVs has increased from around 41 in 2004 to 76 countries in 2012. These Unmanned aerial vehicles (UAVs), are commonly called drones, are aircraft or remote-pilot systems. The range is simple: short-range systems and long-range high-strength systems which require an access road. UAVs have civil and commercial uses, but this work also has an interest in the military role. They can also be called unmanned aerial systems (UAS) and remote-pilot aircraft (RPA). Their main role is Aerospace Research, Surveillance and Recognition (CSR) or Intelligence, Surveillance, Acquisition and Target Recovery (ISTAR). The only United Kingdom armed UAV is Reaper and is used only in Afghanistan. Under the 2010 Strategic and Security Strategy (SDSR), the Government has promised to invest in a fleet of UAVs in combat and recognition roles.

Increased use of UAVs and their use by the United States in Afghanistan, Pakistan and elsewhere raises a number of moral, ethical and legal issues. Remote pilots operate on the same operating rules as crewed aircraft. There is no completely autonomous UAV. [3], [34]

1.2 Strengths and weaknesses

The unmanned aerial vehicles (UAVs) possess advantages and disadvantages as crewed airplanes. UAVs contribute to reducing the risk for airplanes operating in hostile territory. Such systems can be used for "dull, dirty and dangerous" objectives. These can be cost-effective and offer significant information, surveillance and recognition capabilities. This may help to inhibit the ability of the enemy to move in secret. UAVs are more consumable than crewed airplanes, at least in terms of lives, if not in money. Also, a lot of deficiencies - currently lacking the flexibility and adaptability of crew equipped aircraft, and more advanced systems require a greater or more cumbersome requirement than crewed aircraft.

A note of the Joint Defense Ministry's doctrine suggests that "if current trends continue, it is likely that the cost of unmanned complex aircraft will increase to convert rapidly to those of crewed aircraft." The large amount of data provided by the UAV will always require advance technology in automated data to ensure the use of collected information.

But let's not forget the vulnerability to data transmission interference. There will also be restrictions regarding the operation area, especially in civil airspace.

Most analyzes of the use of UAVs share concerns about the legal, moral and ethical issues they raise.

For Romanian armed forces, UAVs will have a greater impact on the Air Force than on other services, as they will be used to fulfill their core function, aerial surveillance and early warning. The army and the navy could use UAVs to "allow them better to deliver their terrestrial or maritime power." [4], [35]

1.3 Restrictions of UAVs in airspace

All remote pilots (UAVs) are treated as military aircraft and subject to the same regulations as aircraft on board. The complete guide on the use of UAVs is in the Civil Aviation Authority (CAA) manual.

In the United Kingdom, unmanned aerial vehicles (UAVS) are allowed to fly only in separate airspace, restricted airspace (temporarily) and in hazardous areas. This is because none of the UAVs currently in operation is equipped with an approved "sense and ability to allow" them to operate in civilian airspace.

The Civil Aviation Authority provides the following definitions:

Sense-and-Avoid is a generic term used to describe a system that involves one or more sensors that is capable of seeing, sensing or detecting traffic or other conflicting dangers, and taking appropriate action to in accordance with the applicable rules. In this way, the system acts as a substitute for seeing and avoiding crewed airplanes.

Separate airspace, as the name suggests, is an airspace block specifically dedicated to the flight of an unmanned airplane. Collision risks are eliminated by strictly preventing or controlling access to this airspace by other aircraft.

2. MULTICRITERAL ANALYSIS (ADVANTAGES, DISADVANTAGES)

2.1 Introduction

Strategic decisions have been described as an "important in terms of actions taken, committed resources or previous sets".

Strategic decisions are "decisions rarely encountered by top leaders of an organization which critically affect organizational health and survival". In addition, the creating, evaluation and implementation process for strategic decisions is generally characterized by taking into account the high risk and the potential synergies between the different options. Long-term consequences and the need for stakeholders to engage in meaningful psychological and social negotiations are absolutely necessary.

A recent trend within organizations is to engage in strategy workshops such as an effective means of engaging in strategic decision-making and ensuring the participation of key actors in the process. A recent Hodgkinson study proved that Multi-Criteria Decision Analysis (MCDA) are barely used to support strategy workshops. This is somewhat surprising because simplified forms of MCDA - where the model is created directly with a group of managers in a decision-making conference - seems to be a perfect tool to support strategic decisions in a work shop.

We believe that alternative MCDA methods can be useful to support a strategy team in charge of design and high value selection for strategic options. However, its use in workshops may be caused by limitations in the MCDA approach, which may make it inefficient to support strategic decisions and the processes in which they are created, debated and evaluated.

We therefore propose a series of changes so that it can be implemented as an effective tool in supporting strategic decisions. Changes will require consideration of both technical and social aspects. The purpose of this chapter is to suggest these changes and to create a framework for using MCDA. To support strategic decision making in strategic workshops, we illustrate these changes with examples of real-world interventions. Strategic decision-makers were involved here.

2.2 Multiple objectives

In the literature, there is sufficient evidence on the transparency of multiple objectives in the strategic decision-making process (eg [18]). The fact that strategic decisions usually involve taking into account several strategic objectives suggests the adoption of the MCDA as a tool for assessing strategic choices. The benefits of scenario planning, combined with MCDA ratings, provide a set of tools that support strategic decisions. Since the 1980s, the use of MCDA for scenario planning has been considered. Most work uses multi-attribute value analysis, such as Goodwin and Wright [25]. However, other MCDA methods may be used [14].

At a theoretical level, Belton and Stewart discussed the use of MCDA and scenario planning. Stewart presented some technical aspects related to this integration and offered a proposal on how it could be done. Montibeller et al. suggested a framework for analyzing multiple attributes. These attributes will be in several scenarios, such as Belton and Stewart, but with emphasis on robustness of strategies.

An important change that some organizations may have is when they use MCDAs based on values that guide the decision-making process. In this case, strategies are seen as means to achieve the organization's strategic goals. This can help both align the strategic vision of the organization with strategic objectives and take strategic options into account. (see [6]).

Therefore, a key issue in supporting strategic decisions is the need to help define and structure them. As presented in recent research [10], people are usually trying to think about the fundamental objectives they need to take into account when making a decision. While managers have a profound understanding of their organizations and think about what they want to achieve, our experience with management teams shows that they usually do not have a clear framework for thinking about decisions.

Consequently, it is reasonable to argue that they need invariably support in defining and negotiating objectives that are considered important and essential in a certain strategic decision context [17].

A variety of tools can be used to structure goals, such as network goals, causal / cognitive maps, workshops, etc. We have used cognitive maps on a large scale - a network of decision-makers who want to reach them and the means they have. Links show the perceived influence - to support the structural objectives and the value of the trees. This is a particularly useful tool because the final structure of the means allows the analyst to value the values of the decision-makers. After setting decision makers, it sets the fundamental and strategic objectives, contributing to the structuring of a value tree (for a discussion of how they can be used to see Montibeller and Belton). There are other applications of cognitive maps for this purpose reported in the literature, e.g., Belton et al. [7], Bana e Costa et al. [5], Ensslin et al. [19], Montibeller et al.

For example, we helped a British Planning and Performance Team (PP team) in identifying strategic goals. The process was supported by a cognitive map that was developed interactively with team members using the Grup Explorer network system (www.phrontis.com) (a set of wirelessly connected laptops) running along the mapping software decision for Explorer (www.banxia.com). These mapping tools allow team members to introduce and structure ideas in "real time".

2.3 Design robust options

Much of the MCDA literature was the evaluation of the options, with a predefined set of alternatives. Although it is an important aspect of many decisions, our experience has shown us that most decisions - especially those at the strategic level - do not start from a well-defined set of options. As Keeney has pointed out, designing better options is a crucial aspect of successful decision support.

We used large-scale cognitive maps to generate options. An example would be the above-mentioned municipal council project, for each strategic objective we asked the group members to generate a list of options. This list of options was then introduced through their laptops and presented in the cognitive map projected on the public display. In this way, we had a brainstorming focused on achieving the strategic objectives of the organization.

The next support an analyst can offer is to create better options. Indeed, the key advantage of using MCDA comes from specifying and measuring the achievement of strategic goals of the organization. In this way, it is easy to determine the weaknesses and strengths of each strategy.

Analysts can then help customers think about ways to reopen options, improve weaknesses, and assess marginal value. Not only an inter-scenario robustness should be an objective, but also an inter-scenario risk, the latter being a concern in reducing performance variability.

2.4 Long term considerations

Most of the MCDA applications reported in the literature present the results from a single point of view and that attempts to represent the performance of an option if implemented.

Particularly, in taking strategic decisions, we must take into account the long-term consequences.

A relatively simple way to take into account long-term consequences in these cases is by applying a time reduction as in the current net worth (NPV) analysis. A key challenge of VNA analysis is always to define an adequate update rate. In private companies, this can be relatively simple because it is related to the cost of capital.

However, the same cannot be said about public decisions where the level of updating is questionable - a high rate can make long-term costs negligible and favor the short term [23]. Another pathway, recently suggested by Santos is the use of system dynamic models to simulate multiple system responses, considering policies as inputs. These responses can be used as policy performance in an MCDA model.

3. MCDA FOR MAKING STRATEGIC DECISIONS: FACILITATING THE PROCESS

In the previous sections we discussed several ways to describe the technical complexity associated with strategic decisions. The main focus will be on designing decision support processes to address the social issues. In association with strategic decision-making we will propose easy decision-making as an effective way to provide this support.

Using "easy decision modeling" to describe a process through models will develop a strategy team, in real time and with or without the help of the computer (Eden, 1990; Franco and Montibeller, Phillips 2007). A decision model is "formal" if it is a strategic decision-making issue rather than a relation to cause-to-effect relationships or relationships between decision-making and their consequences (deterministic or uncertain). A formal decision model is accepted for analysis and manipulation, but not necessarily quantifiable. The decision model produced in an easy manner is used by the members of the strategy team as a "transient object" [16, 13]. It will allow them to share their strategic concerns and increase their individual understanding of strategic issues, assessing the potential impact of different strategic choices, and negotiating strategic actions that are feasible.

When the members of a strategy team take part in an easier modeling process, they are engaged in "conversations" [22] to change their views on the strategic decision. This process is participatory in the sense that team members can make strategic decisions, understand and develop and evaluate a portfolio of strategic decision options. This process is supported by the decision analyst both as a facilitator and as a modeling engineer [2].

Because interaction between decision-makers and stakeholders is needed with decision-makers, in order to be able to build together a strategic decision model, modeling is also an interactive process. Such interactive processes continue until the situation is structured and analyzed in a satisfactory manner. The group must feel sufficiently confident about the commitments and implementation options in order to be able to address them in an acceptable manner.

Modeling is usually organized in clustered stages, which generally correspond to: the development of a model of organizational objectives; creating, refining and evaluating options; developing an action plan. However, decision stages need not be followed in a linear succession, but rather, the participants can move between stages.

From a technological point of view, modeling of decision-makers cannot be a sophisticated activity that calls for a workshop and does not necessarily require software to support it [3]. Simple modeling can also be implemented with the help of your computer. In this case, specialized software is used to support processes [1]. This type of software allows rapid model creation and real-time computation [3].

Some programs, such as Group Explorer (www.banxia.com) and VISA Groupware (www.simul8.com/products/visagroup.htm), allow participants to directly and anonymously submit their views on a decision-making issue.

Then the system is operated by a modeling engineer who analyzes the data according to the group's wishes. Once a decision model is built and stored in the system, multiple analyzes can be performed.

The previous discussions clarify that the modeling of the decision-making facility differs from the standard modeling of decisions. This requires a decision analyst capable of supporting a process of building group models. Group models must be participative, interactive, scenic, nonlinear, and supported by appropriate technology. And at the same time, the decision maker and his approach must respond to the dynamics of group work and the particularities of the situation [57]. The next section explores the continuation of what is needed to become a decision maker.

Facilitated decision model

As has already been said, the modeling of decision-making facilities requires the decision-maker to act as a facilitator in the process of modeling and analyzing group decisions. This means that the decision analyst must be prepared to use general facilitation skills as part of his modeling work. Based on the general facilitation literature and Schuman and others we consider three basic facilitating skills necessary to model decision making facilities:

• Active listening requires that the decision analyst can clarify, develop, summarize and refine participants' contributions by paraphrasing and / or reflecting what the participants say; validating what they say without judging;

• Managing group dynamics is probably one of the most fundamental skills for the facilitated modeller. By facilitating active listening, the decision analyst must be able to identify when the difficult dynamic of the group occurs during modeling and be treated as group situations that must be treated supportively. The difficult dynamics of the group also require the decision analyst to know if, how and why to intervene during the modeling process.

• Closure is a key skill that a facilitated decision maker uses to help the group reach out on the way forward. This assumes that the decision analyst identifies when the group has reached a point, from "playing" to the decision model, requiring closure to a proposal, and reaching a required decision model [55].

4. CONCLUSIONS AND PROPOSALS

The multi-criteria decision analysis (MCDA) has been widely used to support highly complex decisions. The MCDA has been used in both public and private organizations. We believe there is an excellent opportunity for MCDA to support strategic workshops. Given their usefulness nowadays, in these workshops, organizations shape their strategic vision, develop strategic options, and evaluate strategic choices.

In this paper we proposed a framework to use the multi-criteria decision analysis to support strategic decision-making in workshops. The framework is from our practice as decision makers in giving strategic decision support to a wide range.

There are two main issues to be addressed by the decision-maker if we want to support strategic decision-making processes. The first would be to related the content issues, particularly with regard to uncertainty, multiple organizational goals and complex policies. The key issue is the development of robust strategies against multiple scenarios. The second aspect would be related to the process, in particular being an active listener. Dealing with group dynamics and helping the group to reach its goal is a key factor in realizing the objective.

We acknowledge that further research on this issue needs to be carried out, which could allow for further development of this framework. In particular, we suggest the following directions for further research:

• Robustness - Several studies on the robustness of strategic options are required in several scenarios;

• The design of complex policies - the structure of policies composed of interconnected options is an almost unexplored area.

• Long-term consequences - this is an area open to research by MCDA, and developments in other areas.

• Impact of decision-making on the strategy process - there are already some systematic research on the impact of the decision-making conference on the group's results; given the special nature of the strategy workshops, it would be interesting to assess the impact of the framework.

Given the importance of the strategic decision-making process for the survival of any organization, further developments in this area could not only bring research opportunities to the various challenges I have outlined here, but also have a real impact on MCDA practice.

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