

# Scrutinizing the Analytic Hierarchy Process (AHP)

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## INTRODUCTION

Human beings make daily decision making, in which several criteria are involved. The mathematical techniques used to deal with these types of problems are known as multicriteria models. The need to address these problems with multiple criteria has allowed the development of Multiple Criteria Decision Making (MCDM).

MCDMs are found in many fields of human endeavor. Just to mention a few, it has: Industrial maintenance problems (Bigaud, Thibault & Gobert, 2016); Turbine installations (Kolios et al., 2016); Credit evaluation for internet finance companies (Gu et al., 2017); Sustainable renewable energy development (Kunar et al., 217); Evaluation of mutual funds (Mimovic, Jakšić & Leković, 2017); Wind power plant (Ghobadi & Ahmadipari, 2018); Location for a small hydro power project (Patel & Rana, 2018); Location planning of urban distribution center (Sopha, Asih & Nursitasari, 2018); Energy efficiency in automotive engineering (Castro & Parreiras, 2020). And even techniques for group decisions have been developed. (López-Morales & Suárez-Cansino, 2017).

Just as there are multiple applications, MCDMs are made up of a large number of techniques, in particular Wałróbski et al. (2019) list more than forty of them, some, as are the case of ELECTRA and PROMETHEE, contain multiple variants.

Within this wide list, they can be highlighted, following mainly (Kolios et al., 2016): in addition, from ELECTRA and PROMETHEE, to AHP, ANP, DEA, SMART, TOPSIS, VICOR, WPM, WSM and some combinations of some of these methods with fuzzy set.

Additionally, two extremely simple and intuitive methods, but they produce very robust results, should be highlighted. Both are a combination of Weighted Sum Method (WSM), with a slight contribution of Weighted Product Method (WPM). These two methods, presented by Hernández, Hernández & García (2018), are the Matrixes Of Weighing with multiplicative factors (MOWwMf [MDPcFm]) and the Multiattribute Models with multiplicative factors (MMwMf [MMcFm]).

On the other hand, a definition of a MCDM is a procedure that combines the performance of decision alternatives across several, contradicting, qualitative and/or quantitative criteria and results in a compromise solution (Kolios et al., 2016). But Dahdah et al. (2021) point out, relying primarily on Kumar et al. (2017), MCDM is a branch of operations research that aims to find optimal results in complex scenarios that include various indicators, objectives and contradictory criteria. If this last statement is

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taken into account, any technique that does not allow an optimal result to be obtained, under the conditions indicated, cannot be considered an MCDM.

In this sense, if it pays a little attention to the Analytical Hierarchical Processes (AHP) technique.

The analytic hierarchy process (AHP), also analytical hierarchy process, is a structured technique for organizing and analyzing complex decisions, supported by mathematics and psychology, which is based, mainly, on paired comparisons. On the other hand, the technique derived from it, Analytic Network Process (ANP), can be defined as a more general form of the AHP. The main difference between the two techniques is that AHP structures a decision problem in a hierarchy, while the ANP structures it as a network. Since ANP is an extension of AHP, this second technique inherits all its flaws. Therefore, in this chapter the focus will be mainly and almost exclusively on AHP.

Before continuing, it should be noted that in the literature on mathematical models AHP is presented, as one of the most used techniques for decision making, where multiple criteria intervene. However, in this work, it will be shown that it is necessary, for researchers who make use of this technique and its derivative the ANP, to reflect on the axioms that support it. Since a slight review of them, shows that AHP and therefore ANP, have unsalvable operational failures, which should rule out their use as MCDM techniques.

Despite this last statement there is no denying the great boom, which, over the years, has had this technique of hierarchy, in a part of the scientific community.

If it attends to what was said by Chaudhari, Wasu & Sarode (2020), Saaty developed the AHP at the Pennsylvania University, between 1971-1975. Although the authors of this chapter are not in capacity to certify this. But, if it can cite works by Saaty that evidence the presence of the subject in years very close to these dates (Saaty, 1977; 1979a; 1979b; 1980; 1989; 1991).

Additionally, in his book of 2010 (Saaty, 2010), there are citations to the work of the same author and other authors, where reference is made to the subject, of dates close to those previously mentioned (Belton & Gear, 1983; Dyer, 1990; Dyer & Ravinder, 1983; Harker, 1987; Saaty, 1990; 1996; Saaty & Alexander, 1989; Saaty & Forman, 1993; Wind & Saaty, 1980; Zahir, 1996), some of these quotes come from renowned researchers and published in very prestigious journals.

But the appointments to the AHP, do not remain only in the last century. In more recent years, to name but a few, it can mention the works of: Boutkhoum et al. (2021); Chaudhari, Wasu & Sarode (2020); Ghosh & Kar (2018); Guarini et al. (2017); Hassanpour (2021); Mitjans & Méndez (2020); Panwar et al. (2019); Ristanovic, Primorac & Kozina (2021).

In addition, works by some authors, who have been directly or indirectly critical of AHP and its derivative ANP (Csató, 2017; 2018; Kumar et al., 2017), and others who have been highly critical (Dahdah et al., 2021; Hernández & García, 2018a; 2018b; Hernández, García & Hernández, 2014), as well as some who, at last, have dared to acknowledge and speak publicly about their many faults (Munier & Hontoria, 2021).

In this work there will not be an in depth research on AHP, it will be enough a cursory review of its main axioms, to reach the conclusion that this technique has structural flaws, which should deny its use as a technique of MCDM.

As pointed out by Dahdah et al. (2021) relying on several authors (Hernández, García & Hernández, 2014; Kadoić, Redep & Divjak, 2017; Marković, Kadoić & Kovačić, 2018; Saaty, 2010; Saaty, 2016; Stanković et al., 2017), in general, when talking about axioms of Saaty, reference is made to: Reciprocity, Homogeneity and Synthesis, however, it is impossible to speak, nor to use AHP, without mentioning Consistency, which comes to work, practically, as a fourth axiom.

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