The Myth of the Importance of Consistency in Analytical Hierarchical Processes

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ABSTRACT

In this work, rather than relating different areas of knowledge, the authors make use of logic, which is intrinsic to mathematical models. They discuss one of the fallacies that hides behind the analytic hierarchy process (AHP). In particular, the analysis of the consistency index, sometimes referred as the Saaty consistency or simply the consistency, will be discussed. The AHP is based on three fundamental axioms: reciprocity, homogeneity, and synthesis. However, it gives a great relevance to consistency, which is managed like a fourth axiom. On each of these four axioms, some comments will be made. However, this work will focus mainly on discussing the importance of the consistency index, to which, undoubtedly, a large number of essays and many hours of work have been devoted. In trying to answer the question, the calculation of consistency is really important. The aim of the paper is to raise a discussion of one of the fallacies that hides behind the analytic hierarchy process and present a simple and direct way to handle Saaty consistency.

KEYWORDS

Analytic Hierarchy Process (AHP), Axioms, Consistency, Multicriteria Models, Paired Comparisons

INTRODUCTION

In late March and early April 2020, to get a better idea of the use of the term Consistency, a search for articles was made on Google Scholar, with the following entries: consistency Hierarchical Analytical Processes (440,000); consistency Analytical Hierarchical Processes (427,000); consistency Analytic Hierarchy Process (419,000); Analytic Network Process (2,500,000); Multiple Criteria Decision Making (3,810,000); "Analytical Hierarchical Process" (9,260); "Analytic Network Process" (33,200); "Analytic Hierarchy Process" (203,000); "consistency"; "AHP" (87,500); "consistency"; "HAP" (147,000); "consistency"; "Saaty" (40,000); "MCDM" (70,500); "MCDM"; "Analytic Hierarchy Process" (29,400). The numbers in parentheses represent the approximate number of results available. Finally, if it searches directly on Google: consistency Analytical Hierarchical Processes there are more than 63 million entries.

Note that Analytic Network Process (ANP) and MCDM have been included in this search. The reasons are, because ANP is an extension of AHP and because AHP is considered, in a large number of works, a Multiple Criteria Decision Making (MCDM) technique. Although neither ANP nor MCDM they were included in the title of this work. Obviously, from what was stated in the previous sentences, this work also covers these two topics.

Additionally, it was searched in Research Gate: "consistency"; "Analytic Hierarchy Process", which stopped counting after having found five hundred and ninety-three articles that in their title included one of the two expressions of the search. This implies that the number of articles included in this database of scientific articles, which refer to Consistency and the Analytic Hierarchy Process, is quite a considerable number.

As it can see, all these searches are related to the Consistency Index, or the Consistency of Saaty, as it is mentioned on many occasions.

Without pretending to say that this is a scientific conclusion, what can be deduced from all these ciphers is that Consistency and the Analytic Hierarchy Process have been exhaustively studied.

The authors of this work have also been attracted by the study of the Consistency (from now on, it will simply speak of Consistency, to refer to Saaty Consistency, unless it is necessary to make some additional clarification).

As a consequence of this permanent study of Consistency, there are many approaches and methods that have been created with the intention of introducing improvements on the estimation of the same. Considering only the work of Kou et al. (2016), when taking into account the scales of measurement they mention, that, among others, it can find proportional, geometric and logarithmic scales.

In addition to the different scales of measurement, Kou et al. (2016), point out other relevant aspects, highlighting that the relationship between comparison judgments can be multiplicative, additive or undefined (fuzzy). For these different kinds of relationships, different types of consistency (or inconsistency) indices are generated, such as: Index of determinants, Squared differences index, Geometric Consistency Index, Harmonic Consistency Index, Relative error index, Multiplicative geometric consistent index, by just pointing a few of the many existing.

Of this large number of methods to assess Consistency, in addition to those mentioned in the previous work quoted, it can highlight the Cosine Consistency Index (Khatwani & Kar, 2017), Cosine maximization method (Kou & Lin, 2014), Intuitionistic fuzzy preference relation (Zhang, Xu & Liao, 2018), Logarithmic Least Squares Method) (Csató, 2018), or The nearest consistent matrix (Lin, Kou & Ergu, 2013).

Moreover, Liu et al. (2017), talk about six characteristics that a good consistency (or inconsistency) index must meet: Consistency must be represented by a single element; variations should not be presented when permuting alternatives; Monotonicity under reciprocity-preserving mapping; Monotonicity on single comparisons; continuity and does not change if the preferences are reversed. Very similar characteristics are also indicated by Mazurek (2017).

For all the above it is interesting to try to define what is Consistency. Starting from a text, which tries to teach the basics of Analytical Hierarchical Processes (AHP), Mu & Pereyra-Rojas (2017), point out that after the "experts" (the quotes are ours) have issued their judgments, it is necessary to verify that they are consistent.

Immediately, Mu & Pereyra-Rojas (2017), go on to try to present what Consistency is through an example. In this one they clarify to the reader that if an apple is preferred 2 times more than a pear and the pear is preferred 2 times more than an orange, then the apple should be preferred 4 times more than the orange.

From the previous example of Mu & Pereyra-Rojas (2017), about apples, pear and oranges, a couple of very interesting aspects can be found, the first one being the only thing that that Consistency measures is the transitivity, in this case the judgment issued by the "expert". The fact that Consistency measures transitivity is reinforced by Brunelli (2016a), who speaks of transitivity / rational. Although this same author in other work, (Brunelli, 2016b), separates the concepts of consistency and transitivity,

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