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# Prospective analysis of public management scenarios modeled by the Fuzzy Delphi method

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**Abstract.** In the Latin American region, public management systems are driven almost exclusively by a formal mechanism. This is a difficulty when implementing study methodologies that provide objective data for the analysis and evaluation of the effectiveness, relevance and sustainability of the policies established by the states governments. Given that the political-social contexts of each nation determine a series of subjective and imprecise factors, and that the main officials and social actors that rule the development of strategic plans regarding public services are inscribed within a certain reality for internal and external incidents; a neutrosophic analysis of the fuzzy, gray and / or undefined zones of the relations between the political system and the administrative system becomes evident. Neutrosophy, as a discipline that studies undefined areas between opposing ideas or sentences, offers a theoretical framework suitable for the analysis of the previously described problematic. This article summarizes a prospective analysis of public management scenarios, developed through the Fuzzy Delphi method, in order to detect the main difficulties faced by current public management mechanisms and propose solutions accordingly. For this, it relies on a survey conducted in Argentina to officials of the Administration sector. A fuzzy approach to improve public management, methodological applications even case. Buenos Aires: University of Buenos Aires. School of Economics.

**Keywords:** Neutrosophy, Fuzzy Delphi method, neutrosophic analysis, public management, prospective analysis, Government Administration.

## 1 Introduction

The strategies that model public management [1], arise from the interaction between the political system and the administrative system of the states. It is in this interaction where spaces of power are produced with gray areas, which determine the success or failure of the set objectives. It is necessary, therefore, to study the way in which the processes of identification, elaboration, implementation and evaluation are modeling the social management within the political systems.

In Latin America, the public management[2] model is strictly formal, giving way to limitations in the control of the use of real and economic resources of nations. The lack of analysis in the previously defined areas of power, suppresses, in most cases, the obligation to be accountable for the objective results that are achieved and compare them with those that each government assumes to offer.

On this basis, the following issues can be defined as elements that make the optimal performance of public management impossible:

- Poor research, which leads to a lack of transparency in the role of the State.
- Inadequate management of the budget by Congress, which instead of managing their assets as a producer and provider of social services, is centered on approving the requested expenses.
- Centralization, both in the regulations, and in its implementation
- Lack of motivation of public administrators and little or no recognition of efficiency in social management.
- Theoretical approaches that are not able to be corroborated in practice, as a consequence of a legal and juridical system that proposes objective changes, based on a conceptual basis.

The previous difficulties give way to a methodology that is separated from the daily practice. Consequently, an analysis, that proposes new solutions for the social claim of adapting the management model of public organizations, it's needed. It is crucial to establish follow-up and evaluation actions that lead to transparency and viability of public programs and resources, adopting flexible and renovating positions.

The present investigation shows a prospective analysis of the scenarios from which public management is articulated, in order to propose viable solutions for its implementation in the Latin American context, taking as a sample the Argentine society and as a fundamental basis the most recent studies in the field of Neutrosophy[3] .

The models related to the economic State policies and the microeconomic decisions of the companies offer a simplified representation of reality. They do not reveal in detail the economic and social complexities, because they are unlimited.

Neutrosophy proposes an analysis of neutralities [2], taking into account the spectrum of neutralities <Neut-A> between an idea or notion <A> and its opposite or negation <Anti-A>.

The sentences <Neut-A> and <Anti-A> are considered <Non-A> and each idea or notion <A> must be balanced or "neutralized" by the ideas or notions <Anti-A> and <Non-A >

Given that the analysis relevant to the present investigation presents vague or imprecise edges, the consensus between <A>, <Neut-A>, <Anti-A> and <Non-A> is analyzed, through a study supported by the fuzzy model [4].

Finding a balance between the political system and the administrative system requires a search within undefined spaces, which is why the Fuzzy model is appropriate for capturing gray areas .

Analyzing from the neutrosophic logic, where each sentence has three dimensions that are represented by a truth space (T), a falsehood space (F) and an indeterminate space (I), the ideas or approaches between 0 and 1, being 1 Positive or Truth (T) and 0 Negative or False (F).

To establish and analyze the statistics, the neutrosophic probability (NP) [4] is used, where a variable, randomly (x) is distributed in the following way: NP (x) = (T (x), I (x), F (x ))

Taking as a starting point the considered primitive terms: set, element-of and element, you can define inclusion and equality. To name sets, uppercase letters will be used, while different elements will be designated with lowercase letters. The "element-of" of an element in a set will be indicated with  $\in$ ; so that if x is an element of A, then  $x \in A$ .

If a set A is included in another set E, then all elements of set A are included in element E and symbolized  $A \subseteq E$ , and E is the universal or referential set.

The number of elements that make up an E set is its cardinal[5]. If E is finite of n elements, then  $\#E = n$

For every element x that belongs to the set E, the basic function would be[6]:

$$\mu_A: E \rightarrow \{0,1\} / \mu_A(x) = \begin{cases} 1 & x \in A \\ 0 & x \notin A \end{cases} \quad (1)$$

According to the above,  $\mu_A(x) = 1$  indicates that  $x \in A$  and  $\mu_A(x) = 0$  indicates that  $x \notin A$ .

$\mu_A$  is the  $\in$  of x to set A. It is called an empty set, and symbolizes  $\emptyset$ , to the sharp set where  $\mu_{\emptyset}(x) = 0$ .

Basic operations between sets (with A and B subsets of E) :

Union of A and B:

$$A \cup B = \{x / x \in A \vee x \in B\} \text{ "v": } \cup$$

Intersection of A and B:

$$A \cap B = \{x / x \in A \wedge x \in B\} \text{ "\wedge": } \cap$$

Complement of A, formed by elements included in the referential, but not belonging to A:

$$\bar{A} = \{x \in E / x \notin A\}$$

Summarizing; if  $x \in A$ , then  $x \notin \bar{A}$ , and vice versa, if  $x \notin A$  then,  $x \in \bar{A}$ ; so that  $\mu_A(x) = 1$ , only if,  $\mu_{\bar{A}}(x) = 0$ .

In addition, in the Union set, the value of the  $\in$  function will be the largest of the elements that correspond in each set, that is, the greater between  $\mu_A(x)$  and  $\mu_B(x)$ .

On the contrary, in the Intersection set, the value of the  $\in$  function will be the smallest of the corresponding elements in each set, that is, the lowest between  $\mu_A(x)$  and  $\mu_B(x)$ .

In correspondence with the above definitions, the operations specified for the clear sets can be represented symbolically through the characteristic function (valid for any set A, B and C included in a reference E)

$$\mu_{A \cup B}(x) = \max \{ \mu_A(x), \mu_B(x) \}$$

$$\mu_{A \cap B}(x) = \min \{ \mu_A(x), \mu_B(x) \}$$

$$\mu_{\bar{A}}(x) = 1 - \mu_A(x)$$

## 2 Material and methods

Given the implicit need to manage the data compiled prospectively, touching the gray areas where the interaction of the political instrument with the administrative one converge and derive in much more relative information, it has been decided to use the Fuzzy - Delphi method [5,6].

This methodology allows us to analyze complex problems outside the Aristotelian logic of positive and negative. In this way, it is possible to establish a system of statistics on arguments that are included within the <Neut-A> and at the same time structured on the basis of a predictive procedure.

To the basic functions characteristic for sets A, B and C, which are included in a reference E, an analysis based on fuzzy subsets will be applied. In this way, the intervals between "∈" and "∉" will be analyzed; "true and false". The basic function will be generalized to take any real value included in the interval [0, 1].

According to the above, in a universe or referential E, a fuzzy set, represented symbolically by  $\tilde{A}$ , is a function  $\mu_{\tilde{A}}: E \rightarrow [0, 1]$ . Therefore, it assigns to each element of the set E a value  $\mu_{\tilde{A}}(x)$  belonging to the interval [0, 1] a degree or level of ∈ from x to  $\tilde{A}$ .

The symbol  $\sim$  will be adopted to indicate a fuzzy set. The support of a fuzzy subset  $\tilde{A}$  of E is the sharp set that contains all the elements of the reference E whose membership function is non-zero:  $S(\tilde{A}) = \{x \in E / \mu_{\tilde{A}}(x) > 0\}$

If E is infinite, the fuzzy subset is expressed by its ∈ function.

The fuzzy subsets  $\tilde{A}$  and B of the same referential E are equal if the values of their membership functions[7] are the same:

$$\tilde{A} = \tilde{B} \leftrightarrow \forall x \in E: \mu_{\tilde{A}}(x) = \mu_{\tilde{B}}(x) \tag{2}$$

In addition,  $\tilde{A} \subseteq \tilde{B}$  if all values of the membership function  $\tilde{A}$  are equal to or less than the corresponding values of B:

$$\tilde{A} \subseteq \tilde{B} \leftrightarrow \forall x \in E: \mu_{\tilde{A}}(x) \leq \mu_{\tilde{B}}(x)$$

$$\text{It is called the level set } \alpha \text{ of } \tilde{A} \text{ to the sharp set } A_{\alpha} = \{x \in E / \mu_{\tilde{A}}(x) \geq \alpha\} \tag{3}$$

Using this technique, an analysis will be carried out for several cases of planning of public budgets in Argentina, building research from a fuzzy zero base-budget. This last element allows to work with data that have a certain degree of uncertainty, coming from referential estimations of experts in the subject. The use of non-linear thresholds and non-triangular fuzzy numbers is then valid.

The information provided by the sample of experts will define, internally and externally, the operation of the allocation and distribution of resources in different public order managements, at a sector level. For the present analysis, we will take a sample in the sector "Government Administration".

The material will be studied under the premise that, both the practical implementation of the directives oriented and the results obtained, will have a certain degree of intensity in their realization and in the fulfillment of their objectives respectively, always within the categories of minimum, median and maximum activity.

To calculate the distance between the fuzzy numbers, we will use Kelley's definition[8] as a basis to delimit a distance or pseudometric of a set X as the function d of the Cartesian product X x X in the non-negative real numbers, such that for every element x, y, z ∈ X, is verified:

$$d(x, y) = d(y, x)$$

$$x = y \rightarrow d(x, y) = 0$$

$$d(x, y) * d(y, z) \geq d(x, z) \text{ (triangular inequality)}$$

where \* according to Kaufmann and Gupta [9] is an operator associated with the notion of distance. The real number d(x, y) is called the distance from x to y. If in addition  $d(x, y) = 0 \rightarrow x = y$ , then the function d is metric.

The distance between two continuous fuzzy numbers  $\tilde{A}$  and B of  $\mathbb{R}$ , expressed by  $\alpha: A_{\alpha} = [a_1(\alpha), a_2(\alpha)]$  and  $B_{\alpha} = [b_1(\alpha), b_2(\alpha)]$ , is obtained generalizing the distances to the left and right of the intervals for all values  $\alpha \in [0, 1]$ . (Figures 1 and 2)

If  $(a_1 - b_1) (a_2 - b_2) \geq 0$ , there is no intersection between the lines to the left

This distance is the area of the region indicated in Figure 1, which can be obtained by the sum of two defined integrals, called respectively, distance to the left and distance to the right:

$$d_l(\tilde{A}, \tilde{B}) = \int_0^1 |a_1(\alpha) - b_1(\alpha)| d\alpha$$

$$d_r(\tilde{A}, \tilde{B}) = \int_0^1 |a_2(\alpha) - b_2(\alpha)| d\alpha$$

$$d(\tilde{A}, \tilde{B}) = \int_0^1 |a_1(\alpha) - b_1(\alpha)| d\alpha + \int_0^1 |a_2(\alpha) - b_2(\alpha)| d\alpha$$

Figure 1

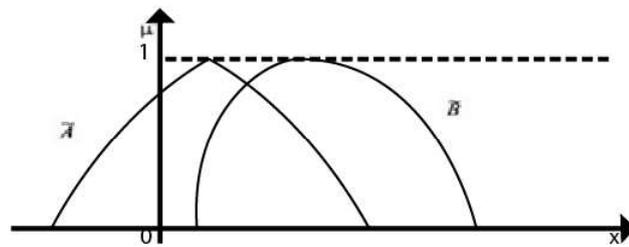


Figure 2

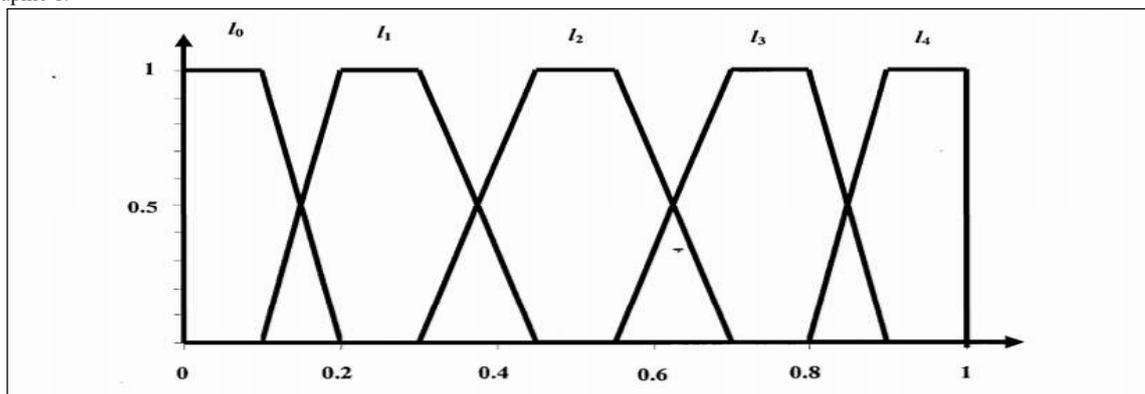
Through the aforementioned methods, it is feasible to determine responses to problems that include the human factor, inseparable from intrinsic variability and flexibility. Making the Fuzzy - Delphi an adequate option for the improvement of public management [9].

To process the information collected, the semantics specified in Table 1 were used, using in all cases a set of five cardinal terms. Its representation is shown in Graphic 1.

Table 1:

Label	Meaning	NBTr
I4	Very high	(0.80, 0.90, 1.0, 1.0)
I3	High	(0.55, 0.70, 0.80, 0.90)
I2	Neutral	(0.30, 0.45, 0.55, 0.70)
I1	Low	(0.10, 0.20, 0.30, 0.45)
I0	Very low	(0.0, 0.0, 0.10, 0.20)

Graphic 1.



The opinions of the experts who carried out the survey cannot be accurately reflected, given their high degree of subjectivity and the characteristic uncertainty of the political-social environment.

The fuzzy method has provided the necessary flexibility to model the numerical information in decision problems [10]. On the other hand, the diversity of the language and the form of expression of each subject of the sample can be represented and classified.

The questionnaires are applied to the Government Administration sector.

### Results:

- Once the surveys were analyzed and processed, the following results were observed:
- In accordance with the approaches that meet the needs of the population, the definition of public policies is neither correct nor incorrect.
- The personnel in charge of delimiting public policies have limited information on the social and sectorial context.
- The objectives of public management in the Government Administration sector are undefined and inadequate.

- There are no metric models to check and analyze these objectives according to their efficiency, effectiveness, results, sustainability and impact.
- Government Administration sector policies partially comply with their priorities
- The objective assets of the Government Administration sector are barely adequate.
- Policies aggravate the internal regional imbalance of the State
- The policies of the Government Administration sector do not tribute to improve the economy at the international level.
- The policies of the Government Administration sector do not improve or worsen equity and regional growth
- The legislative framework of the Government Administration sector is not well defined.

### 3 Discussion

In response to the results obtained by the surveys, the public management developed by the Government Administration sector does not fully satisfy the needs of the population in the corresponding context. Among its main deficiencies, the lack of policies that contribute strategically to economic and social development [11] in the international framework and the lack of cohesion between the regions stands out. The latter is due to a scant analysis of the particularities of each territory when formulating a relevant policy.

As an immediate solution, it is proposed, in the first instance, to achieve an appropriate knowledge of the environment and a planning of changes by stages, defining deadlines and evaluating the viability of each policy or measure to be implemented.

It is important that joint work is carried out with the other sectors (Agriculture, Education and Culture, Energy, Industry, Promotion and Social Assistance, Water Resources, Drinking Water and Sewerage, Health, Transport, Housing and Urban Planning) to achieve the articulation of a sustainable mechanism and coherent implementation.[12]

The Government Administration sector must pursue long-term sustainability, with the support and consensus of the strategic plans of the State. For this, he needs goods that allow him to satisfy his needs; therefore, it must have a greater budget and control of the continuity and efficiency of its policies.

It is proposed to periodically make reports and inform the other sectors of reports on their project needs. It is also suggested to assess the level of urgency of the needs and implement trained structures, with procedural manuals correctly designed to analyze decisions.

### Conclusions

After the analysis of the survey carried out in a sample corresponding to the Government Administration sector, the need to conceive new policies for public management was implicit. These must be based on a consensus among the different social actors and be based on the sustainable practice of a coherent and consistent framework with the different sectors that make possible the implementation of a plan for state management.

The results obtained by the neutrosophic analysis of the acquired data, evidence the lack of a progressive projection in the management of the Government Administration sector, so that it is suggested to work on the development of a plan with a view to economic growth and an opening to the international context.

The creativity, renewal and modernization of the analyzed sector emerge as essential aspects that should shape public management in the future, because only through them will be able to solve the problems of deficiency in the interaction between the political system and the administrative system of the State.

The need to study in depth the implementation of a plan that includes all sectors involved in public management is implied, as an alternative to the formulation of a new state plan that effectively addresses the main deficiencies in government and legislative State policies.

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