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Analysis of Institutional Performance in the Public Function of the Departments in Colombia by Clustering and Artificial Neural Networks

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Abstract

One of the central functions of the Administrative Department of Public Administration in Colombia is to evaluate and promote institutional performance in the field of public administration. In this context, the purpose of this study is to analyze the institutional performance achieved by the 32 departments that make up the Colombian territory during the year 2023. For this purpose, a cross-sectional, descriptive and quantitative methodology was implemented, supported by advanced clustering techniques and artificial intelligence neural networks. These tools made it possible to classify the departments into homogeneous cluster profiles and project their institutional performance, based on the results of the measurement carried out by the Administrative Department of the Civil Service within the framework of the Integrated Planning and Management Model (MIPG). The findings of the study revealed the existence of four institutional performance profiles, which reveal notable regional disparities. In quantitative terms, 62.5% of the departments recorded a performance rated between good and excellent, with an average score of 85.5 out of 100. On the other hand, the remaining 37.5% obtained an average rating of 64.3 out of 100, which places them in a range of low to regular performance. These differences underscore the heterogeneity in institutional capacity and the effectiveness of public management at the departmental level. The results of this research have significant implications for public management in Colombia, as they not only identify institutional performance profiles, but also highlight the critical variables that influence these results. This information is fundamental to guide decision-making, focus efforts and design public policies that promote continuous improvement of departmental administration. The study also contributes to reducing regional gaps and strengthening governance in the country, which represents progress towards more efficient, transparent and equitable public management.

Key words: public efficiency, public function, clustering, artificial neural networks, institutional performance.

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1. Introduction

In Colombia, the 1991 Political Constitution set a new course in terms of transformation and efficiency in the management of public institutions. This fundamental charter proposes profound changes aimed at strengthening social, economic and environmental policy, based on inclusion, justice, equality, territorial planning around water, human security, the right to food, productive transformation, regional convergence, internationalization and climate action.

In this sense, the fundamental purpose of the Magna Carta is articulated with the National Development Plan-NDP 2022-2026, "Colombia World Power of Life", in which the National Government defines the roadmap to promote Colombia to become the leading country in the global struggle for life, nature and humanity. This plan constitutes the new social contract and the opportunity to achieve the Government's great objective of total peace, with which the differences marked by injustice, inequality and exclusion can be overcome and the armed conflict that has plunged Colombia into violence, hopelessness and poverty can be avoided.

This transformation towards the search for total peace proposes access to new opportunities for goods and services for all Colombians, as well as equitable gender participation, for a better integral wellbeing and improvement of the quality of life of the inhabitants, with a territorial differential approach, in order to achieve the reduction of the marked social and economic gaps in households and territories. To achieve this change in the country, strong public institutions are required, with human capacities and technical and legal instruments that meet their development objectives and respond to the needs and expectations of citizens.

Therefore, the purpose of this research is to analyze the results of the Institutional Performance Index (IDI), within the framework of the Integrated Planning and Management Model (MIPG), of the public management processes of the 32 departments of Colombia for the year 2023, through the application of clustering models and Artificial Neural Networks (ANN).

The analysis of characteristic profiles or clusters of civil service performance of Colombian departments based on the Institutional Performance Index can provide valuable results to evaluate and project the performance and efficiency of Colombia's 32 departments. In this context, the following research questions arise: Is it possible to identify characteristic profiles of the performance of the public function of Colombian departments based on the results of the institutional performance measurement? How to identify the key variables in the improvement and efficiency of the public function of Colombian departments? How to project the performance and efficiency of Colombian departments? This research seeks to answer these questions through a cluster analysis and the use of artificial neural networks, with the objective of providing useful information that can guide policies for improving the efficiency of institutional management in the civil service in Colombia.

The methodology applied in this research was based on a logical positivist epistemological model, with a propositional approach, through a descriptive and quantitative cross-sectional study, applying the clustering and ANN models, based on the results of the IDI measurement carried out by the Administrative Department of the Public Function in Colombia within the framework of the MIPG. The data used correspond to the information recorded in the year 2023 by 32 governorships of the departments of Colombia.

The article is structured in an organized and coherent manner, following a logical sequence that facilitates understanding and analysis of the topic addressed. First, the introduction is presented, which contextualizes the research topic, highlighting its relevance and establishing the objectives and the research problem question. In the second section, the theoretical framework is developed, which constitutes the conceptual basis of the article, in which the key meanings necessary to understand the development of the theoretical review of the literature are defined and explained. The third section describes the methodological aspects, detailing the clustering and ANN research method, explaining clearly and precisely the tools, techniques and procedures used to collect and analyze the information. In the fourth section, the article focuses on the discussion and findings, analyzing the results obtained in relation to the problem questions posed at the beginning of the research. Finally, the last section of the conclusions is

presented, which summarizes the most relevant findings reached after the analysis of the data and the theoretical and practical implications of these results, highlighting their contribution to the field of study.

2. Theoretical Framework

2.1. Background and regulations of the Civil Service in Colombia

The Administrative Department of the Civil Service (DASC) in Colombia was created in 1958 by Law 19, with the purpose of providing the public administration with an agency in charge of managing the personnel in the service of the State. In 1992, on December 29, 1992, the Government issued Decree 2169, which substantially modified the role of the DASC, entrusting it with the formulation of policies and advisory services in matters of organizations, administration and management of human talent, as well as changing its name to Administrative Department of the Public Function (ADPF). Subsequently, in 1999, Decree 1444 was issued, and the ADPF was modified, according to the provisions of Law 489 of 1998, in relation to the generation of policies on internal control, streamlining of procedures, administrative development, information systems and the public administration's success bank. In September 2000, by means of Decree 1677, the ADPF was restructured once again, assigning it the functions of formulating general public administration policies. For the year 2016, the ADPF, through Decree 430, determines as its object the strengthening of the capacities of public servants and of the entities and agencies of the State. And the current structure of the ADPF is modified by Decree 666 of April 25, 2027, which creates the Communications Advisory Office, responsible for implementing the policy of internal and external communication and strategic relationship of the Public Function [1], [2].

This modern agency of the Civil Service is projected as a transforming entity for peace building, with a new institutional management model that facilitates the application of public performance measurement tools and the control of institutions, with the purpose of consolidating efficient, innovative and institutionally strengthened public entities at the national and territorial levels [3].

2.2. Public Service in Colombia

The Public Function in Colombia is the set of activities, rules and principles that regulate the management of the State, ensuring the efficient and transparent delivery of public services, the management of resources and the fulfillment of the essential purposes of the State. This function is integrated by entities such as the Administrative Department of Public Function (ADPF), the offices of governors, mayors and control bodies such as the Comptroller General and the Attorney General, and is governed by constitutional principles such as equality, transparency, efficiency, morality, speed and impartiality [4].

The characteristics of the civil service include: legality, which ensures that all actions comply with the legal framework; decentralization, which distributes responsibilities among the national, departmental and municipal levels; professionalization, which requires that civil servants have the necessary competencies to perform their duties; and citizen participation, which promotes the involvement of citizens in decision-making. It aims to promote the general welfare, strengthen trust in institutions, and ensure that civil servants act with impartiality and professionalism in the face of challenges such as corruption, administrative modernization, and effective decentralization to respond to the needs of the population and ensure a closer, more effective, and transparent state [5].

The public administration in Colombia works with various agencies and entities to ensure efficient and transparent public administration at the service of citizens. One of these entities is the Foundation for the Promotion of Accountability and Open Government (FPAG), which plays an important role in promoting open government practices, transparency and accountability in the public sector, as well as in promoting accountability and working with the ADPF and other public entities to implement tools and methodologies that strengthen administrative control, efficiency and ethics in public management [6].The modernization of public administration and effective decentralization to respond to the needs of the population and ensure a closer, more efficient and transparent state [5].

2.3. Clustering method

Cluster analysis, an unsupervised machine learning technique, is designed to discern natural groupings within a data set by evaluating the similarities between data points [7], [8], [9], [10]. The underlying principle is to divide data points into clusters such that points in the same cluster are more

similar to each other than points in other clusters. According to [11], [12]. the three subproblems addressed by clustering processes are (i) defining a similarity measure to judge the similarity (or distance) between different items (ii) implementing an efficient algorithm to discover clusters of most similar items in an unsupervised manner and (iii) deriving a description that can characterize the items in a cluster succinctly. Traditional clustering algorithms used Euclidean distance measures to judge the similarity of two data items [13].

In public service research, one of the main applications of cluster analysis is the delimitation of segments by territorial departments. By using the 7 variables associated with the institutional management model that underlie the data collected through the Single Management Reporting and Progress Form FURAG, researchers can discover distinct market segments characterized by unique attributes. In addition, cluster analysis provides a valuable tool for grouping Colombia's departments by institutional performance with differentiated participation profiles. Grouping departments according to their strategic performance in management, efficiency and institutional control.

The clustering study starts with a set of cases or objects, each of which is described by a set of observed variables. The fundamental objective of this analysis is to partition these objects into groups or clusters, so as to maximize intra-group homogeneity and maximize inter-group heterogeneity. In other words, the aim is to ensure that objects within the same cluster show a high degree of similarity in terms of the variables considered, while objects belonging to different clusters exhibit significant differences between them.

From a statistical point of view, this problem can be formulated in terms of variability optimization: the goal is to minimize the internal dispersion within each cluster (reducing the within-group variance), while maximizing the separation between clusters (increasing the between-group variance). This balance between cohesion and separation is fundamental to ensure the validity and usefulness of the partition obtained [14]. Next, we consider the following set of objects or cases from Table 1.

Table 1.
Example set of objects.

	$C1$	…	Ci	…	Ck
$O1$	$X11$	…	$X1i$	…	$X1k$
…	…	…	…	…	…
Oj	$Xj1$	…	Xji	…	Xjk
…	…	…	…	…	…
On	$Xn1$	…	Xni	…	Xnk

Where O={O1,...,On} represents a set of n objects, such as persons, products or entities, each characterized by k variables (also called measures or attributes), such as age, weight, height, gender, race, among others. The objective is to divide O into k clusters, C1,...,Ck, such that the union of all clusters completely covers the original set, i.e., Ui=1 Ci=O. This structure is represented by an n×k matrix, where n is the number of objects and k is the number of variables.

The clustering technique has had multiple applications in different fields of knowledge, authors such as: Fernández et al. [15], designed for the agricultural sector in Cuba, a methodology to evaluate the competency profiles of the managers of the different agencies attached to both the public and private sectors; likewise, Walle et al. [16], in their study identified the main linkages and clusters in the region of Tamaulipas (Mexico), highlighting eight important clusters that contribute to the intermediate consumption demand of the state. For his part, Romero [17], determined the performance classification patterns of public sector spending using the time series clustering technique in the regions of Peru, for the period 2007-2019. And, Cuadron et al. [18], in their research explored the advantages of Large Linguistic Models (LLM) and their adaptation to linguistic and domain-specific data for the European public sector, related to the clustering of promises in the transition route for tourism.

In this public service research, one of the main applications of cluster analysis is the delimitation of segments by territorial departments, carried out by using the variables associated with the institutional

management model that underlie the data collected through the Single Management Report and Progress Form FPAG, researchers can discover different market segments characterized by unique attributes. In addition, cluster analysis provides a valuable tool for grouping Colombia's departments by institutional performance with differentiated participation profiles. Grouping of departments according to their strategic performance in management, efficiency and institutional control.

2.4. Artificial Neural Networks (ANNs)

Artificial intelligence techniques have become an excellent tool for departmental forecasting in one of the institutional performance profiles of the public sector [19], [20], [21]. According to Nespoli et al. [22], forecasting based on ANNs, which has been used in various fields since [23], first published their comprehensive book of many neural network techniques from an engineering perspective, is one of the most effective methods for the projection of institutional performance in the departments or states of any territorial entity. However, Nespoli et al. [22], also highlights some of the main drawbacks of ANNs, such as the fact that they require a large amount of data for the training process, a random initial data set that may reduce the reliability of the predicted results, and the challenge and time required for the accurate development of the model architecture. Nevertheless, different ANN solutions have been investigated for the projection of institutional performance measurement in public sector departments or municipalities [24], [25], [26].

Likewise, other studies have demonstrated the relevance and effectiveness of the RNA technique to explore the potential of rRNA in the form of RNA-based biocontrol agents for external applications with improved environmental profiles [27]. For Puron & Villaseñor [28], the technique of neural network analysis and self-organizing maps has the potential to describe the multi-parametric characterization of multiple metrics and indicators of this phenomenon and its evolution over time [29].

3. Methodology

This research work was developed from a logical positivist epistemological model, a propositional perspective, through a descriptive cross-sectional study and a quantitative approach, based on the results of the institutional performance measurement carried out by the Administrative Department of the Public Function in Colombia within the framework of the Integrated Planning and Management Model MIPG. The data used correspond to the information recorded in the year 2023 by 32 governorships of the departments of Colombia.

Methodologically, the following stages were developed: 1) variable selection and data preparation; 2) cluster analysis; 3) mean analysis and cluster characterization; 4) cluster mapping; 5) development of the ANNs model; and 6) analysis of results and conclusions.

Stage 1. Selection of variables and data preparation. The 7 variables associated with the institutional management model were used as the basis for the data collected through the Single Management Report and Progress Form FURAG, which correspond to: V1: Human Resources, V2: Strategic direction and planning, V3: Management for results with values, V4: Evaluation of results, V5: Evaluation of results, and V6: Management for results with values. V1: Human Resources, V2: Strategic Direction and Planning, V3: Management for Results with Values, V4: Evaluation of Results, V5: Information and Communication, V6: Knowledge Management and V7: Internal Control. The institutional measurement indexes associated with the 7 variables analyzed in the 32 Governorates of the departments of Colombia were obtained, which are valued on a scale from 0 to 100, with 100 being the maximum performance or efficiency. The data of this research work are available in the web page of Public Function [30]. The data were processed and organized for analysis.

Stage 2. Cluster analysis. In this stage, Minitab 19 software was used, chosen for its ease of use, the analysis models available in its interface and the relevance of the output information, which allows a broad evaluation of the relevance and efficiency of the models. The analysis considered 4 cluster models using similarity measures: Euclidean distance, squared Euclidean distance, Pearson and Manhattan. These measures were selected considering previous research results and their ability to capture different dimensions of the variables and their effectiveness in working with the type of data available. The Ward criterion was used as the linkage criterion, which is widely accepted by the scientific community for its sound statistical principles and has been shown in previous research to be a robust criterion for identifying homogeneous, compact and differentiated clusters that minimizes intra-cluster variance and maximizes cluster heterogeneity. Intra-cluster homogeneity and inter-cluster heterogeneity were assessed using the

average distance from the centroids and between the centroids of the identified groups or clusters. To select the best cluster model, the Typing Ratio Index TRI [31] was defined (Eq. 1), based on the minimum value of the indicator.

TRI= Average distance from centroids (intragroup homogeneity/Average distance between centroids (intergroup hetererogeneity)

This index is a proposal based on principles discussed in the literature. The elbow graph criterion was used to determine the optimal number of clusters.

A total of 4 clusters were considered, which were defined using the elbow graph criterion, which evaluates the point at which the distance between clusters increases considerably.

Stage 3. Analysis of means and characterization of clusters. An analysis of means by variables was performed in each of the 4 clusters defined from which the characteristic profiles of institutional performance of the Colombian departments are established and performance levels are set.

Stage 4. Cluster mapping. Next, the four types of clusters identified were identified on the political map of Colombia. For this purpose, Python graphic tools were used, the coordinates of the departments [32] were downloaded, and a graphic code was assigned to identify each cluster.

Stage 5. Development of the ANN model. In order to project the departments in one of the institutional performance profiles, an ANN model was developed. For this purpose, a Multilayer Perceptron architecture was applied using SPSS 21 software. This software was used because of its ease of use, large library of machine learning algorithms that allow efficient data management. The ANN model can project or reclassify the profile of a department in the event of changes in the measurement of the variables considered. Likewise, the ANN model provides a variable importance analysis, which determines the relevance of the variable in the ANN projection model.

Stage 6. Analysis of results and conclusions. Finally, the results were interpreted by identifying patterns and trends in the performance variables in each profile. Conclusions and implications were formulated. This provides a solid basis for analysis and the formulation of management and performance policy recommendations.

The methodological approach addressed in this research allowed a deep understanding of the patterns of Institutional Performance in the Public Function of Colombian Departments, which provides a solid basis for analyzing and formulating public policy recommendations. Figure 1 shows the technical specifications of the cluster model, and the ANN model used for the research.

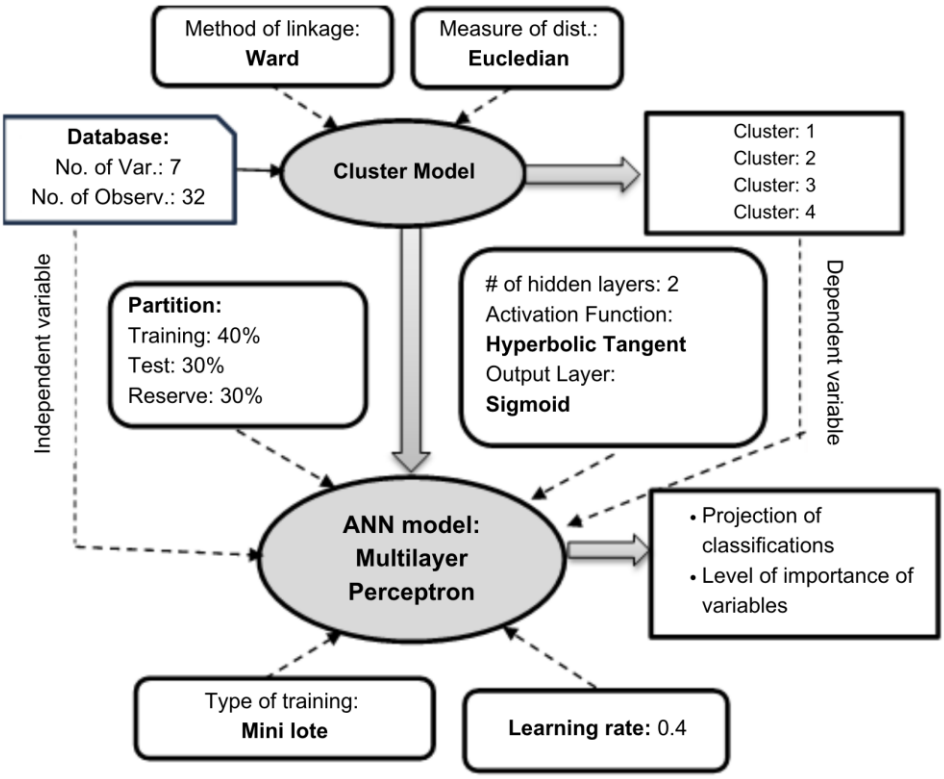

Figure 1. Integrated Cluster-RNA model for analysis of institutional performance of the public function

4. Results

4.1. Cluster Analysis

With the data loaded into the Minitab 19 software, we proceeded to perform the cluster analysis. Four models were run with distance measures and linkage criteria as follows: Euclidean-Ward, Euclidean squared-Ward, Pearson-Ward and Manhattan-Ward. These models were selected considering their ability to capture different dimensions of the variables and their effectiveness in working with the type of data available. It is important to highlight the recognition of the Ward criterion in the scientific community for its solid statistical principles and its capacity to generate homogeneous and differentiated clusters that minimize intracluster variance and maximize the discriminant level of the groupings. With the above, TRI was calculated, observing a tie in the best cluster model: Euclidean-Ward and Euclidean Square-Ward with TRI = 0.3106755 (see Table 1). For the purposes of this research work, the Euclidean Square-Ward model was used.

Table 1:
TRI of the cluster models

Distance	Linkage criteria	Averages from centroids	Averages between centroids	Typifying Ratio Index - TRI
Pearson	Ward	17.20255	42.9338333	0.40067585
Euclidean Square	Ward	16.068525	51.72125	0.3106755
Euclidean	Ward	16.068525	51.72125	0.3106755
Manhattan	Ward	16.12215	50.1524333	0.32146297

To establish the number of clusters, the elbow graph criterion was used (Figure 2). From the graph, 4 clusters were determined for classification, identifying distinctive patterns and regional disparities in the institutional performance of the public function by department.

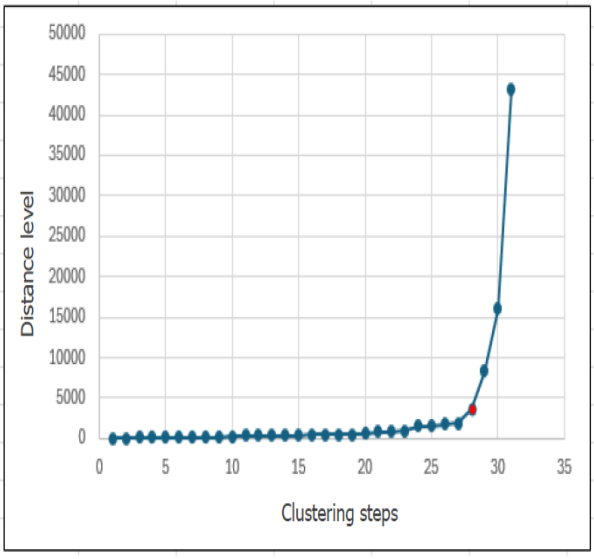

Figure 2.
Elbow graph. Distance level vs. grouping steps.

The dendrogram (Figure 3) shows the hierarchical clustering of the observations, confirming the consistency of the Ward-Euclidean model for profiling the results.

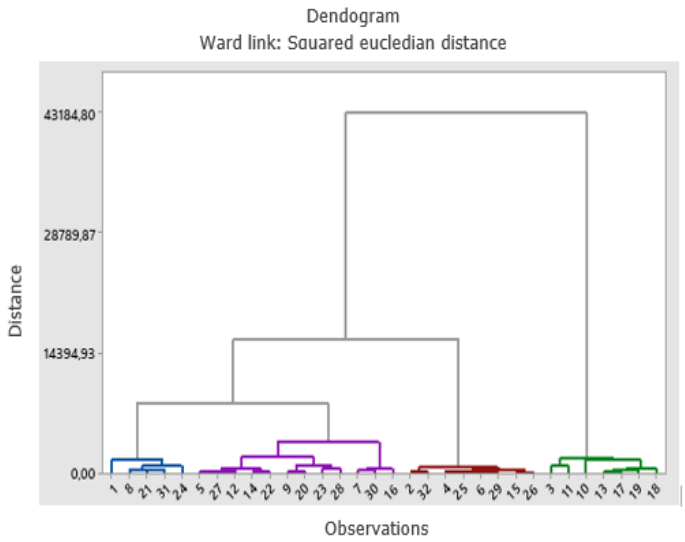

Figure 3.
Dendrogram

*Profiles identified***.** Table 2 shows the classification of Colombia's 32 departments into the 4 profiles associated with the Ward-Euclidean cluster model.

Table 2.
Results of the classification of competency profiles

	Number of Departments	Within the sum of the squares of the cluster	Average distance from centroid	Maximum distance from centroid
Cluster 1	5	1601.43	17.0823	25.3591
Cluster 2	8	810.97	9.7791	13.6195
Cluster 3	7	2685.65	18.8024	26.4619
Cluster 4	12	4566.03	18.6103	27.3146

Table 3 shows the distance between cluster centroids. The magnitude of these distances compared to the average distances from the centroid recorded in Table 2, shows the heterogeneity between the identified profiles.

Table 3:
Distance between centroids

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Cluster 1	0.0000	58.6718	39.2544	34.2825
Cluster 2	58.6718	0.0000	88.4511	31.5294
Cluster 3	39.2544	88.4511	0.0000	58.1383
Cluster 4	34.2825	31.5294	58.1383	0.0000

Next, a mean analysis of the variables was performed for each of the identified profiles. Table 4 shows the characteristic results of the variables in each of the academic performance profiles. Figure 4

illustrates the performance levels in the 4 identified profiles. The best performance levels correspond to values close to 100.

Table 4:
Average score by cluster variable

Cluster	Profile	v1	v2	v3	v4	v5	v6	v7
Cluster 1	Profile 3	65.8	76.7	68.1	76.2	56.4	64.0	73.2
Cluster 2	Profile 1	91.3	95.0	85.8	93.0	82.2	90.5	95.4
Cluster 3	Profile 4	62.2	71.1	63.2	66.9	57.8	26.8	71.7
Cluster 4	Profile 2	83.1	89.2	78.3	86.5	70.5	65.2	90.8

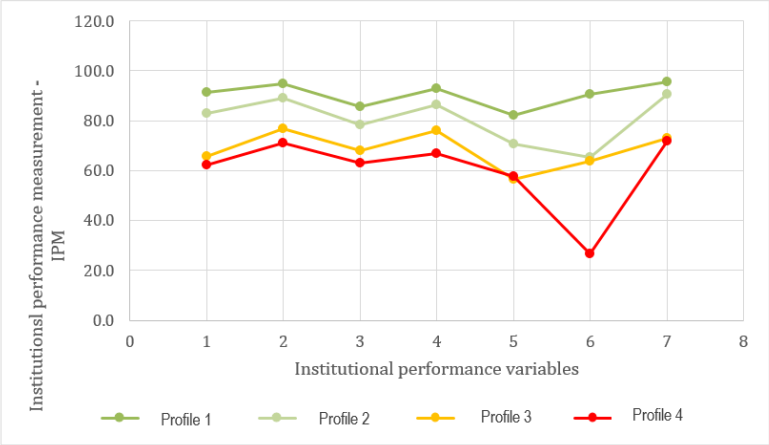

Figure 4 Profiles of Institutional Performance in the Public Function of Colombian Departments

Analysis of the map of Colombia. Figure 5 shows a map of Colombia with four types of markers representing the institutional performance profiles in the public function of Colombia's departments: a) red color (profile 4), corresponding to the departments with the lowest performance profile with an overall average of 60; b) orange color (profile 3), which identifies the departments with regular performance and a rating of 68.6 c) blue color (profile 2), associated with the departments with good institutional performance and d) green color (profile 1), representing the departments with excellent institutional performance.

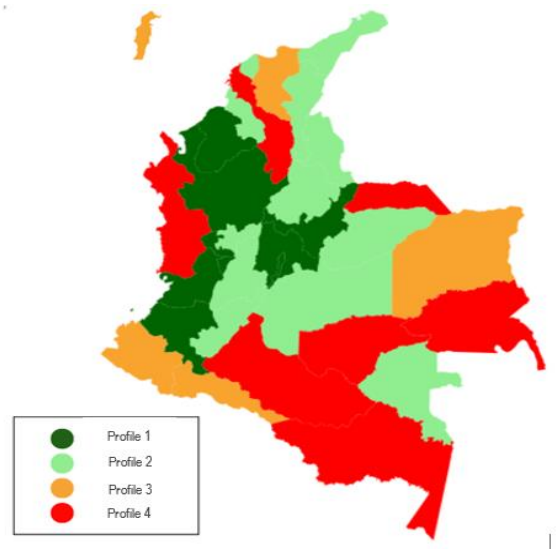

Figure 5 Map of institutional performance profiles in the civil service of Colombia's departments.

Artificial neural network model. To project the membership of future observations to the institutional performance profiles of the Colombian departments and the level of importance of the variables in the classification model, an ANN model was developed. For the above, a Multilayer Perceptron with two hidden layers, hyperbolic tangent activation function and sigmoid function in the output layer were used in the neural model.

For training and learning the network, a partition was used with 40% of the observations in the training sample, 30% in the test sample and 30% in the backup sample. The data were processed in triplicate to provide sufficient data for training and learning the network. A minilot type training was used with 2 records per minilot and a learning rate of 0.4 (This was to achieve the best performance of the network). This model configuration is illustrated in Figure 1. The ANN model showed a high accuracy in classifying the departments in the identified performance profiles (Table 5) with a 100% hit rate in each of the training, test and reserve samples. The results show the predictive ability and robustness of the model to reproduce complex patterns in the departments' institutional performance data.

Table 5.
Classification of the ANN model. Dependent variable: Clusters

		Forecast				
Sample	Observed	1,00	2,00	3,00	4,00	Percent correct
Entrenamiento	1,00	8	0	0	0	100,0%
	2,00	0	7	0	0	100,0%
	3,00	0	0	9	0	100,0%
	4,00	0	0	0	11	100,0%
	Global percent	22,9%	20,0%	25,7%	31,4%	100,0%
Prueba	1,00	4	0	0	0	100,0%
	2,00	0	3	0	0	100,0%
	3,00	0	0	4	0	100,0%
	4,00	0	0	0	8	100,0%
	Global percent	21,1%	15,8%	21,1%	42,1%	100,0%
Reservation	1,00	3	0	0	0	100,0%
	2,00	0	5	0	0	100,0%
	3,00	0	0	2	0	100,0%
	4,00	0	0	0	5	100,0%
	Global percent	20,0%	33,3%	13,3%	33,3%	100,0%
Dependent variable: Cluster						

Table 6 shows the standardized importance of the variables in the model, highlighting the importance of the variables Information and Communication (100%), Evaluation of results (78.9%), Internal Control (74.2%) and, Managing for results with values (68.2%). Tthe natural sciences score as the most influential variable in the ranking of the profiles, followed by the critical reading score and the English score.

Table 6
Importance of the independent variables

	Variable	Importance	Standardized importance
V1	Human Talent	0.115	54.9%
V2	Strategic direction and planning	0.111	53.2%
V3	Managing for results with values	0.142	68.2%
V4	Evaluation of results	0.165	78.9%

V5	Information and Communication	0.209	100.0%
V6	Knowledge Management	0.103	49.3%
V7	Internal Control	0.155	74.2%

5. Conclusions and Discussion

This research shows the relevance of the Clustering-ANN model to identify and project institutional performance profiles in the public function of the departments of Colombia and provides a detailed overview of the institutional performance of the departments and regions, identifying contrasts at the regional level, which can be taken as a reference for the formulation of public policies aimed at improving the results in the public management of the departments. The main results are as follows:

- Identification of four profiles of institutional performance of the public function in the departments, which reflect regional disparities. 62.5% of the departments observed institutional performance between good and excellent, reaching an average of 85.5/100 in the performance measurement, while 37.5% of the remaining departments reached 64.3/100 with a rating between low and regular performance. The departments with the best performance in areas such as human talent, strategic planning, knowledge management and internal control stand out.
- In the analysis of the importance of the variables, the following were identified as the most relevant variables in the classification of profiles: V5: Information and Communication (100%), V4: Evaluation of results (78.9%), V7: Internal Control (74.2%) and V3: Management for results with values (68.2%). These variables should be considered as a priority in strategic improvement processes.
- The ANN model reliably projects future institutional performance results, with 100% accuracy in the training, test and reserve samples, thus providing a useful tool for the planning and evaluation of efficiency and control policies in the civil service. This suggests that the model is robust and can be used to project the future performance of departments. Its implementation could facilitate the early identification of trends, as well as the targeting of resources and strategies in the regions with the greatest need for intervention.
- The mapping of the institutional performance profiles of the departments showed a trend towards better performance of the departments located in the central and Andean region, apart from departments such as Atlántico, La Guajira, Sucre and Vaupés, while the departments with lower performance tended to be in the periphery of the country.

It is important to highlight the significant implications of the results of this research for public management in Colombia, since it identifies performance profiles and key variables that guide and focus the management and design of public policies for the continuous improvement of the departments. Therefore, differentiated interventions that respond to the characteristics of the performance profiles are recommended. Thus, for example, departments with low performance (profile 4) require prioritizing investments in infrastructure, training of human talent and strengthening of internal control systems.

Likewise, the variables Information and Communication, Evaluation of Results, Internal Control and Management for Results with Values were identified as influential for the classification of profiles, it is recommended to strengthen the information and communication systems in order to facilitate accountability processes and evaluation of results in order to achieve greater transparency and improvement for the allocation and optimization of resources.

Advanced technologies such as ANNs have great potential for application in monitoring performance and identifying trends so that informed and proactive decisions can be made more quickly.

Although the research provides an overview of Colombia's institutional performance, it is important to recognize its limitations. First, the information corresponds only to the year 2023, which limits the analysis of long-term trends. The study is also limited to departmental governments, so it would be interesting to delve deeper into the performance of municipalities and other public agencies at the municipal, departmental or national level.

Finally, this study offers a robust methodological tool that integrates cluster analysis and artificial neural networks for the analysis of institutional performance in the Colombian civil service. This allows identifying areas for improvement and projecting the impact of possible interventions, thus contributing with a robust tool for the formulation of more effective and equitable public policies.

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