

The mediating role of structural capital in the relationship between human capital and performance in the public administrations of Mexico and Peru

Norma Angélica Pedraza Melo* Research professor, CINOTAM-SIP, Universidad Autónoma de Tamaulipas, Tamaulipas, Mexico.
napedraza@docentes.uat.edu.mxBernardo De la Gala Velásquez Professor, Faculty of Administration, Universidad Nacional de San Agustín de Arequipa, Arequipa, Peru.
bdelagala@unsa.edu.pe

Abstract

Intellectual capital refers to the set of intangible assets that create competitiveness in public and private organizations and has a strategically significant role concerning resources, capacities and organizational performance. However, the academic output on intellectual capital in public administration is limited. The present study was conducted in public organizations in Tamaulipas, Mexico, and Arequipa, Peru; both countries are developing economies. The aim was to analyze the effects of human and structural capital on performance in public administration. A total of 502 questionnaires were administered to public employees in the two countries, using the neural networks technique and structural equation modeling. We found that human capital positively impacted organizational performance, and this relationship was mediated by structural capital. Thus, we recommend implementing structural and human capital management practices, given their role in enhancing the performance in public organizations.

Keywords: intellectual capital; human capital; organizational performance; structural capital; public management.

Mediación del capital estructural en la relación del capital humano y desempeño de la administración pública México y Perú

Resumen

El capital intelectual representa el conjunto de activos intangibles que crean competitividad en organizaciones públicas y privadas, ganando relevancia estratégica dentro de los recursos, capacidades y desempeño organizacional. La productividad académica del capital intelectual es limitada en la administración pública. El estudio se realizó en entidades públicas de Tamaulipas, México y Arequipa, Perú, que corresponden a países de economías en desarrollo. El objetivo es analizar los efectos del capital humano y estructural en el desempeño en la administración pública. Se aplicaron 502 cuestionario a servidores públicos en los dos países, utilizándose la técnica de redes neuronales y ecuaciones estructurales. Se observó que el capital humano influye positivamente en el desempeño organizacional, además, el capital estructural medió esta relación. Recomendamos implementar prácticas de gestión del capital humano y estructural, por sus implicaciones en el desempeño de las organizaciones públicas.

Palabras clave: capital intelectual; capital humano; desempeño organizacional; capital estructural; gerencia pública.

Mediação do capital estrutural na relação entre capital humano e desempenho da administração pública México e Peru

Resumo

O capital intelectual representa o conjunto de ativos intangíveis que criam competitividade nas organizações públicas e privadas, ganhando relevância estratégica dentro dos recursos, capacidades e desempenho organizacional. A produtividade acadêmica do capital intelectual é limitada na administração pública. O estudo foi realizado em entidades públicas de Tamaulipas, México e Arequipa, Peru, que correspondem a países com economias em desenvolvimento. O objetivo foi analisar os efeitos do capital humano e estrutural no desempenho da administração pública. Foram aplicados 502 questionários a servidores públicos de ambos os países, utilizando a técnica de redes neurais e equações estruturais. Observou-se que o capital humano influencia positivamente o desempenho organizacional, além disso, o capital estrutural mediou essa relação. Recomenda-se a implementação de práticas de gestão de capital humano e estrutural, devido às suas implicações para o desempenho das organizações públicas.

Palavras-chave: capital intelectual; capital humano; desempenho organizacional; capital estrutural; gestão pública.

* Corresponding author.

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1. Introduction

In global economies, the implications of the shift from the industrial era to the knowledge era have underlined the importance of managing intangible assets, repositioning strategic thinking in the configuration and achievement of organizational aims and goals. These immaterial assets represent resources and capacities that, if appropriately managed, contribute to the performance of public and private organizations, and the value creation and competitiveness of enterprises (Bontis et al., 2018; Chaharbaghi & Cripps, 2006; Liu & Jiang, 2020; Shahzad et al., 2021).

In the current business landscape, marked by constant changes, globalization, crisis and complexity in organizational management systems and their systemic interaction with the environment, the public administration is not exempt from the implications and challenges posed by these environmental variables. It is thus considered essential that the public sector manages its intangible assets, given that it is a sector in which the organizations are knowledge- and service-intensive (Chowdhury et al., 2019; Dwi Astuti, 2020; Kamaruddin & Abeysekera, 2021). Furthermore, these types of organizations are more inclined to improve their productivity and process innovation rates (Chaharbaghi & Cripps, 2006).

Intellectual capital (IC) is a variable of interest in the management of public organizations (Dwi Astuti et al., 2020) and private entities (Meirelles et al., 2017). It is worth noting that the traditional accounting approach toward the rational measurement of a phenomenon is complicated by the intangible nature of IC (Chaharbaghi & Cripps, 2006), particularly in the case of its study in public institutions. Furthermore, access to financial information and accountability in the public sector is restricted, especially during the current pandemic situation; it is difficult to financially quantify public activities, operations and processes (Pedraza et al., 2021).

The COVID-19 pandemic has exposed societies, governments and markets to situations requiring reinventing the actions of organizations and actors across all production sectors in order to merely survive, let alone grow, against a complex backdrop of crisis. This highlights the need to manage intangible resources, specifically IC, to enhance current and future performance, with public management not being immune to these challenges.

Recent studies have evidenced that the pandemic has had adverse effects on innovation in public organizations (Xin, Min, 2021). This implies challenges for public management because today's society increasingly expects a better performance from governments, demanding effectiveness, economy, quality and transparency in the administration of budgetary resources. Citizens and public service users have become more active and critical in their observation of the impacts and performance of the public sector (Díaz de León, 2013; De la Garza et al., 2018; Verger & Normand, 2015).

The understanding of IC and its relationship with organizational performance has been much studied in the industrial and financial sectors, in insurance, technological and pharmaceutical firms, and in small and medium-sized enterprises (Bayraktaroglu et al., 2019), but there is limited academic output in the field of public administration. Thus, it is considered essential to contribute to research in this sector, drawing on diverse research paradigms and models, to enhance knowledge and empirical evidence on the management of intangible assets in the public sector (Dwi Astuti, et al., 2020; Farah & Abouzeid, 2017; Kamaruddin & Abeysekera, 2021).

Consequently, we consider the present study makes an interesting contribution to the literature, focusing on the relationship between the dimensions of IC (human and structural) and performance in the area of public administration, specifically in two Latin American developing economies, with the study being conducted in Tamaulipas, Mexico and Arequipa, Peru. Another key contribution of the study is how the analysis variables are studied and addressed. We specifically draw on the artificial neural networks technique (relational approach), which is a novel paradigm for studying and explaining research phenomena in management science (Fonseca-Pedrero, 2018; Hevey, 2018; Saénz & Álvaro, 2002; Siderska, 2017).

Based on the ideas above, the aim of this work is to answer the following question: What is the impact of human capital (HC) and structural capital (SC) on organizational performance (OP) in public sector offices and entities located in Tamaulipas, Mexico and Arequipa, Peru? The study is structured as follows: the first section presents a general introduction on the significance of the topic, while the second section reviews the literature and explains the theoretical framework. The third section describes the methodological design, which informs the type of study conducted, the research model and hypotheses, the sample, and the data collection and analysis techniques. The fourth section presents and discusses the results, while the final section defines the main conclusions, implications and future lines of research.

Using partial least squares structural equation modeling (PLS-SEM), human capital was found to have significant, positive effects on the performance of the public organizations analyzed in Tamaulipas, Mexico, and Arequipa, Peru. Additionally, structural capital was observed to mediate this relationship and increase the determination coefficients. Based on these findings, it would be advisable for public management to consider the strategical importance of implementing administrative practices focused on these two intellectual capital dimensions (HC and SC), given the benefits for their institutional image and the improvements in the processes, procedures and services they provide for users and citizens.

2. Theoretical framework

2.1 Organizational performance in public administrations and intellectual capital

Organizational performance (OP) in the field of public administration continues to be a topic of interest in recent years, given the reforms enacted to modernize the state (Vicher García, 2009; Kamaruddin & Abeysekera, 2021) in a variety of countries. These reforms have been aimed at driving government actions under the framework of fundamental principles such as efficiency, efficacy, economy and quality in the administration of public resources, with these goals being embodied in the approach to planning and evaluation known as New Public Management (NPM) (Díaz de León, 2013; De la Garza et al., 2018; Kamaruddin & Abeysekera, 2021; Moyado, 2011; Verger & Normand, 2015). NPM is a school of thought that proposes, for example, extrapolating practices from the management of private enterprise to the public sector (Broucker, De Wit, & Verhoeven, 2017).

The NPM model has been implemented in countries such as England, New Zealand, the United States and France and, in Latin America, in Argentina, Mexico, Brazil and Chile, among others, with the intention being to improve the performance and results of public management (Kamaruddin & Abeysekera, 2021). This approach to strategic planning focuses on managing for outcomes (MfO), which, as the core practice of NPM, involves a strategy including techniques to diagnose public problems, planning, programming and budgeting, grounded in logical models for the design and execution of governmental actions. This process goes hand in hand with systems to monitor and evaluate the effectiveness of public policies and programs (Hyndman & Lapsley, 2016; Dal Molin, Turri, & Agasisti, 2017; Pliscoff-Varas, 2017; Ramos, 2016; Segatto & Abrucio, 2017).

Nonetheless, despite the embracing of NPM and other strategic thinking approaches (administration by goals, quality, process re-engineering) and actions taken by governments to shift the functions of the state towards the market, the outcomes in various countries, particularly in those in Latin America, highlight the limited capacity to effectively solve major national problems (Aguilar, 2007; Martínez Vilchis, 2009; Vicher García, 2009) in areas such as health, education, poverty, corruption, the economy, competitiveness, and the sustainable development of societies and peoples.

Consequently, given the complex, dynamic environments to which the public administration is forced to respond, the management of intangible assets, particularly those involved in IC, is considered a valuable area of academic research that may help improve performance by enhancing knowledge on intangible resources. Such resources include management capacities in the public sector (HC), the organizational structure required to obtain outcomes and impact indicators (SC), and the effective application of public resources in scenarios where transparency and accountability are of prime importance, given that societies tend to be more critical when they experience and evaluate the performance of the public administration (Kamaruddin & Abeysekera, 2021; Mendoza, García, Delgado & Barreiro, 2018; Verger & Normand, 2015).

The notion of measuring OP draws us to first look at the rational approach to the construct, where priority is given to accounting and financial perspectives (Chaharbaghi & Cripps, 2006). In the knowledge era, however, the challenge lies in analyzing this phenomenon from other viewpoints and not necessarily those based on the traditional method of financial indicators. In this sense, the literature includes models for managing intangible assets (e.g., Skandia Navigator, Balanced Business Scorecard), which entail the perspective of non-financial indicators and the combination of both outlooks on understanding OP (financial and non-financial). Table 1 shows the main approaches to studying IC in OP (González & Rodríguez, 2010; Edvinsson & Sullivan, 1996; Kaplan & Norton, 1993; Sveiby, 1997; 2000).

In the knowledge era, intellectual capital (IC) has gained importance in the strategic management of resources and organizational capacities. It is estimated as the value of the intangible and non-calculable assets that allow competitiveness to be created in private and public organizations (Ferreira, 2014; Liu & Jiang, 2020; Kamaruddin & Abeysekera, 2021; Penrose, 1959; Wiedenhofer et al., 2017). These valuable resources include organizational capacities, employees' competencies, know-how, the systems and processes that underlie an organization's operations and the management of relationships with stakeholders. These intangible assets have traditionally been divided across three dimensions: human, structural and relational capital (Bontis et al., 2015; Bontis et al., 2018; Chowdhury et al., 2019; Jardon & Martínez-Cobas, 2021; Kamaruddin & Abeysekera, 2021).

Table 1. Models for managing intangible assets related to OP

Balanced business scorecard	Canadian Imperial Bank	Intangible assets model	Skandia Navigator System	Strategic management by competencies: intangible capital
Innovation	Financial	Processes	Administration	Competencies: personal, organizational, technological and relational
Growth	Clients	Patents	Financial	
Motivation	Organizational structure	Structure	Processes	
Learning		Information systems	Clients	
Management		Clients	HC	

Source: own elaboration, based on González & Rodríguez (2010).

Human capital (HC) refers to the set of values, attitudes, skills and competencies of employees (CH), which can add value to an organization, that is, it is the exclusive property of the workers (Evans, Brown, & Baker, 2015). It includes workers' knowledge, experience, creativity, training, academic attainment, loyalty, and motivation, among other indicators, all of which belong to the workers and which they take with them when they leave a company (Liu & Jiang, 2020; Pedraza et al., 2017; Pedraza et al., 2021). Consequently, it is key for this component of IC to be managed strategically.

Structural capital (SC) refers to the technological and organizational resources developed to identify, store, transfer, and grow the knowledge acquired from HC, exploiting this intangible asset to foster its use to benefit OP. It entails techniques such as process manuals, procedures, information systems, digital networks, organizational culture, systems of collaboration and organizational learning (Bontis et al., 2018; Pedraza, La-vín, Marmolejo, Vasconcelo & García, 2017; Pedraza et al., 2021). In short, SC is the knowledge internalized by the organization (Evans et al., 2015), which generates value and which can be formalized (patents, licenses, information systems, databases) (Jardon & Martínez-Cobas, 2021), suggesting, therefore, that SC may mediate and strengthen the relationship between HC and OP (Allameh, 2018; Gogan et al., 2015; Pedraza et al., 2021; Salinas et al., 2020).

From a rational perspective, the challenge and complexity of measuring IC have been well established. Nonetheless, and despite the problem of its identification and measurement (Wang, Wang, & Liang, 2014), the literature reports that, regardless of the approach used to measure it (qualitative vs. quantitative), the empirical evidence suggests the existence of diverse relationships between the dimensions of the IC construct and OP. Studies have shown positive effects, negative effects and even the absence of a relationship between the constructs. The evidence presented by scholars is shown in Table 2.

One of the contributions of the present work is that SC is assumed to be the IC dimension that facilitates its development by appropriating the benefits that HC brings to an organization. This is because the organizational and technological infrastructure it represents are strategies that allow the knowledge owned by the employees to be captured and managed, with the expectation of this having an effect on efficiency, productivity, innovation and access to information for it to be encoded as know-how. Thus, the contribution of HC is maximized through the formal organizational process and structures (SC) established by the firm and which is considered to promote the contributions of employees' competencies to OP (Allameh, 2018; Gogan et al., 2015; Pedraza et al., 2021; Salinas et al., 2020).

The significance of the present work lies in the generation of knowledge on the impact of human and structural capital on OP in public administration (in two

regions of developing Latin American economies). Most of the studies on this phenomenon have been conducted in productive industries in the private sector, in fields such as the pharmaceutical industry, information technologies, insurance companies, manufacturing industries and financial, with limited academic output focused on public management (Bayraktaroglu et al., 2019; Dwi Astuti et al., 2020; Farah & Abouzeid, 2017). Thus, we provide empirical evidence that facilitates, from the perspective of management-level public employees, the analysis and understanding of the effects of IC on goal achievement in public organizations.

Table 2. Framework of references on the study of the relationships between IC dimensions and OP.

Premises	Sources	Effects evidenced
Relationship between HC and OP	Barkat, Beh, Ahmed & Ahmed (2018); Bayraktaroglu et al. (2019); Farah & Abouzeid (2017); Felicio, Couto & Caiado (2014); Gogan et al. (2016); Hejazi, Ghanbari & Alipour (2016); Hesniati et al. (2019); Hsu & Wang, (2012); Kweh, Ting, Hanh, & Zhang (2019); Ramírez, Dieguez-Soto, & Manzaneque (2020); Soewarno y Tjahjadi (2020); Torre, Tommasetti, & Maione (2020); Wang et al. (2014)	Positive
	Jameelah, Osmanb, & Musa (2015)	No relationship
Relationship between SC and OP	Al-Hawajreh (2013); Farah & Abouzeid (2017); Gogan et al. (2015); Hesniati et al. (2019); Hsu & Wang, (2012); Ramírez et al. (2020); Torre et al. (2020); Soewarno & Tjahjadi (2020); Wang et al. (2014)	Positive
	Bayraktaroglu et al. (2019); Hejazi et al. (2016); Leitner (2015)	Negative
	Barkat et al. (2018); Kweh et al. (2019); Jameelah et al., (2015)	No relationship

Note: HC=human capital, SC= structural capital, Op= organizational performance

Source: own elaboration.

3. Methodology

3.1 Definition and scope of the research

This research was conducted under the rational paradigm (positivist), that is, using a quantitative approach, deductive method and a non-experimental design (Hernández et al., 2014) to examine the influence of human and structural capital on organizational performance in the setting of public sector organizations in Tamaulipas, Mexico, and Arequipa, Peru, and comparing the effects between the regions. Under a predictive framework, we established the model and the hypotheses to be tested (H1a, H1b, H2a, H2b, H3a, H3b). The relationships to be analyzed are represented schematically in Figure 1.

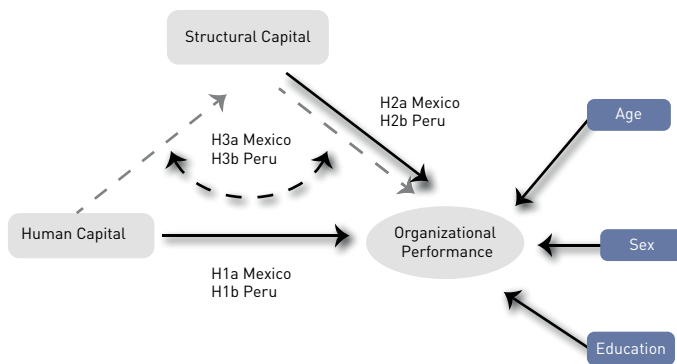


Figure 1. Theoretical model of the study.
Source: own elaboration.

- H1a: Human capital has a positive effect on organizational performance in the public administration in Mexico.
 H1b: Human capital has a positive effect on organizational performance in the public administration in Peru.
 H2a: Structural capital has a positive effect on organizational performance in the public administration in Mexico.
 H2b: Structural capital has a positive effect on organizational performance in the public administration in Peru.
 H3a: Structural capital mediates the relationship between human capital and organizational performance in the public administration in Mexico.
 H3b: Structural capital mediates the relationship between human capital and organizational performance in the public administration in Peru.

3.2 Sample and data collection

We considered it appropriate to draw on the perception of managers to analyze the phenomenon, as these have a more comprehensive vision of the management of their organizations (Liu & Jiang, 2020). The questionnaire was administered to public employees in high and medium-level management positions that agreed to participate. The non-probabilistic sample comprised 502 respondents: 251 employees from public organizations located in Tamaulipas, Mexico, and 251 counterparts from Arequipa, Peru, accounting for equal participation from each of the two regions, with the aim being to achieve more than 500 surveys for the comparative analysis of the data. We sent out 400 questionnaires in Mexico and 415 in Peru, using mainly Google Forms and, to a lesser extent, hard copy questionnaires.

We received responses from 300 participants in Mexico and 280 in Peru. However, we eliminated 49 and 29 surveys, respectively, as they presented problems of linear bias or missing data, resulting in a final sample for analysis of 251 surveys per country. Additionally, in collating the information, we considered the recommendation that each public organization should be represented by at least three respondents (Kamukama, Augustine, & Ntaji, 2010). The main characteristics of the respondents from the governmental institutions in Mexico and Peru were as

follows: 79.56% had worked in the organization for less than 10 years, of whom 66.1% had a length of service of less than 5 years. Furthermore, 52.8% were aged 41 years or below, with 63.1% being professional employees and 53% being male.

The questionnaire comprised four sections, the first of which collected data on HC, the second on SC, and the third on OP (Table 3). The fourth and final section contained questions of a sociodemographic nature. The framework of references used for the items proposed to measure the constructs was based on other works on IC conducted in other contexts (Bontis et al., 2015; Pedraza et al., 2017; Pedraza et al., 2021). Regarding the OP variable, we developed a battery of items to measure the phenomenon in public organizations from a non-financial perspective, which has been used in other analyses in similar contexts (Pedraza et al., 2021). The items were scored on a 5-point Likert-type scale (1=Never, 2=Rarely, 3= Sometimes, 4=Frequently, 5=Always).

Table 3. Conceptual framework for the latent variables.

Construct	Conceptual definition	Items scored on a Likert-type scale
Human capital (HC)	Represents a person's assets, experience, knowledge, competencies, skills, attitudes and values.	18 items measuring public employees' own capacities
Structural capital (CE)	Involves organizational capital (processes, policies, routines, procedures) and technological capital (information systems), which are the organization's property.	15 items measuring indicators of organization and technological capital.
Organizational performance (DO)	Represents metrics that evaluate an organization's performance from the perception of intangible, non-financial aspects.	7 items related to indicators of public image, improvement of processes, services, and procedures.
Control variables	i) Respondent's age ii) Public employee's sex iii) Education level (primary, secondary, higher secondary, professional, postgraduate)	Variables measured nominally, using numbers to classify categories and response groups.

Source: own elaboration, drawing on Barkat et al. (2018); Gogan et al. (2015); Hashim, Osman, & Alhabshi (2015); Farah & Abouzeid (2017); Pedraza et al. (2017); Pedraza et al. (2021).

3.3 Information processing techniques

3.3.1 Neural networks

Neural network (NN) analysis (Costantini et al., 2015; Hevey, 2018) is a highly novel technique in this field of research, which, in recent years, has been increasingly implemented, especially in psychology (Borsboom & Cramer, 2013; Epskamp, Denny, & Eiko, 2018). It is characterized by the use of scales of perception. Few articles have used NNs in the analysis of business management and accounting. Neural networks interpret the interaction of indicators individually, in conjunction, and as

reciprocally reinforcing [Borsboom & Cramer, 2013]. This technique examines constructs formatively, as opposed to other techniques that seek to reduce the structure of the constructs according to the information they share [Epskamp & Fried, 2018].

NN analysis can be regarded as complementary to structural equational modeling (SEM). The latter allows the relationships between constructs to be evaluated by means of factor analyses regressions [Hair et al., 2017], while RNs analyze the interaction of indicators by examining strength, closeness and betweenness. Both types of analysis result in an enhanced understanding of the phenomenon under study, which ranges from the relations between each indicator to the effect they have on the constructs in question (latent variables).

In RNs, the variables are known as nodes, and the relationships between them are called edges; a node can represent an item or variable [Hevey, 2018]. The present research used EBIC Glasso, a combination of two RN techniques. The absolute minimum selection and contraction operator, known as LASSO, is designed to reduce the estimations of a model close to zero (eliminating them), the result being a relatively small number of edges that explain the covariance of the nodes [Kelmanson, 2019].

Relational NNs extract useful information to make inferences based on the available data and their learning capacity [Saénz & Álvaro, 2002]. This technique allows us to evaluate the network of connections between nodes. It has the same, or greater, capacity for classification as statistical techniques, with the advantage that they can be applied regardless of whether they fulfil the theoretical premises of parametric methodologies [Pitarque et al., 2000]. In NNs, centrality analysis is essential; it is able to examine the relationships between the nodes in the model, which are evaluated by means of the edges. These are shown as lines of different thicknesses and colors. The thicker the lines, the greater their importance and weight. Blue lines denote a positive relationship, and red ones represent a negative one [Kelmanson, 2019].

Three measures are used to analyze the structure of NNs. The first is the distance and length of the shortest path between two nodes, the second is connectivity and grouping, and the third is centrality analysis [Costantini et

al., 2015]. Our research uses centrality, which measures the indicators of strength, closeness, betweenness and expected influence. Strength refers to the influence of a node concerning the others, closeness measures the capacity of a node to predict others correctly, and betweenness measures the level of connection between each node and the others. The highest values in the centrality indices identify the most important nodes in the network [Fonseca-Pedrero, 2018; Hevey, 2018].

3.3.2 Partial least squares (PLS) structural equations

Having used NNs to identify the underlying structure of the indicators, we conducted the explanatory analysis by means of the partial least squares technique, which is widely utilized in social sciences, especially in organizational studies [Cepeda et al., 2019]. Structural equations are estimated using the analysis of two models. First, the measurement model is evaluated, estimating the validity, reliability and collinearity of the constructs under study. Then, the structural model is estimated, verifying the direct and indirect relationships between the latent variables [Hair et al., 2014; Avkiran, 2018]. To this end, we used SmartPLS 3.3.3, a structural equation software package that is considered to be of great efficacy in complex reflective models and to have great statistical power when using smaller samples.

4. Analysis of results and discussion

4.1 Exploring the connections between nodes in HC, SC and OP

Once the neural networks for the constructs in both countries had been established [Figure 2], we first analyzed centrality, following Epskamp et al., [2018]. The stability correlation (SC) coefficient was used to accept centrality, with a cutoff point of ≥ 0.50 . This criterion was used to evaluate the indices of strength, closeness, betweenness and expected influence, which allow the most important nodes to be identified [Table 4], that is, those characterizing each construct under analysis [Epskamp et al., 2018; Klein et al., 2020; Robinaugh et al., 2016].

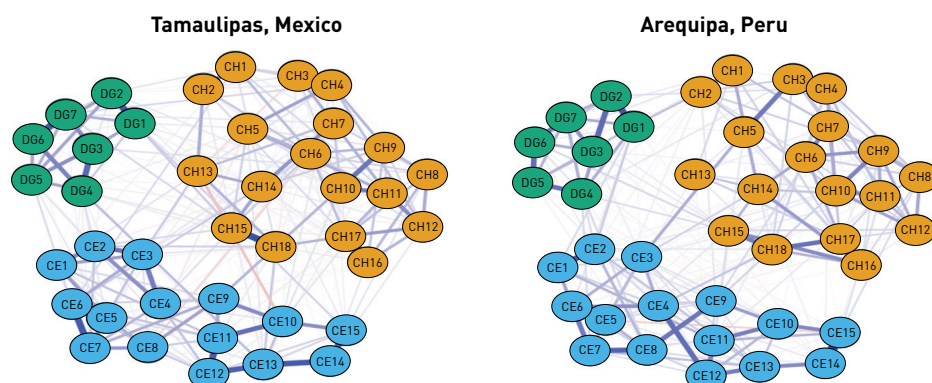


Figure 2. Neural networks for the variables of HC, SC and OP.

Note: SC= structural capital nodes; HC= human capital nodes; OP= organizational performance nodes. A detailed description of each node can be found in Annex 1.

Source: own elaboration.

The NNs clearly show the items are discriminately grouped in their respective construct (Figure 2). Green is used to show the OP nodes, orange for the HC items and blue to represent the characteristics of SC. The structure confirms the indicators that characterize and permit the measurement of each construct. The findings coincide with those of other authors (Bontis et al., 2015; Liu & Jiang, 2020; Pedraza et al., 2021).

A more in-depth analysis of the network was conducted, focusing on centrality (expected influence, closeness, strength, betweenness). The parameter of expected influence (EI) is the best indicator of node importance (Robinaugh et al., 2016), with a cutoff point of ≤ 0.25 showing low node importance, while ≥ 0.50 indicates great importance (Epskamp et al., 2018). Table 4 shows the most important nodes in each construct (HC, SC and OP).

The EI results show coincidences in several of the centrality analyses. The nodes with a low influence differ in Mexico and Peru (Table 4), although nodes SC2, OP5 and OP6 are seen to have little importance in the NNs in either country. The identification of highly influential nodes indicates 72.5% of the total nodes for Mexico and 65% in the case of Peru, many of which coincide in both countries, especially in human capital (10 nodes) and structural capital (6 nodes). In organizational performance, nodes OP1 and OP7 are highly influential in both countries; these items refer to the image of the public administration offices and the quality of the processes and services provided.

The centrality analysis reveals that in Peru (24 nodes), the greatest strength is human capital (13 nodes). In Mexico, the greatest strength is found in structural capital, with 9 nodes. In organizational performance, Peru exhibits a greater number of more important nodes. The evaluation of the closeness criterion reveals 13 important human capital nodes for the case of Peru and 12 for Mexico, while, in contrast, in structural capital, 9 nodes are important in the Mexican neural network but 8 in the case of Peru. The results for the strength analysis are similar, where SC is, by a small margin, the most important dimension, with HC being the most important domain in Peru. Additionally, organizational performance shows the same nodes as being important in both countries.

The betweenness analysis reveals 13 important HC nodes for Mexico and 12 for Peru, while SC is more important in Peru, with 11 nodes, compared to Mexico (10 nodes). As regards OP, Peru has 5 important nodes, compared to 3 in the case of Mexico. These results show greater interconnectedness of human capital nodes in Mexico and greater interconnectedness of structural capital and organizational performance in Peru.

The HC centrality analyses reveal interesting findings for both countries. Mexico presents strengths in human capital in node betweenness, with an adequate closeness

between nodes and a lower presence of strong nodes (fewer than 50%), with HC1, HC2, HC5, and HC8 being the most significant. Peru presents highly similar results across the three centrality measures, with a greater balance in human capital, where nodes HC3, HC5, HC7, HC8, HC10, HC12, HC13, HC16 and HC17 are the most outstanding.

These findings suggest that the features of human capital in Mexican and Peruvian public institutions function as a bridge to other management behaviors, given the sufficient closeness between nodes. Nonetheless, the lack of node strength in the case of Mexico may lead them not to influence such behaviors. On the other hand, in Peru, as the three measures of centrality are balanced, the management of human capital emerges as a key factor in the management of public organizations.

The centrality analyses for structural capital in Mexico show similar results across the three measures, with the level of betweenness, closeness and strength positively contributing to the management of Mexican public institutions, with nodes SC 12 and SC 13 being the most influential. Peru also exhibits similar results across the three measures, although there is a lower presence of nodes, with SC4, SC6 and SC8 being the most outstanding. These findings suggest the strength of the SC dimension in both countries, with greater strategic importance in the case of Mexico.

As regards OP, the results show adequate closeness between nodes in the Mexican institutions and an acceptable betweenness with limited strength, while Peru shows the same level of closeness, betweenness and strength. Nonetheless, node strength is the main shortcoming in both countries, especially in Mexico, indicating that the performance nodes lack the capacity to influence public administration outcomes.

4.2 Weight analyses for HC, SC and OP

The second phase of the analysis in RN methodology is the weight matrix, which aims at identifying through correlations. The weights are evaluated by identifying the stability coefficients $SC \geq 0.3$ as important relationships (Epskamp et al., 2018). Table 5 summarizes the relationships between nodes in each construct by country, with their respective stability coefficients (SCo).

Having identified the crucial relationships between the nodes of each construct in each country (Table 5), we find that HC features three significant relationships. The first is that of HC3-HC4, with weights of 0.489 and 0.384 in Mexico and Peru, respectively. It suggests that personnel in the public institutions in these countries associate experience in the job and the skills required for the position as factors necessary to perform the duties involved in the position they hold in the organizations. This is consistent with other studies conducted in public administration (Pedraza et al., 2021).

Table 4. Analysis of node centrality in the variables of HC, SC and OP by country and study of the strength of edge weights.

Country	Construct	No importance		Node importance		
		Expected influence ≤ 0.25	Strength ≥ 0.50	Closeness ≥ 0.50	Betweenness ≥ 0.50	Expected influence ≥ 0.50
Mexico	HC	HC9,HC10, HC12,	HC1,HC2, HC4,HC5, HC7,HC8, HC11,HC17, HC18	HC1,HC2, HC3,HC5, HC8,HC9, HC10,HC13, HC14 HC15, HC16,HC18	HC1,HC2, HC3,HC5, HC6,HC7, HC8,HC10, HC11,HC12, HC13,HC15, HC16,HC17, HC18	HC1,HC2,HC3, HC4,HC5,HC7, HC8,HC11,HC13, HC14,HC15,HC16, HC17,HC18
	SC	SC2	SC3,SC4, SC6,SC7, SC11,SC12 SC13,SC14,SC15	SC1,SC5,SC6, SC9,SC10,SC11, SC12,SC13, SC15	SC1,SC3, SC4,SC5, SC8,SC9, SC10,SC12, SC13,SC14	SC3,SC5,SC6, SC7,SC8,SC9, SC10,SC11, SC12,SC13, SC14,SC15
	OP	OP2,OP3, OP5,OP6	OP4	OP1,OP2,OP3, OP4,OP5,OP6, OP7	OP3, OP4, OP5	OP1, OP4, OP7
Peru	HC	HC15	HC1,HC2, HC3,HC5, HC6,HC7, HC8,HC9, HC10, HC12, HC13, HC16, HC17	HC3, HC4,HC5,HC7, HC8,HC10, HC12,HC13, HC14,HC15, HC16,HC17, HC18	HC2,HC6, HC7, HC8, HC9,HC10, HC11, HC12, HC13, HC16, HC17, HC18	HC1, HC2, HC3, HC5, HC6, HC7, HC8, HC9, HC10, HC11, HC12, HC13, HC16, HC17
	SC	SC2,SC9, SC11,SC14	SC1,SC4,SC5, SC6,SC7,SC8, SC12,SC15	SC3, SC4, SC6, SC7, SC8, SC9, SC14, SC15	SC2, SC3, SC4, SC5, SC6, SC8, SC9, SC10, SC11, SC12, SC14	SC1,SC4,SC5, SC6,SC7,SC8, SC12,SC13
	OP	OP4,OP5, OP6	OP1,OP3,OP7	OP1,OP2,OP3, OP4,OP5,OP6, OP7	OP1,OP3, OP5, OP6,OP7	OP1, OP2, OP3, OP7

Note: Description of nodes in [Annex 1 \(Table A1\)](#).

Source: own elaboration.

The second relationship is only found in Mexico, where HC15-HC18, with a weight of 0.382, suggests these are important practices associated with job satisfaction and the positive appreciation of the policies implemented by managers. Finally, for Mexico and Peru, the relationship CH16-CH17, with weights of 0.453 and 0.336, respectively, supports the notion that fostering collaborative work and creating trusting environments is associated with employees' commitment to their institutions.

The SC analysis reveals an important relationship between nodes SC14-Sc15, with weights of 0.312 and 0.487 for Mexico and Peru, respectively. This association shows the importance that public service managers attach to the relationship between information systems and other organizational techniques, such as administrative manuals and organizational structures, which, according to the literature, are SC strategies that allow individual and collective knowledge in organizations to be identified, safeguarded and managed ([Bontis et al., 2015](#); [Gogan et al., 2015](#); [Pedraza et al., 2021](#)).

Additionally, in this dimension, we find relationships for Mexico that are not present in Peru, an example being that of nodes SC6-SC7, whose weight is 0.331. This relationship points to the importance of having access to innovative resources to improve the quality of processes and services continuously. Furthermore, the relationship SC11-SC12, with a weight of 0.321, highlights the

importance of updating policies and procedures as well as having structures and systems on which to base such innovation, which is considered necessary in managing SC ([Bontis et al., 2018](#); [Pedraza et al., 2017](#); [Jardon & Martinez-Cobas, 2021](#)).

Continuing with Mexico, the relationship SC12-SC13, with a weight of 0.309, underlines the importance given to the design and formalization of organizational and functional structure for the access to key information to support the organization's results in innovation. In addition, the relationship of nodes CE13- CE14, with a weight of 0.330, highlights the importance of technological resources for performing duties in public organizations.

Relationship SC14-SC15 in both countries, with a weight of over 0.30, suggests the importance of the utility of having organizational techniques (administrative manuals, organizational charts) and the use of information technology, such as information systems, for decision making. Relationship SC1- SC2, with a weight of 0.328, is only found in Peru, being indicators related to training and developing human capital.

Relationship OP1-OP2 is found in Mexico and Peru, with a weight of 0.342 and 0.340, respectively. These nodes reflect public organization managers' interest in enhancing the institutional image and attending to public service users' needs. In the case of Mexico, we also find relationship OP6-OP7, with a weight of 0.346, underscoring

the importance given to the quality of the processes and services provided and its association with achieving goals and results in Mexican public institutions.

Table 5. Weights of the critical relationships in the nodes of human capital, structural capital and organizational performance.

Country	HC	SCo	SC	SCo	OP	SCo
Mexico	*HC3--	0.489	SC6--	0.331	*OP1--	0.342
	HC4		SC7		OP2	
	HC15--	0.382	SC11--	0.321	OP6--	0.346
	HC18		SC12		OP7	
	*HC16--	0.453	SC12--	0.309		
	HC17		SC13			
			SC13--		0.330	
	SC14					
		*SC14--	0.312			
		SC15				
Peru	*HC3--	0.384	SC1--	0.328	*OP1--	0.340
	HC4		SC2		OP2	
	*HC16--	0.336	*SC14--	0.487		
	HC17		SC15			

Note: HC=human capital, SC=structural capital, OP=organizational or governmental performance, SCo=stability coefficient. (*) Indicates that the relationship is found in both countries.

Source: own elaboration.

This analysis by construct of the relationships between nodes (Table 5) suggests the existence in Mexico of a strategic orientation towards structural capital management behaviors, where we find five important relationships. These indicators involve administrative manuals, information systems and other resources related to innovation and fulfillment of institutional objectives. In addition, Mexico presents a higher number of relationships between the three constructs under study. In contrast, Peru shows a balance in the relationships between human and structural capital. However, in human capital, experience, job-related skills and teamwork are associated with good performance, as well as generating commitment to the organization.

4.3 The effect of human and structural capital on organizational performance

The descriptive analysis of the study variables reveals mean values of over 3 for the latent variables (HC, SC and OP), which reflects the high scores given by the

respondents to the characteristics used to measure each construct. The standard deviations and asymmetry values are below 1, although the correlations reveal high values across the variables (above 0.60). The indicators of collinearity (VIF) are between the expected ranges of 1 and 3, which shows there is no weakness in these aspects of the evaluation (Tables 6 and 7).

Using NNs to explore, by construct, the behavior of the items and following the analysis of the relations between nodes in both countries, we estimated the measurement model (construct validity) and the structural model (PLS-SEM). It is worth recalling that the measurement models check reliability, convergent and discriminant validity and collinearity in reflective variables. Table 7 shows adequate results for reliability (Cronbach's alpha and composite reliability of over 0.70), divergent validity (Fornell & Larcker, 1981) and heterotrait-monotrait ratio, and convergent validity (AVE), with values ≥ 0.50 . Collinearity, measured by VIF showed appropriate indicators (below 3).

After satisfactorily estimating the measurement model (Table 7), we analyzed the structural model (PLS-SEM). Table 8 shows the results of the research hypotheses. First, we analyzed the direct relationship between HC and OP, and subsequently, we included the mediating variable of SC, with the aim being to examine the differences between the two models and the relevance of the mediation effect of structural capital on the relationships between HC and OP in the public organizations analyzed in both countries.

The results reveal direct significant and positive relationships between HC and OP ($R=0.567^{***}$; 0.558^{**}), with similar values detected in both countries. However, the determination coefficients were found to be higher in Mexico than in Peru, suggesting a greater influence of HC, possibly due to the significant value of education level in the case of Mexico. The results confirm the study hypotheses H1a and H1b, coinciding with the findings of studies in other settings (Barkat et al., 2018; Bayraktaroglu et al., 2019; Farah y Abouzeid, 2017; Felicio et al., 2014; Gogan et al., 2015; Hejazi et al., 2016; Hesniati et al., 2019; Hsu & Wang, 2012; Kweh et al., 2019; Pedraza et al., 2021; Ramírez et al., 2020; Soewarno & Tjahjadi, 2020; Torre et al., 2020; Wang et al., 2014). The results also provide empirical evidence that human capital helps explain organizational performance in the public administration sector in both countries.

Table 6. Descriptive statistics for the latent and control variables in the research model.

	Mean	SD	Asymmetry	(1)	(2)	(3)	(4)	(5)	(6)
(1) Age				1					
(2) Education				0.072	1				
(3) Sex				-0.304**	.007	1			
(4) HC	3.963	0.670	-0.891	0.111*	0.0366	-0.158	1		
(5) SC	3.309	0.870	-0.170	-0.053	0.043	-0.035	0.632**	1	
(6) Op	3.723	0.745	-0.461	0.067	0.057	-0.073	0.651*	0.636**	1

Source: own elaboration.

Table 7. Reliability, validity and collinearity of the measurement models in both countries.

Mexico	Cronbach's Alpha	Composite reliability	Convergent validity AVE	VIF	Discriminant validity (Forner & Larcker; HTMT)		
					CE	CH	DG
	> 0.7	> 0.7	> 0.5	≤ 3.3			
SC	0.942	0.950	0.593	1.611	0.770	0.575	0.628
HC	0.893	0.911	0.505	1.492	0.566	0.711	0.590
OP	0.927	0.941	0.694		0.595	0.575	0.833
Peru							
SC	0.953	0.959	0.644	1.704	0.803	0.665	0.652
HC	0.939	0.948	0.646	1.700	0.638	0.804	0.599
OP	0.940	0.951	0.735		0.624	0.568	0.857

Note: The values in bold in diagonal correspond to the analysis of discriminant validity using the criterion of Forner and Larcker (1981); the values above this diagonal correspond to the heterotrait-monotrait analysis (HTMT)

Source: own elaboration.

Table 8. Summary of the results of the research models – direct effects (1) and indirect effects (2).

Hypotheses	Model (1) direct effects		Model (2) indirect effects (mediation)	
	Mexico	Peru	Mexico	Peru
Relationships				
HC → OP	0.567***	0.558***	0.353***	0.281***
SC → OP			0.383***	0.437***
HC → SC → OP			0.217***	0.279***
Age	-0.021	-0.121*	0.049	-0.097*
Sex	0.081*	0.026	0.043	0.05
Education	0.182***	-0.4	0.139**	-0.027
Adjusted R ²	0.364***	0.333***	0.450***	0.442***

Note: *sig ≤ 0.05; ** sig ≤ 0.01; ***sig ≤ 0.001

Source: own elaboration.

The mediation model (Figure 3), which shows the indirect and direct relationships, yielded values of R= 0.353*** and 0.281* for HC in Mexico and Peru, respectively, while in the case of SC, we found values of R= 0.383*** and 0.437**, with a higher coefficient for Peru, confirming all the values are positive and significant (***). Additionally, the indirect mediation coefficients show adequate values (R=0.217***; 0.279***), confirming the importance of SC, which increases the influence of HC on OP in both countries, albeit at a higher rate in Peru.

The results also show significant increases in the determination coefficients compared to the base model (R²= 0.450***; 0.442***), and thus our findings confirm the research hypotheses H2a, H2b, H3a and H3b. Additionally, our results coincide with the findings in the literature on the contribution of human capital to organizational performance while providing empirical evidence from the public administration sector in both countries (Al-Hawajreh, 2013; Farah & Abouzeid, 2017; Gogan et al., 2016; Hesniati et al., 2019; Hsu & Wang, 2012; Ramírez et al., 2020; Torre et al., 2020; Soewarno & Tjahjadi, 2020; Wang et al., 2014).

Our research confirms the positive and significant effects of HC on the performance of the public orga-

nizations analyzed in both countries. It also provides empirical evidence in favor of the hypothesis that SC is a mechanism for the appropriation of the knowledge embodied in HC, which implies that it mediates and maximizes the effect of the competences of human capital on organizational performance in the context of public administrations (Barkat et al.,2018; Bayraktaroglu et al., 2019; Farah & Abouzeid, 2017; Felicio et al., 2014; Gogan et al., 2015; Hejazi et al., 2016; Hesniati et al., 2019; Hsu & Wang, 2012; Kweh et al., 2019; Pedraza et al., 2021; Ramírez et al., 2020; Soewarno & Tjahjadi, 2020; Torre et al., 2020; Wang et al., 2014).

Among our main findings, it is worth highlighting that both regions show that human capital competencies are highly valued. Specifically, we found that importance was attached to the experience and the capacities required for employees to perform the duties involved in their position in the organization. Value was also placed on collaborative skills and an environment of trust as drivers of commitment to the organization. Additionally, in the case of Mexico, importance was given to the variable of job satisfaction.

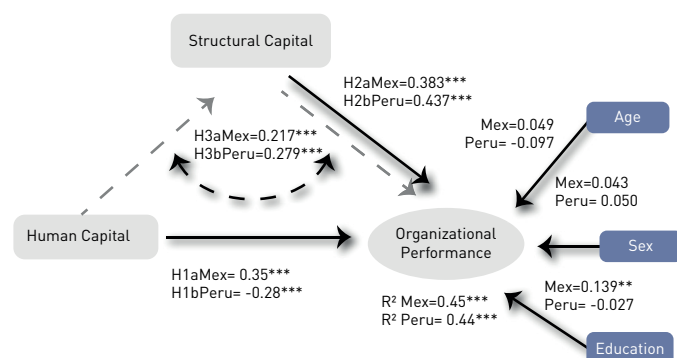


Figure 3. Research model on indirect effects (mediation) between HC, SC and OP.

Note: R²=determination coefficient; Mex=Mexico; h= research hypothesis; **= 95% confidence level; *** = 99% confidence level.

Source: own elaboration.

Concerning structural capital, importance was found to be attached to the relationship between information

systems and other organizational techniques, such as administrative manuals (for example, on procedures, policies, and job positions), having a defined organizational and functional structure, technological structures and resources (information systems) as a basis for innovation and enhancing processes and service quality. In fact, the image of public entities and the quality and innovation of their processes, procedures and services were considered important indicators of the performance of their organizations by the managers surveyed in both countries.

5. Conclusions and future lines of research

This study reports on the important role of intellectual capital and its relationship with organizational performance in the understanding and management of intangible assets in public administration. It uses advanced analysis techniques, such as artificial neural networks (NNs) with a relational focus (Fonseca-Pedrero, 2018; Hevey, 2018; Saénz & Álvaro, 2002; Siderska, 2017) and structural equation modeling as non-parametric techniques to examine predictions.

In conclusion, it was found that in the public organizations analyzed in both regions (Tamaulipas, Mexico, and Arequipa, Peru), the neural network of this construct revealed the main features that characterize public employees' competencies. These were experience, education level, knowledge and the skills required to carry out the duties involved in their positions properly. This suggests the prime importance of designing an in-service career training program for public administrations as a strategy to retain qualified talent in this type of organization. It is also advisable to generate environments that promote collaboration, trust, commitment and satisfaction.

Concerning structural capital, the literature has provided evidence on organizational techniques (organizational capital) and technological resources (technological capital) that facilitate the organizational infrastructure needed to define work methods. In this sense, the neural network for this construct suggests that the public organizations analyzed consider it necessary and recommendable to have administrative manuals, information systems, databases, well-defined organic structures and policies and processes designed to enhance innovation and the quality of the operations and services provided, ultimately boosting the public image of their entities.

It is worth noting that the academic output on the management of intangible assets, specifically on intellectual capital in public administrations, is limited. Indeed, as regards assessing and relating the impact of IC on organizational performance in public sector organizations, the generation of knowledge is practically nonexistent. Hence, among the main contributions of this work is the development of knowledge in the field of intellectual capital (HC and SC) and organizational performance in public management. A further significant contribution is

that of the context: two regions in developing economies in Latin America (Mexico and Peru).

Human capital (experience, education level, capacities) and structural capital were confirmed to have a significant positive effect on the performance of the public organizations analyzed in both countries. Nonetheless, higher determination coefficients were found in Tamaulipas (Mexico) in the case of the influence of HC, with this arguably being due to the variable of managers' education level, which showed a significant value in comparison to that of their counterparts in the organizations in Arequipa (Peru).

The present study also provides empirical evidence on the mediation effect of structural capital (SC) on the relationship between HC and OP. This finding is one of the study's main contributions since it generates knowledge to help understand the indirect effect of SC in the context of public management. This shows the importance of organizational and technological capital as a strategy to identify, store, manage and socialize knowledge from HC to benefit the organization, such that when the personnel in question leave their jobs, the know-how has been internalized, becoming part of the intellectual property of these public organizations.

This study contributes to the literature by providing an approach to the understanding of, and provides empirical evidence on, the relationships between the dimensions of intellectual capital (IC) and organizational performance in the offices and entities of the public administration in two emerging economies. The comparative nature of the study suggests the findings might be extrapolated to other developing countries, taking into consideration the limited knowledge generation, in the sense that the study only involved public organizations from two regions. It would be necessary to conduct further studies to increase the participation of more entities and similar countries to analyze trends to further understand the phenomenon under study.

One of the main implications of this work is that aiming to explain a phenomenon as complex as performance in public administrations using only two predictor variables, namely human and structural capital, is a simplistic approach to understanding the issue, given the dynamic, systemic and crisis environments that public organization managers have to tackle. This leads us to the critical reflection that the academic and research communities need to address study designs under the scientific paradigm of complexity, where the phenomenon under analysis is approached from a multicausal, interdisciplinary and multimodal perspective.

To advance the knowledge on organizational performance in the public sector, we propose future research lines based on the complexity theory. Topics that might be addressed in holistic research tap into the analysis of the effects of legal frameworks; strategic performance management (NPM); human talent administration, including competencies and other

variables related to the social being (work environment, culture, leadership, motivation, commitment, wellbeing and job satisfaction); relational capital, which involves the management of knowledge generated by effective, interactive relationships with stakeholders (users, suppliers, society, the legislative and judicial authorities, academia); technological capital (information technology, e-government); public finances (budgets, use of public resources, accountability, access transparency of information); and sustainable development (dimensions of the economy, social investment and the environment).

Conflict of interest

The authors declare no conflict of interest.

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Annexes

Table A1. Description of the questionnaire

HC1. ... Learn continuously from others
HC2. ... Are capable of participating in labor flexibility programs (job rotation, job enrichment).
HC3. ... Have the experience required for their duties.
HC4. ... Have the skills required for the job.
HC5. ... Have the professional studies required for their managerial level.
HC6. ... Collaborate together to solve problems and develop negotiated solutions.
HC7. ... Share resources and user information.
HC8. ... Obtain the best results when they work in teams.
HC9. ... Are able to generate new ideas and knowledge
HC10. ... Are bright and creative.
HC11. ... Efficiently tackle difficulties.
HC12. ... Are focused on offering quality services.
HC13. ... Have a low rate of employee turnover
HC14. ... Collaborate with managers in decision making
HC15. ... Are satisfied with the management and the organizational policies.
HC16. ... Are committed to the organization.
HC17. ... Foster trust and collaboration in work teams.
HC18. ... Are satisfied with the organizations innovation programs and policies.
SC1. ... Has training programs to develop and update competencies.
SC2. The recruitment and selection programs focus on hiring the best candidates
SC3. ... Successfully undertakes job succession programs.
SC4. ... Has strategies for innovation and technological watch.
SC5. ... Economic incentives for employees that generate new ideas for the continuous improvement of processes.
SC6. ... Continuously undertakes innovation projects (processes, services, technology, systems).
SC7. ... Dedicates resources to innovation projects (services, processes and systems).
SC8. ... Has strategies and systems to acquire, preserve and protect knowledge/technology (patents, copyrights, registered trademarks, etc.).
SC9. ... Stores employees' knowledge and experience in manuals, systems and processes.
SC10. ... Has documents on procedures that help implement routine actions.
SC11. ... Continuously updates policy and operational procedures.
SC12. ... Has structures, systems and procedures that promote innovation.
SC13. ... Has the infrastructure necessary for employees to access relevant information.
SC14. ... Has computerized information systems (databases and systems).
SC15. ... Has a defined organizational structure (organization manuals, positions, organizational charts)
OP1. Image of its offices and its services.
OP2. Adaptation to users' needs.
OP3. Rapid response to citizens' demands.
OP4. Value added to process and services.
OP5. Users' satisfaction with public processes and services.
OP6. Performance in fulfillment of objectives and results.
OP7. Quality in the process and public services provided.