

Human Capital and Its Impact on Scientific Production in Public Higher Education Institutions: A Case

Genny Navarro Claro¹, José Gregorio Arévalo Ascanio², Wilder Quintero Quintero³, Juan Carlos Hernández Criado⁴

¹Magíster en Dirección Estratégica, Especialista en práctica docente universitaria, Administradora de empresas, Docente Universidad Francisco de Paula Santander Ocaña,

²PhD en Administración, Magíster en Administración, Administrador de empresas, Docente Universidad Francisco de Paula Santander Ocaña,

³PhD en Administración, Magíster en Administración, Contador Público, Docente Universidad Francisco de Paula Santander Ocaña,

⁴PhD en Desarrollo Sostenible, Ingeniero Ambiental, Magíster en Desarrollo Sostenible y Gestión Ambiental Docente Universidad Francisco de Paula Santander Ocaña,

DOI: <https://doi.org/10.5281/zenodo.17066786>

Abstract

Introduction:

Human capital (HC) has emerged as a key area of interest within the scientific community, as it comprises intangible assets that contribute to competitive advantage and long-term institutional development. In higher education, the role of HC in enhancing scientific output is gaining increasing relevance, particularly in public universities in developing regions.

Objective:

This study aims to evaluate the influence of human capital on scientific production in a public Higher Education Institution (HEI) located in Norte de Santander, Colombia.

Methods:

A quantitative explanatory design was used, combining primary data from a validated Likert-scale survey of 205 researchers with secondary data from Minciencias. Structural Equation Modeling (SEM) and Exploratory Factor Analysis (EFA) were applied to assess the relationship between latent variables and scientific production.

Results:

SEM results showed that human capital exerts a positive and statistically significant influence on scientific production. The explanatory power of the model was high, with an R^2 value of 0.88. The most influential dimensions included researcher training, qualified experience, motivation, attitude, and research competencies.

Conclusions:

Human capital is a critical and sufficient factor in explaining scientific production in the studied HEI. The findings support the development of institutional strategies to strengthen researcher competencies, enhance motivation, and promote academic excellence. This research contributes to the theoretical and practical understanding of the relationship between HC and scientific productivity in higher education contexts.

Keywords:

Emerging markets, Quality culture, Configurational model, Systems thinking, Organizational performance.

1. Introduction

Human capital (HC) plays a key role in organizational management and is considered a source of competitive and strategic advantage. In the existing literature, the definition of human capital, according to [1], has encompassed a wide range of meanings and applications across various disciplines. As a result, there is insufficient clarity for applying these concepts effectively to achieve competitive advantage.

The origins of HC theory stem from the field of economics. According to [2], theoretical approaches to the study of HC analyze the individual and social effects of investment in both formal and informal education. Additionally, concepts such as skills, competencies, and knowledge are rooted in disciplines like psychology, labor sociology, and management studies.

The objective of this article is to evaluate the influence of human capital on scientific production in public Higher Education Institutions (HEIs) through a case study. To achieve this, a quantitative approach was applied using Structural Equation Modeling (SEM). Primary data were collected through a Likert-scale survey administered to 205 researchers from a public HEI in Norte de Santander, Colombia. Secondary data regarding scientific production were obtained from Minciencias. In line with this approach, the following hypothesis is proposed: Human capital influences the scientific production of researchers at a public HEI in Norte de Santander, Colombia.

This article is structured as follows: first, the introduction and research hypothesis are presented; then, the theoretical framework is developed, including background and definitions of human capital. Next, the methodology is described, detailing the hypothesis, research type, method, design, population and sample, data collection techniques, and instruments. The following section presents the results and discussion, and the article concludes with the main findings of the study.

2. Theoretical Framework

During the 1960s, the processes of recruitment, selection, induction, and management of human capital (HC) began to be developed [3]. The concept of human capital was strengthened through Human Resource Management, in response to the new challenges faced by

organizations. This led to the formation of specialized HR sub-departments with expanded responsibilities in areas such as organizational climate, planning, communication, participation, motivation, total quality, employee training, and skills development [4].

In the 1970s, personnel management processes became more formalized. However, it was in the 1980s when Human Resource Management emerged formally, alongside the establishment of labor associations, such as trade unions, and the formalization of hiring and dismissal procedures. This era is often referred to as the "golden age" of human capital, as it marked the development of a scientific and structured model encompassing human resource planning, recruitment and selection, training, labor relations, occupational safety, and employee motivation [5].

Theoretically, human capital began to gain relevance in the late 1950s and early 1960s, according to [6], when several scholars sought to explain how a country's population contributes to its economic and social development. According to [7], [8], and [9], the availability of physical capital does not determine a nation's economic productivity; rather, it depends substantially on the level of education and the quality of its human capital. For this reason, authors such as Gary Becker and Jacob Mincer focused on the return on individual and business investment in worker education [10].

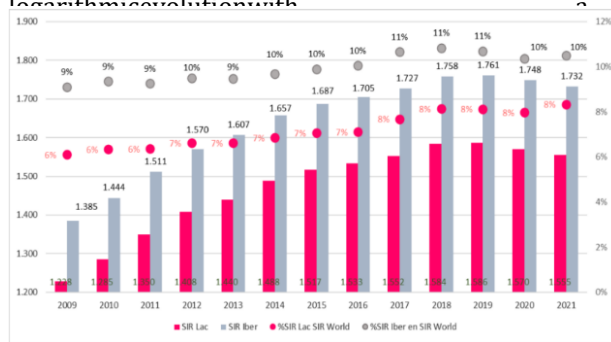
According to [11], [12], and [13], human capital refers to the knowledge and skills or training of workers as a form of capital acquired through education and experience, with a deliberate investment that yields returns over time [14]. Due to its intangible nature, human capital has become a field of study shared by economics, public policy, and management sciences. According to [15], there is a migration or "brain drain" of human capital from one country to another based on economic capacity, which increases competitiveness and productivity [16].

In Higher Education Institutions (HEIs), human capital is understood, as agreed by authors such as [17] through [25], as the knowledge possessed and applied by professors, researchers, students, and administrators. This capital is acquired through experience, training, and continuous development, and is essential for the effective execution of institutional processes and

activities. According to [26], HC in HEIs includes variables such as the number of doctoral researchers and faculty members, among others.

Scientific production is defined as the output of research products, including research articles, books, book chapters, patents, utility models, technological products, architecture, and design, among others [27]. These outputs are primarily generated by universities and research centers, whether public or private.

Historically, according to [28], scientific production has shown a logarithmic evolution with



over countries.

According to [29], the increase in scientific production (SP) indexed in Scopus from the ten most productive countries between 1996 and 2015 showed a significant growth rate. China led with a 15.11% increase, followed by India with 9.86%, and Japan with a smaller growth rate of 1.32%. Notably, the growth rate declined from the first period (1996–2005) to the second (2006–2015) for all ten countries analyzed, except India, which nearly doubled its growth rate. In contrast, Japan experienced a negative growth rate due to a reduction in publications, as shown in Table.

Country	No. of Publications (1996–2005)	Growth Rate (1996–2005)	Growth Rate (2006–2015)	Growth Rate Variation
United States	9,360,233	2.84%	4.29%	1.16%
China	4,076,414	15.11%	21.15%	9.16%
United Kingdom	2,624,530	3.76%	4.78%	2.11%
Germany	2,365,108	3.80%	5.62%	2.02%
Japan	2,212,636	1.32%	3.92%	-1.34%
France	1,684,479	3.39%	4.61%	1.84%
Canada	1,339,471	4.13%	5.68%	2.30%

Italy	1,318,466	4.97%	5.58%	3.93%
India	1,140,717	9.86%	7.69%	11.39%
Spain	1,045,796	6.55%	8.18%	4.53%

In Latin America and Ibero-America, according to [30] and [31], the evolution of scientific production (SP) is estimated using the Scimago Institutions Rankings Ibero-America (SIR IBER) and the Scimago Institutions Rankings Latin America (SIR LAC). As seen in the following figure, there has been a positive trend in the quantity and quality of scientific publications produced by Ibero-American and Latin American universities indexed in Scopus.

According to the figure above, scientific publications indexed in Scopus have shown significant growth in recent years. In the Latin American region, there was an increase of 122 institutions included in the SIR LAC ranking between 2009 and 2011, representing 6% participation in the global Scimago Institutions Rankings (SIR World) during that period. From 2012 to 2016, the number of new institutions entering SIR LAC grew by 315, raising the region's share to 7% in the global ranking. In the period 2017 to 2019, the number peaked at 1,586 institutions, followed by a decline of 31 institutions between 2020 and 2021. Notably, during 2017 to 2021, Latin America contributed 8% to the SIR World ranking [31, 32].

Regarding the Ibero-American region, between 2009 and 2011, the number of institutions grew by 126, accounting for 9% participation in the SIR World ranking. From 2012 to 2016, the increase was 135 institutions, reaching 10% participation. During the 2017 to 2019 period, 34 more institutions were added, with participation rising to 11%. However, between 2020 and 2021, a decrease of 29 institutions was recorded.

This trend indicates that over the 13-year period analyzed, there has been a gradual increase in the number of universities in both Latin America and Ibero-America indexed in Scopus, thereby expanding their presence in the global SIR World ranking. This sustained inclusion reflects the consolidation of scientific production (SP) in the region's higher education institutions [31, 33, 34].

3. Methodology

This study followed an explanatory research design with a quantitative approach. To measure intellectual capital (IC), primary data were collected through a Likert-scale survey administered to 205 researchers. The instrument underwent content validity assessment by five experts, criterion validity via Cronbach's alpha, and construct validity through Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) measure. Subsequently, Exploratory Factor Analysis (EFA) was used to refine and select the items.

For the analysis of scientific production, secondary data were obtained from Minciencias. Additionally, for the evaluation of scientific knowledge dissemination, data were gathered on the h-index and participation in conference proceedings indexed in Scopus and Web of Science (WoS).

Method. The study employed the hypothetico-deductive method, as it proceeds from a general analysis of IC, scientific production, and knowledge dissemination toward a more specific examination within the context of public Higher Education Institutions (HEIs) in the Santander region of Colombia.

Research Design. A non-experimental, cross-sectional, mixed-source, multivariable design was used. Data were collected at a single point in time, with no manipulation of variables. The design is considered multivariable because it includes one independent variable (IC) and two dependent variables (scientific production and knowledge dissemination).

Research Paradigm. This study is grounded in the positivist paradigm, as it aims to explain the influence of intellectual capital on both scientific production and the dissemination of scientific knowledge using measurable variables and statistical modeling.

Data Processing and Analysis. Responses were tabulated according to frequency distributions and analyzed using Structural Equation Modeling (SEM) techniques.

4. Resultados

The results of this study were obtained through Structural Equation Modeling (SEM), which allowed for the validation of the hypothesis and the identification of the most relevant Human Capital (HC) factors that influence scientific production. SEM enables the estimation of effects

and relationships between study variables [35, 36].

In this study, HC was examined through three latent variables: Researcher Attitude, Researcher Motivation, and Researcher Competencies. Additionally, two observed exogenous variables—Qualified Experience and Academic Training of Researchers—were analyzed. These two variables were not measured on Likert scales; instead, they were parametric variables obtained from Minciencias.

Global Model

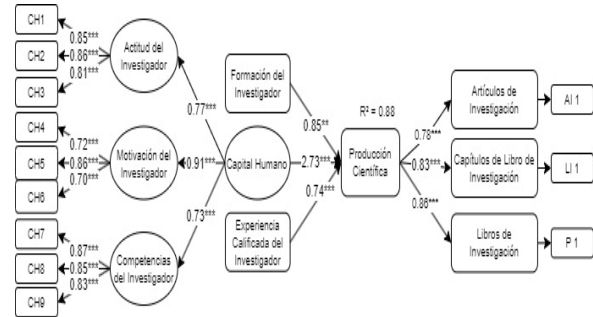
The global model represents the most important outcome in SEM, as it determines the overall adequacy of the theoretical model. In this study, nine goodness-of-fit indices were used to evaluate the model: Chi-Square (χ^2), RMSEA (Root Mean Square Error of Approximation), CFI (Comparative Fit Index), TLI (Tucker-Lewis Index), NFI (Normed Fit Index), GFI (Goodness of Fit Index), AGFI (Adjusted Goodness of Fit Index), and SRMR (Standardized Root Mean Square Residual).

The model links the latent variable Human Capital to the latent endogenous variable Scientific Production, assuming a normal distribution and using the Diagonally Weighted Least Squares (DWLS) estimation method. This estimation technique assumes an underlying latent normal distribution for each observed categorical variable [37, 38], and works with polyserial correlations (correlations between ordinal variables). The optimization method selected for DWLS was Nonlinear Minimization subject to Box Constraints (NLMINB).

The implementation of the SEM was carried out using the SEMOPY library in the Python programming language (version 3.11) [39] and the LAVAAN library in R (Rosseel, 2012). To evaluate the significance of relationships between exogenous and endogenous variables within the structural model, p-values were used with significance levels of 1% (\square), 5% (**), and 10% (\square **)



The structural model tests the significance of the indices in the causal relationships, both direct and indirect, within the proposed model. The p-values are reported with confidence levels of 99% (***), 95% (**), and 90% (*). The validation of the structural model is presented below in next figure.



This model was evaluated from three perspectives:

Indicator Reliability. This refers to the evaluation of factor loadings of the indicators relative to their respective latent variable (or construct). The recommended threshold is a factor loading greater than 0.70, although loadings around 0.60 are also acceptable [32]. In the proposed model, all indicator loadings meet this requirement.

Convergent Validity. This assesses the extent to which elements of the measurement scale theoretically relate to the construct, based on two criteria:

- (1) Composite reliability for each latent variable should exceed 0.70, and
- (2) Average Variance Extracted (AVE) should exceed 0.50 [33].

In this study, convergent validity is confirmed, as all values exceed the required thresholds (see Table).

Internal Consistency. In this evaluation, Cronbach's alpha coefficient should exceed 0.70 [34], although in some cases slightly lower values may be accepted. The results of this study confirm that all indices meet or surpass the threshold.

Resultados modelo de la medida

Variable	Dimensions	Composite Reliability	AVE
Human Capital	Researcher Attitude	0.81	0.77
	Researcher Motivation	0.70	0.61
	Researcher Competencies	0.74	0.69

Structural Model

In this SEM model, the latent variables are related to scientific production. For this purpose, a transformation from a Poisson distribution to a normal distribution was performed, using the Diagonally Weighted Least Squares (DWLS) estimation method. As the model does not rely on continuous data (i.e., it does not use the Maximum Likelihood estimation method), ordinal data were employed instead. Consequently, polychoric correlations between variables were used, since two different types of measurement scales were applied.

The first was a non-parametric Likert scale used to assess Human Capital based on the following dimensions: Training, Experience, Attitude, Motivation, and Competencies of the researchers. The second scale involved parametric data related to Scientific Production, including the publication of articles, books, and book chapters.

Goodness-of-fit indices were also estimated, and both the measurement model and the structural model were evaluated to determine whether the research hypothesis could be accepted or rejected. Finally, the direct effects of the path coefficients were analyzed in terms of their sign (positive or negative) and magnitude; only direct effects were considered in this study.

An important indicator in SEM analysis is the explained variance (R^2). According to [41], R^2 represents the proportion of variance in the dependent variable explained by one or more independent variables in a regression model. R^2 values range from 0 to 1, with values closer to 1 indicating better model fit. In this study, the model yielded an R^2 value of 0.88, meaning that approximately 88% of the variance in scientific production (dependent variable) is explained by human capital (independent variable), which demonstrates a high predictive power.

5. Discussion

In line with this, results showed that human capital has a positive and statistically significant influence on scientific production at the public HEI studied in Norte de Santander, Colombia, with a p-value of 0.029 (significant at the 95% confidence level), and a correlation coefficient of 2.73* with a positive effect. Specifically, the dimensions of researcher attitude, motivation, and competencies showed strong positive contributions.

The researcher training dimension also showed a positive and highly significant influence on scientific production, with a p-value of 0.000* (99% confidence level), and a correlation coefficient of 0.85*. Similarly, the qualified experience of researchers was also positively and significantly related to scientific output, with a p-value of 0.000* and a correlation coefficient of 0.74*.

These findings support the acceptance of H1: Human Capital influences the scientific production of researchers in a public HEI in Norte de Santander, Colombia.

Several studies support these findings. For example, [42] demonstrated that researcher training at the master's and doctoral level positively influences scientific output at the Universidad Católica de Colombia. [43] found that doctoral-level training among 85 faculty and researchers at the Universidad de Guayaquil (Ecuador) significantly increased scientific production. [44] also confirmed that researchers affiliated with the Brazilian National Council for Scientific and Technological Development (CNPq) who held higher academic degrees contributed more to intellectual output.

Empirical research also confirms the influence of qualified experience on scientific output. [45] showed that researcher experience significantly increased article production at public universities in Jordan (University of Jordan, Jordan University of Science and Technology, Yarmouk University, and Hashemite University). [46] likewise demonstrated that female researchers' experience contributed to academic and scientific output at both public and private universities in Syria.

Regarding the dimensions of human capital, the Researcher Attitude dimension (observations H1, H2, and H3) was statistically significant and positive, with a p-value of 0.000* (99% confidence level) and a correlation coefficient of 0.77*. This confirms that all three items reliably measure the dimension: H1 (0.85***), H2 (0.86***), and H3 (0.81***).

Other empirical studies also validate the role of attitude in scientific output. [47] found that researchers' attitudes significantly influenced the scientific output of 6,344 researchers from 15 countries. [48] explored how the attitudes of 200 researchers—including Ph.D. students at UiT The Arctic University of Norway—influenced open-access publication and the generation of new knowledge. Similarly, [49] found that ethical research attitudes positively influenced the scientific output of 100 researchers at the Hormozgan University of Medical Sciences in Iran.

The Researcher Motivation dimension (observations H4, H5, and H6) was also positive and statistically significant, with a p-value of 0.000* and a correlation coefficient of 0.91*. The individual coefficients were: H4 (0.72***), H5 (0.86***), and H6 (0.70***), confirming the internal consistency of this construct.

[50] found that motivation significantly influenced the scientific production of 228 researchers in Japan's public HEIs in the fields of natural sciences, mathematics, and engineering. [51] also demonstrated that researcher motivations in Malaysia included publishing in indexed journals (Scopus and WoS) and forming international research networks.

Finally, the Researcher Competencies dimension (observations H7, H8, and H9) was found to be positive and statistically significant, with a p-value of 0.000* and a correlation coefficient of 0.73*. The individual indicators were: H7 (0.87***), H8 (0.85***), and H9 (0.83***), confirming the conceptual validity of the dimension.

Other studies reinforce these findings. [52] confirmed that research competencies significantly influenced the scientific production of 29 industrial engineering professors at a private university in Lima, Peru. [53] identified essential competencies among Iranian research centers, such as creativity, innovation, cognitive abilities, writing skills, and responsibility. [54] confirmed that 325 researchers from the University of Punjab and Government College University in Pakistan possessed competencies in research design, statistical software, and academic writing, all of which had a positive impact on the quality of their scientific output.

Conclusions

The results of this research statistically, theoretically, and empirically confirm that human capital (HC) has a positive and significant influence on the scientific production (SP) of researchers at

a public Higher Education Institution (HEI) in Norte de Santander, Colombia. In this regard, the proposed hypothesis is validated.

This positive and significant relationship was demonstrated through five key dimensions of HC:

Researcher training, where SP was found to be directly proportional to the academic level of researchers. Notably, researchers holding doctoral and master's degrees accounted for 94% and 96% of the total SP, respectively.

Qualified experience, where researchers ranked as Senior by the Colombian Ministry of Science, Technology, and Innovation (Minciencias) were identified as the most productive and the highest in terms of scientific quality. Conversely, researchers in the Associate category were found to be less productive.

Researcher attitude, which plays a critical role in producing high-impact research outputs that address real-world problems and contribute to the generation of new knowledge.

Researcher motivation, driven by economic, professional, hierarchical, or other incentives, was shown to enhance scientific productivity.

Researcher competencies, especially in academic writing and data processing, were among the most decisive factors in generating scientific publications.

Human capital, when enriched with these skills and abilities, contributes significantly to the publication of articles, books, and book chapters. Therefore, HEIs should actively support the development of these competencies among their researchers to strengthen institutional research output and impact.

Future Research Directions

Future studies should conduct longitudinal analyses on how human capital evolves over time in Higher Education Institutions (HEIs), especially in relation to research productivity, academic career development, and institutional research capacity. Additional research could explore the role of artificial intelligence and data analytics in optimizing talent management and scientific knowledge dissemination. Moreover, comparative studies across different institutional, disciplinary, and regional contexts would help uncover patterns and divergences in how human capital contributes to scientific production, offering valuable insights into both global trends and local challenges in the pursuit of academic excellence.

References

- [1] I. Fisher, *The Theory of Interest : As Determined by Impatience to Spend Income and Opportunity to Invest It*, New York: MacMillan Company, 1930.
- [2] N. Didier, «A través de las nociones de Capital Humano,» *evista Iberoamericana de Psicología: Ciencia y Tecnología*, vol. 6, n° 2, pp. 7-16, 2013.
- [3] P. Monteferrante, «La Gerencia de la Gente: de dónde vinimos y hacia dónde vamos,» *Debates IESA*, vol. 10, n° 1, p. 12 – 14, 2004.
- [4] F. Casimiro, «Los Recursos Humanos en las empresas. Breve análisis en cuanto a evolución y tendencias en su gestión,» *Observatorio de la Economía Latinoamericana*, n° 85, 2007.
- [5] E. Jaques, *La organización requerida*, Argentina: Ediciones Granica., 2004.
- [6] N. Didier, «través de las nociones de Capital Humano,» *Revista Iberoamericana de Psicología: Ciencia y Tecnología*, vol. 6, n° 2, pp. 7-15, 2013.
- [7] J. Mincer, «On-the-job-training: Costs, returns, and some implications,» *Journal of Political Economy*, vol. 70, n° 1, pp. 50-79, 1962.
- [8] G. S. Becker, «Investment in Human Capital: A Theoretical Analysis,» *Journal of Political Economy*, vol. 70, n° 5, pp. 9-49, 1962.
- [9] T. W. Schultz, «Human Capital, schooling and health,» *Economics and Human Biology*, vol. 1, n° 2, pp. 207-221, 2003.
- [10] N. Didier y C. Perez, «Perfil del Capacitando en Chile: Variables que inciden en el acceso,» *Revista Latinoamericana de Estudios del Trabajo*, vol. 27, n° 17, pp. 165-190, 2012.
- [11] G. S. Becker, «Investment in Human Capital: A Theoretical Analysis,» *Journal of Political Economy*, vol. 70, p. 9-49, 1962.
- [12] M. A. Hitt, L. Bierman, K. Shimizu y R. Kochhar, «Direct and Moderating Effects of Human Capital on Strategy and Performance in Professional Service Firms: A Resource-Based Perspective,» *The Academy of*

- Management Journal*, vol. 44, n° 1, pp. 13-28, 2001.
- [13] R. A. Cheramie, M. C. Sturman y K. Walsh, «Executive career management: Switching organizations and the boundaryless career,» *Journal of Vocational Behavior*, vol. 71, n° 3, pp. 359-374, 2007.
- [14] F. M. Nafukho, N. Hairston y K. Brooks, «Human capital theory: implications for human resource development,» *Human Resource Development International*, vol. 7, n° 4, pp. 545-551, 2010.
- [15] M. Beine, F. Docquier y H. Rapoport, «Brain Drain and Human Capital Formation in Developing Countries: Winners and Losers,» *The Economic Journal*, vol. 42, n° 3, 2008.
- [16] W. L. Gardner, B. J. Avolio, F. Luthans, D. R. May y F. Walumbwa, «Can you see the real me? A self-based model of authentic leader and follower development,» *The Leadership Quarterly*, vol. 16, n° 3, p. 343-372, 2005.
- [17] .. Euroforum Escorial, «Medición del Capital Intelectual. Modelo Intelect,» Ed. I.U. , Madrid, 1998.
- [18] K. H. Leitner, «Intellectual capital reporting for universities: Conceptual background and application for Austrian universities,» *Research Evaluation*, vol. 13, n° 2, pp. 129-140, 2004.
- [19] S. Elena, «Governing the University of the 21st Century: Intellectual Capital as a tool for strategic management. Lessons from the European experience,» Universidad Autónoma de Madrid, España, 2007.
- [20] Y. Ramírez, C. Lorduy y J. A. Rojas, «Intellectual capital management in Spanish universities,» *Journal of Intellectual Capital*, vol. 8, n° 4, pp. 732-748, 2007.
- [21] M. L. Cañibano y P. Sanchez, «Intellectual Capital Management and Reporting in Universities and Research Institutions,» *Estudios de Economía Aplicada*, vol. 26, n° 2, pp. 7-25, 2008.
- [22] I. Bezhani, «Intellectual capital reporting at UK universities,» *Journal of Intellectual Capital*, vol. 11, n° 2, pp. 179-207., 2010.
- [23] C. Casanueva y A. Gallego, «Social capital and individual innovativeness in university research networks,» *Innovation: management, policy & practice*, vol. 12, n° 1, pp. 105-117., 2010.
- [24] G. Secundo, A. Margherita, G. Elia y G. Passiante, «Intangible Assets in Higher Education and Research: Mission, Performance or Both?,» *Journal of Intellectual Capital*, vol. 11, n° 2, pp. 140-157, 2010.
- [25] Y. Ramírez, «Intellectual capital management and reporting in European higher education institutions,» *Intangible Capital*, vol. 9, n° 1, pp. 1-19, 2013.
- [26] A. Kianto, T. Andreeva y Y. Pavlov, «The impact of intellectual capital management on company competitiveness and financial performance, doi: 10.1057/kmrp.2013.9,» *Knowledge Management Research & Practice*, vol. 11, n° 2, p. 112-122, 2013.
- [27] Minciencias, «Modelo de medición de grupos de investigación, desarrollo tecnológico o de innovación y de reconocimiento de investigadores del sistema nacional de ciencia, tecnología e innovación,» 2021. [En línea]. Available: https://minciencias.gov.co/sites/default/files/upload/convocatoria/anexo_1_-_documento_conceptual_2021.pdf.
- [28] S. E. Monroy y H. Diaz, «Time series-based bibliometric analysis of the dynamics of scientific production,» *Scientometrics*, vol. 115, n° 3, pp. 1139-1159, 2018.
- [29] B. Elango, «Growth of Scientific Publications: An Analysis of Top Ten Countries,» *Library Philosophy and Practice (e-journal)*. Library, IFET College of Engineering, Villupuram, India, elangokb@yahoo.com, pp. 1-11, 2018.
- [30] C. Vasquez, M. Luna, N. Bucci, M. Torres y A. C. T. Vilorio, «University Clusters from SIR IBER Indicators of Innovation Factor 2016-2019,» *Procedia Computer Science*, vol. 160, pp. 451-456, 2019.
- [31] F. De-Moya, E. Herrán, A. Bustos, E. Corera,

- G. Tibaná y F. Rivadeneyra, «Ranking iberoamericano de instituciones de educación superior 2021 (SIR Iber),» Granada: Ediciones Profesionales de la Información, 2021.
- [32] A. L. Comrey y H. B. Lee, *A First Course in Factor Analysis*, 2nd Edition ed., New York: Psychology Press, 1992.
- [33] C. Fornell y D. F. Larcker, «Evaluating Structural Equation Models with Unobservable Variables and Measurement Error,» *Journal of Marketing Research*, vol. 18, nº 2, pp. 39-50, 1981.
- [34] J. C. Nunnally, *Psychometric Theory*, New York: McGraw-Hill, 1978.
- [35] J. F. Hair, W. C. Black, B. J. Babin y R. E. Anderson, *Multivariate Data Analysis*. 7th Edition., Pearson Education, Upper Saddle River., 2014, pp. 115-116.
- [36] D. McCoach y D. Cintron, «Review of An Introduction to Modern Modeling Methods,» *Structural Equation Modeling: A Multidisciplinary Journal*, vol. 29, nº 6, p. 983-984, 2022.
- [37] J. T. Newsom, Z. A. Hachem, A. M. Granger y E. C. Denning, «Where Did I Go Wrong with My Model? Ten Tips for Getting Results in SEM,» *Structural Equation Modeling: A Multidisciplinary Journal*, 2022.
- [38] L. Cheng-Hsien, «Confirmatory factor analysis with ordinal data: Comparing robust maximum likelihood and diagonally weighted least squares,» *Behavior Research Methods*, vol. 48, nº 3, p. 936-949, 2016.
- [39] A. A. Igolkina y G. Meshcheryakov, «semopy: A Python Package for Structural Equation Modeling,» *Structural Equation Modeling: A Multidisciplinary Journal*, vol. 27, nº 6, pp. 952-963, 2020.
- [40] Y. Rosseel, «lavaan: An R Package for Structural Equation Modeling,» *Journal of Statistical Software*, vol. 48, nº 2, pp. 1-36, 2012.
- [41] S. A. Glantz y B. Slinker, *Primer of Applied Regression and Analysis of Variance*, McGraw-Hill, 1990.
- [42] W. O. Prieto y J. M. Tejedor, «La generación de nuevo conocimiento en economía: un modelo de crecimiento endógeno,» *Revista Finanzas y Política Económica*, vol. 12, nº 2, pp. 553-588, 2020.
- [43] C. Barros y O. Turpo, «La formación en investigación y su incidencia en la producción científica del profesorado de educación de una universidad pública de Ecuador,» *Publicaciones de la Facultad de Educacion y Humanidades del Campus de Melilla*, vol. 50, nº 2, pp. 167 - 185, 2020.
- [44] L. Nunes, A. Malacarne, R. F. Macedo y R. De Bortoli, «Generation of intangible assets in higher education institutions,» *Scientometrics*, vol. 121, nº 2, pp. 957 - 975, 2019.
- [45] P. Larzillière, «Research in context: Scientific production and researchers' experience in Jordan,» *Science, Technology and Society*, vol. 15, nº 2, pp. 309 - 338, 2010.
- [46] S. Dalati, «Factors affecting syrian female researchers' experience during crisis: Inductive approach,» *Business, Management and Economics Engineering*, vol. 19, nº 1, pp. 91 - 110, 2021.
- [47] A. Mulligan y M. Mabe, «The effect of the internet on researcher motivations, behaviour and attitudes,» *Journal of Documentation*, vol. 67, nº 2, pp. 290 - 311, 2011.
- [48] M. R. Msomphora, «UiT-Researchers' Attitudes and Practices Towards Open Access Publication: Lessons Learnt for Improving SelfArchiving in Institutional Repository,» *Libres*, vol. 1, pp. 14 - 36, 2019.
- [49] A. Heyat, A. Piroozan, A. N. Zade, S. Mohebi, S. Shekouhiyan, M. Salimi, S. Dehghan y S. Fallahi, «Researchers' attitude about ethics in research at Hormozgan University of medical sciences, Bandar-e-Abbas, Iran,» *Advances in Environmental Biology*, vol. 7, nº 1, pp. 56 - 60, 2013.
- [50] S. Katoh, R. H. L. Aalbers y S. Sengoku, «Effects and interactions of researcher's

motivation and personality in promoting interdisciplinary and transdisciplinary research,» *Sustainability (Switzerland)*, vol. 13, nº 22, pp. 1-19, 2021.

- [51] M. Lambovska y K. Yordanov, «Motivation of researchers to publish in high-quality journals: A theoretical framework,» *TEM Journal*, vol. 9, nº 1, pp. 188 - 197, 2020.
- [52] R. C. Dávila, M. M. Martín, A. García, E. García y G. B. Alfaro, «Caracterización de la formación investigativa y la producción científica en docentes de una universidad privada de Lima,» *Universidad y Sociedad*, vol. 14, nº 55, pp. 618 - 627, 2022.
- [53] A. F. Farahani, «Prioritizing the Researchers' Important Competencies in Research Centres,» *Tehnicki Glasnik*, vol. 4, pp. 557 - 565, 2022.
- [54] N. Hussain, S. Ur Rehman, K. Ameen y M. Safdar, «Training needs assessment of postgraduate researchers of Pakistan,» *Global Knowledge, Memory and Communication*, vol. 71, nº 4-5, pp. 322 - 341, 2022.