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Human capital and competitiveness: An analysis using AHP and factor analysis

Capital humano y Competitividad: Un análisis con AHP y análisis factorial

Liset Cancio ⬤   •   **Arlin Nardo** ⬤

Abstract   This study examines the influence of human capital on organizational competitiveness using a mixed methodological approach that integrates the Analytic Hierarchy Process (AHP) and Exploratory Factor Analysis (EFA). The research is based on the design of a hierarchical model composed of seven key dimensions of human capital: technical training, soft skills, work experience, leadership, innovation, work commitment, and strategic alignment. These dimensions were evaluated through expert judgment and subsequently empirically contrasted through a survey of 227 professionals from various productive sectors. The results of the HPA revealed that the most strategically valued dimensions are technical training, soft skills, and work experience, while commitment and strategic alignment received less weight. The EFA allowed us to identify three latent factors that structure human capital: technical competence, socioemotional skills, and strategic commitment. The triangulation of both techniques revealed gaps between the technical perspective of experts and the lived experience of employees, especially regarding the role of commitment and adaptability in creating organizational value. That competitiveness depends not only on operational capabilities but also on attitudinal factors that strengthen the connection between human talent and the institutional mission. The proposed model provides a comprehensive and replicable tool for strategic decision-making in human talent management.

Keywords   human capital, competitiveness, analytical hierarchy, factor analysis, talent management.

Resumen   El presente estudio examinó la influencia del capital humano en la competitividad organizacional mediante un enfoque metodológico mixto que integra el Proceso Analítico Jerárquico (AHP) y el Análisis Factorial Exploratorio (AFE). La investigación parte del diseño de un modelo jerárquico compuesto por siete dimensiones clave del capital humano: formación técnica, habilidades blandas, experiencia laboral, liderazgo, innovación, compromiso laboral y alineación estratégica. Estas dimensiones se evaluaron a través del juicio de expertos y posteriormente contrastadas empíricamente mediante una encuesta aplicada a 227 profesionales de diversos sectores productivos. Los resultados del AHP revelaron que las dimensiones más valoradas estratégicamente son la formación técnica, las habilidades blandas y la experiencia laboral, mientras que el compromiso y la alineación estratégica recibieron menor ponderación. El AFE permitió identificar tres factores latentes que estructuran el capital humano: competencia técnica, habilidades socioemocionales y compromiso estratégico. La triangulación de ambas técnicas evidenció brechas entre la visión técnica de los expertos y la experiencia vivida por los trabajadores, especialmente en lo que respecta al rol del compromiso y la adaptabilidad en la creación de valor organizacional. La competitividad no depende únicamente de capacidades operativas, sino también de factores actitudinales que fortalecen la vinculación del talento humano con la misión institucional. El modelo propuesto ofrece una herramienta integral y replicable para la toma de decisiones estratégicas en la gestión del talento humano.

Palabras clave   capital humano, competitividad, jerarquía analítica, análisis factorial, gestión del talento.

✉   Liset Cancio
lisetcancioroguez@gmail.com

Unidad Educativa Fray Álvaro Valladares, Puyo, Ecuador.

Unidad Educativa Fray Álvaro Valladares, Puyo, Ecuador.

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Introduction

In the current global environment, marked by digital transformation, geopolitical instability, and the increasing automation of production processes, the pursuit of sustainable competitive advantages has become a strategic priority for states, organizations, and institutions. Within this scenario of high complexity and uncertainty, human capital has emerged as a critical asset, not only from an economic perspective but also as a catalyst for innovation, social cohesion, and sustainable development (World Economic Outlook). Forum (2023). Unlike traditional factors of production—land, capital, and labor—human capital encompasses qualitative dimensions associated with education, experience, creativity, commitment, and an individual's ability to adapt, which largely determine an organization's capacity to respond to environmental challenges.

The relationship between human capital and competitiveness has been widely addressed from various theoretical perspectives, including knowledge economics, resource and capability theory, and strategic talent management. From the perspective of Gary Becker (1994), human capital can be considered an investment that generates economic returns to the extent that it increases individual productivity. This view was later expanded by authors such as Barney (1991), who, based on resource theory, considers intangible assets—such as tacit knowledge, specialized technical skills, and leadership—to constitute a source of competitive advantage that is difficult to imitate. Within this framework, human talent management has established itself as a key field for designing and implementing strategies aimed at strengthening competitiveness at different levels: microeconomic (company), mesoeconomic (sector), and macroeconomic (country).

Global Talent Competitiveness Index (GTCI) and the Global Competitiveness World Economic Report Forum studies show that nations that successfully integrate inclusive education, health, innovation, and employability policies exhibit higher levels of sustained competitiveness over the long term (INSEAD, 2022; WEF, 2023). Furthermore, recent empirical research has confirmed that variables such as continuous professional development, emotional intelligence, organizational learning, work engagement, and an innovative culture are positively correlated with competitive performance at both the organizational and regional levels (Boon et al., 2018; Delery & Roumpi, 2017).

Despite these advances, significant methodological challenges persist in analyzing the relationship between human capital and competitiveness. One of these challenges lies in the difficulty of prioritizing the multiple dimensions that comprise human capital and their relative impact on competitiveness. Most studies are based on partial indicators or general proxies, such as average educational level or investment in training, while neglecting factors like soft skills, resilience, adaptability, or the strategic alignment of talent with organizational objectives. This fragmentation prevents a holistic and operational understanding of the phenomenon, which hinders decision-making in business or public policy contexts.

Based on the above, this article proposes an integrated analysis model that combines the Analytic Hierarchy Method (AHP) with Exploratory Factor Analysis (EFA) techniques to identify, prioritize, and group the key dimensions of human capital that impact competitiveness. The AHP, developed by Saaty (1980), enables the structuring of complex decision-making problems through paired comparisons between criteria, utilizing expert judgment as a key input. For its part, the EFA constitutes a robust statistical technique for reducing data complexity and detecting underlying structures in large volumes of information (Hair et al., 2019). The integration of both methods provides robustness to the analysis by combining quantitative rigor with a qualitative perspective, allowing the generation of hierarchical models that are useful for strategic decision-making.

This approach addresses the need to equip managers with tools that enable them to strategically prioritize investments in human capital, optimize resources, and focus interventions on areas of most significant competitive impact. Furthermore, by employing a mixed-methodological design, the model's applicability is expanded to both public and private organizations, regardless of their size or sector of production. The choice of a generic and transversal context responds to the intention of providing an analytical framework that is transferable to multiple realities, facilitating its adoption in diverse environments, such as the business sector, educational institutions, local governments, and multilateral organizations.

The overall objective of this research is twofold: first, to establish a hierarchy of human capital factors according to their perceived impact on competitiveness using the AHP method; second, to empirically explore the clustering of these factors through factor analysis, in order to reveal latent patterns and facilitate their operational interpretation. Based on this analysis, we aim to contribute to the development of more strategic, evidence-based talent management models that can adapt to changing environments.

In brief, this article aims to bridge the gap between theoretical knowledge and organizational practice, offering an

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interdisciplinary analytical tool that facilitates a more comprehensive understanding of the role of human capital in fostering sustainable competitiveness in the 21st century.

Methodology

The study employed a sequential exploratory mixed-method design, integrating qualitative and quantitative approaches to analyze the influence of human capital on organizational competitiveness. Using a non-experimental, cross-sectional, and explanatory framework, it combined two complementary phases: (1) a qualitative stage applying the Analytic Hierarchy Process (AHP) to prioritize key dimensions, and (2) a quantitative stage using Exploratory Factor Analysis (EFA) to identify underlying structures. In Phase 1, a panel of 15 human capital and organizational development experts conducted pairwise comparisons of criteria, including technical training, soft skills, work experience, leadership, innovation, work commitment, and strategic alignment, ensuring consistency ratios of ≤ 0.10. In Phase 2, a validated 28-item instrument (CVI = 0.88) was administered to 227 professionals from diverse economic sectors who met the defined experience criteria. Data suitability was confirmed (KMO = 0.81; Bartlett's $p < 0.001$), and EFA with Varimax rotation retained factors with eigenvalues > 1.0 and loadings > 0.50, eliminating items with low communalities or cross-loadings. Reliability was excellent ($\alpha = 0.91$ overall; all dimensions > 0.75). The results revealed latent factors aligning with both technical and socio-emotional aspects of human capital, and expert input provided interpretive depth, yielding a robust, empirically grounded model for guiding talent management strategies.

Results and discussion

The Analytic Hierarchy Process (AHP) analysis allowed for the development of a hierarchy of priorities based on expert judgment regarding the relative impact of different dimensions of human capital on organizational competitiveness. As shown in the weighting table, experts identified technical training (18%) as the most relevant criterion, followed by soft skills (16%) and work experience (14%). Leadership (15%) and innovation (13%) were also highly valued, while work commitment and strategic alignment shared the lowest relative weight (12% each).

To visualize the relative importance assigned by experts to each dimension of human capital, a graph summarizing the weights obtained using the Analytic Hierarchy Method (AHP) is presented below. This graph clearly shows the established order of priority, from the dimension with the most significant perceived impact on competitiveness to the one with the least. The visual representation facilitates the interpretation of the results and provides strategic input for decision-making in human talent management.

This pattern demonstrates a technical-instrumental orientation among experts, who prioritize dimensions directly associated with immediate productivity, operational performance capacity, and the generation of tangible results. This view is consistent with studies by Boon et al. (2018) and Delery & Roumpi (2017), which highlight the importance of specialized human capital as a source of sustainable competitive advantage.

However, it should be noted that the relative weights between dimensions do not present radical differences, which reinforces the idea that human capital should be understood as an integrated configuration of attributes that interact synergistically. In other words, organizational competitiveness is not built on a single dimension, but rather on the balance
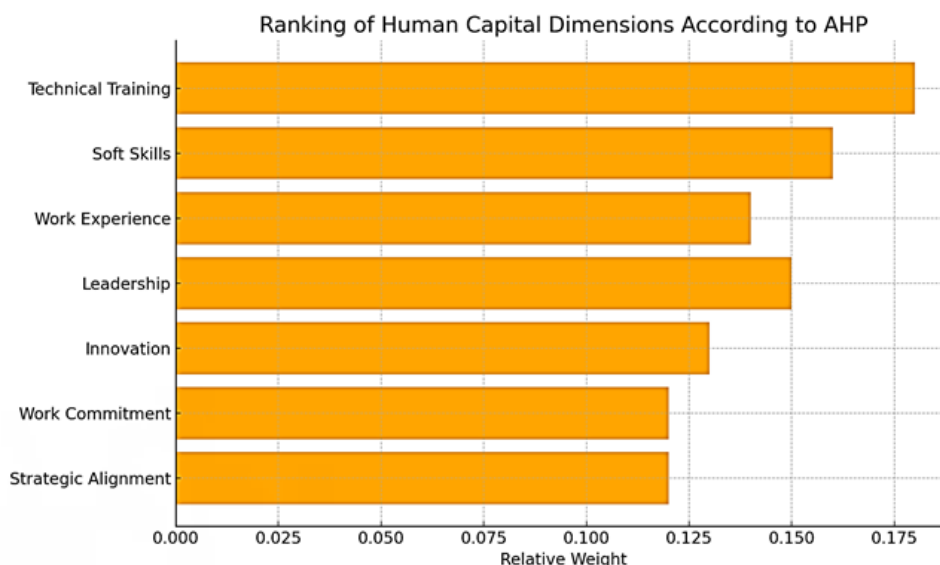
Figure 1. Hierarchy of human capital dimensions according to AHP.

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between cognitive, emotional, attitudinal, and strategic capabilities (Barney, 1991; Becker, 1994).

Furthermore, the evaluation of the consistency of the judgments using the Consistency Index (CI) and the Consistency Ratio (CR) demonstrated a high coherence in the panel responses, with average RC values lower than the threshold of 0.10 established by Saaty (1980), which validates the reliability of the weights obtained.

The application of Exploratory Factor Analysis (EFA) to a sample of 227 respondents enabled us to extract three latent factors that collectively explain 67.3% of the total variance. This factor structure, obtained through principal components extraction and Varimax rotation, revealed significant clusters that organize the dimensions of human capital more empirically and experientially.

Once statistical factor analysis techniques were applied, structural patterns were identified that grouped the evaluated items into three latent factors. The following table presents the factor loadings for each item related to the three extracted factors, enabling us to understand how the different dimensions of human capital are conceptually organized from the respondents' perspective. Higher loadings indicate a stronger association between the item and the corresponding factor, thus providing an empirical map of the underlying interrelationships between variables (Table 1).

Factor 1: Technical competence (28.7% of explained variance): includes items such as continuous training (0.76), professional certification (0.72), and problem-solving (0.48). This factor underscores the strategic importance of updating specific knowledge and skills to enhance organizational efficiency and adaptability. According to Hair et al. (2019), this type of factor is typically associated with measurable performance, making it easily assessable in results-oriented organizational contexts.

Factor 2: Socio-emotional Skills (23.1% of explained variance): This grouping includes items such as teamwork (0.81), assertive communication (0.77), and conflict resolution (0.79). These skills, often considered "soft," have gained increasing importance in hybrid and multicultural environments, where distributed leadership, empathy, and collaboration are key to innovation and organizational cohesion (Goleman, 2017; Prada et al., 2021). Their high factor loading indicates that workers perceive these skills as differentiating components of competitive performance.

Factor 3: Strategic Commitment (15.5% of explained variance): It is composed of variables such as intrinsic motivation (0.72), alignment with organizational goals (0.78), and adaptability (0.73). This factor refers to an attitudinal-professional component that links the worker's subjectivity with institutional objectives. In recent studies, such as Saks (2022), this type of alignment has been identified as a predictor of engagement, job retention, and internal innovation.

The instrument's reliability was assessed using Cronbach's alpha, yielding an overall reliability of 0.91 and dimension values greater than 0.75, supporting the questionnaire's internal consistency. Furthermore, the KMO index (0.81) and Bartlett's test ($\chi^2 = 1457.24$; $p < 0.001$) confirmed the matrix's suitability for factor analysis.

The triangulation of results between the AHP and the AFE provides a dual understanding of the phenomenon: normative from the expert perspective and empirical from the workers' experience. This enriched methodological approach allows for the identification of perception gaps, areas of convergence, and blind spots in the talent management strategy.

For example, while experts assigned less weight to work engagement as a dimension, the factorial results demonstrate that strategic engagement emerges as a structural dimension with a high empirical load. This divergence suggests that organizations may be underestimating the value of engagement as a source of internal sustainability, loyalty, and strategic alignment. Authors such as Boxall & Purcell (2016) ar-

Table 2. Factor loadings of the items according to exploratory factor analysis (EFA)

Item	Factor 1 (Technical competence)	Factor2 (Socioemotional skills)	Factor 3 (Strategic commitment)
Continuous training	0.76	0.32	0.28
Professional certification	0.72	0.36	0.22
Assertive communication	0.45	0.77	0.31
Teamwork	0.40	0.81	0.29
Work experience	0.35	0.42	0.27
Problem solving	0.48	0.79	0.30
Applied innovation	0.36	0.40	0.70
Change management	0.34	0.39	0.68
Intrinsic motivation	0.22	0.34	0.72
Mission commitment	0.20	0.31	0.75
Alignment with organizational goals	0.18	0.29	0.78
Adaptability	0.19	0.26	0.73

gue that talent-based competitive advantage is not sustained solely by technical competencies, but also by the level of emotional and ideological attachment that employees have to the organization.

Another interesting tension lies between technical training and socio-emotional skills. While the former leads the AHP, the latter appears to have greater factorial cohesion, which can be interpreted as a sign of cultural transformation in today's work environments. This is consistent with the growing demand for transversal skills in VUCA (volatile, uncertain, complex, and ambiguous) contexts, where communication, adaptability, and emotional intelligence become essential (World Economic Forum, 2018; Forum, 2023).

In short, the findings invite us to rethink the way human talent development strategies are designed: not as a sum of isolated components, but as a dynamic, interconnected, and adaptable system, in which technical, emotional, and strategic elements mutually enhance one another to generate a sustainable competitive advantage.

Conclusions

This study empirically and methodologically demonstrates that human capital is not a uniform or purely technical entity but a complex, dynamic, and multidimensional construct whose influence on organizational competitiveness emerges from the interaction of diverse competencies, attitudes, and capabilities at complementary levels. The Analytical Hierarchy Process (AHP) revealed an expert-driven prioritization that emphasizes technical training, soft skills, and work experience, reflecting a performance-oriented vision aligned with competitive production environments, but downplays work commitment and strategic alignment. In contrast, Exploratory Factor Analysis (EFA) uncovered a more balanced latent structure comprising technical competence, socio-emotional skills, and strategic commitment, highlighting the importance of intrinsic motivation, adaptability, and alignment with institutional goals. This divergence highlights a gap between formal technical criteria and the empirical factors that shape organizational behavior, with potential consequences for competitiveness. Combining AHP and EFA proved effective for both ranking priorities and identifying conceptual clusters, offering a basis for training design, performance evaluation, competency-based selection, and retention strategies. The results reinforce the resource and capability theory (Barney, 1991) and knowledge economy principles (Becker, 1994), providing evidence for the strategic value of transversal competencies and soft skills in human capital management. While acknowledging limitations in sample size and sector-specific applicability, the proposed mixed-method approach presents a replicable framework for

aligning normative and empirical perspectives to enhance organizational competitiveness through strategic talent management.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Author contributions

Conceptualization: Cancio, L., & Nardo, A. **Data curation:** Cancio, L., & Nardo, A. **Formal analysis:** Cancio, L., & Nardo, A. **Research:** Cancio, L., & Nardo, A. **Methodology:** Cancio, L., & Nardo, A. **Supervision:** CCancio, L., & Nardo, A. **Validation:** Cancio, L., & Nardo, A. **Visualization:** Cancio, L., & Nardo, A. **Writing the original draft:** Cancio, L., & Nardo, A. **Writing, review and editing:** Cancio, L., & Nardo, A.

Data availability statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Statement on the use of AI

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