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DETERMINING THE HUMAN CAPITAL PERFORMANCE OF LATIN AMERICAN COUNTRIES AND TÜRKİYE WITH CRITIC-BASED ARAS METHOD

LATİN AMERİKA ÜLKELERİ VE TÜRKİYE'NİN BEŞERİ SERMAYE PERFORMANSININ CRITIC TABANLI ARAS YÖNTEMİYLE BELİRLENMESİ

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ABSTRACT

This study aims to determine the human capital performance of Latin American Countries and Türkiye using the CRITIC (Criteria Importance Through Intercriteria Correlation) and ARAS (Additive Ratio Assessment) techniques. In the analysis, the CRITIC-based ARAS method has been used. This method is a combination of two methods. The CRITIC method has provided the objective weights of the criteria, and the ARAS method obtains human capital performances and rankings of the countries. To evaluate the human capital stock of the countries, the following criteria are utilized: the infant mortality rate (per 1,000 live births), unemployment rate (percentage of the total labor force), average life expectancy at birth, total (years), labor force participation rate (percentage of the total population aged 15-64), current health expenditure (percentage of GDP), internet users (percentage of the total population), and population aged 15-64 (percentage of the total population). The analysis covers the years 2019, 2020, and 2021. According to the results of the CRITIC method, the infant mortality rate has been the least significant criterion for every year under study, whereas the unemployment rate is the most significant. The ARAS method suggests that, in every year examined, Cuba has done its best in terms of human capital. Chile and Uruguay rank second and third, respectively, after Cuba. Throughout the years under study, Guinea has performed the worst, followed by Haiti. Venezuela in 2021 and Honduras in 2019 and 2020 rank third-worst. Among the 22 nations, Türkiye ranks 15th in 2019, 12th in 2020, and 13th in 2021.

MAKALE BİLGİSİ

Anahtar Kelimeler
Beşerî Sermaye, Çok Kriterli Karar Verme Teknikleri, ARAS Metodu, CRITIC Metodu, Latin Amerika Ülkeleri
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ÖZET

Bu çalışmanın amacı, Latin Amerika Ülkeleri ve Türkiye'nin beşerî sermaye performansını CRITIC (Kriterlerarası Korelasyon Yoluyla Kriter Önemi) ve ARAS (Katkı Oranı Değerlendirmesi) tekniklerini kullanarak belirlemektir. Analizde CRITIC tabanlı ARAS yöntemi kullanılmıştır. Bu yöntem iki yöntemin birleşimidir. Kriterlerin nesnel ağırlıkları CRITIC yöntemiyle belirlenmekte, ülkelerin beşerî sermaye performansları ve sıralaması ise ARAS yöntemiyle elde edilmektedir. Ülkelerin beşerî sermaye stokunun değerlendirilmesinde şu kriterler kullanılmaktadır: Bebek ölüm oranı (1000 canlı doğumda), işsizlik oranı (toplam işgücünün yüzdesi), doğumda ortalama yaşam süresi, toplam (yıl), işgücüne katılım oranı (15-64 yaş arası toplam nüfus içindeki yüzde), cari sağlık harcamaları (GSYH içindeki yüzde), internet kullanıcıları (toplam nüfus içindeki yüzde) ve 15-64 yaş arası nüfus (toplam nüfus içindeki yüzde). Analiz 2019, 2020 ve 2021 yıllarını kapsamaktadır. CRITIC yöntemi sonuçlarına göre, incelenen her yıl için bebek ölüm oranı en az önemli kriter olurken, işsizlik oranı en önemli kriter olmuştur. ARAS yöntemi, incelenen her yılda Küba'nın beşeri sermaye açısından en iyi performansı gösterdiğini ortaya koymaktadır. Şili ve Uruguay Küba'nın ardından sırasıyla ikinci ve üçüncü sırada yer almaktadır. İncelenen yıllar boyunca Gine en kötü performansı göstermiş ve onu Haiti izlemiştir. 2021'de Venezuela ve 2019 ile 2020'de Honduras üçüncü en kötü ülkeler arasında yer almıştır. Türkiye, 22 ülke arasında 2019'da 15'inci, 2020'de 12'inci, 2021'de ise 13'üncü sırada yer almıştır.

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Human capital refers to the knowledge, skills, and other qualities that individuals develop concerning economic activities. It encompasses all the abilities possessed by the workforce, such as knowledge and skills, that contribute to personal and social development and lead to an increase in economic welfare (OECD, 1998:8,11).

Economies are aware that in addition to physical capital capacity, human capital capacity must also be at a sufficient level for economic growth. The increase in the amount of human capital per capita leads to a higher rate of human and physical capital investment, which increases the income per capita (Barro 1991: 409). Countries with high human capital capacity, more specifically, countries with highly educated citizens, have taken one of the important steps in terms of economic growth and long-term development. A well-educated workforce is more mobile, prone to learning new tasks and skills, implementing various newly developed technologies and complex equipment, and has a more innovative approach to problem-solving. Therefore, such high-skilled human capital positively affects the competitiveness of countries in international markets and accelerates their development processes (Ali and Jabeen, 2015: 579). Investments made by governments in developing education and technological infrastructure will have a more positive effect on growth by increasing human capital accumulation than the increase in physical capital investment. In this context, underdeveloped countries with inadequate human capital and infrastructure levels cannot receive sufficient foreign capital, and this causes their growth rates to remain low (Çeştepe and Gençel 2019: 140).

Human capital is essential to developing nations' socioeconomic progress. The following reasons contribute to its significance: Health and education expenditures increase worker productivity, which propels economies forward. Better-skilled and healthier workers contribute more to services, agriculture, and industries, increasing GDP per capita (Sain and Bozkurt, 2023). As demonstrated by East Asian economies during their periods of rapid expansion, empirical evidence indicates a substantial correlation between human capital accumulation and economic growth. By improving life expectancy and lowering productivity losses from disease, human capital investment in health leads to a healthier workforce. This is particularly crucial in developing countries that are dealing with public health issues (Patrinos, 2016).

Education gives people the means to find better jobs, which raises earnings and improves living conditions. This lessens cycles of poverty that span generations (Heckman, 2016). For example, countries that make significant investments in basic and secondary education find a direct influence on reducing poverty by giving disadvantaged populations more opportunities.

People with higher levels of education are more likely to call for improved accountability, transparency, and governance, which promotes stable political settings that support growth. The delivery of public services in the fields of infrastructure, education, and health is also enhanced by skilled human resources (Bajraktari, 2016). Employees with knowledge and expertise are better able to embrace and develop new technology. (Guz and Kvashnina, 2023) This is crucial for nations hoping to shift from economies centered on agriculture to those centered on industry or knowledge.

This study will compare Türkiye and Latin American countries in terms of human capital performance. Latin American countries were chosen for comparison because of the similarity of these countries with Türkiye in many aspects. Türkiye's economy is similar to that of many Latin American nations. Emerging market economies in Latin America and Türkiye both deal with issues including inflation, income inequality, and outside economic shocks (Koç and Yakışık, 2016:199). With gross domestic products that are close to $1 trillion, Türkiye and Mexico, for instance, have two of the biggest economies in their respective areas. Global economic crises, like the 2008 financial crisis, have also had a detrimental impact on both areas. Furthermore, trade agreements are essential to the economic development of both Latin American nations and Türkiye. While Latin American nations like Mexico also profit from trade accords like the North American Free Trade Agreement (NAFTA) (now The United States-Mexico-Canada Agreement, USMCA), Türkiye is a member of the European Union (EU) Customs Union (Öztürk, 2021).

An estimation and understanding of a nation's future growth potential can be obtained from its existing level of human capital. One way to assess a nation's standing within a group is to compare its human capital to that of other nations that are comparable to it. The weighting of the factors in multi-criteria decision-making (MCDM) studies can be accomplished objectively through calculating techniques or subjectively by seeking expert opinion. Academic research frequently employs the CRITIC (Criteria Importance Through Intercriteria Correlation) method, which assigns objective weights to the criteria based on their relative importance. Numerous MCDM methods exist, including ARAS (Additive Ratio Assessment), ELECTRE (Elimination Et Choix Tradui-sant la Realite), TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), COPRAS (Complex Proportional Assessment), and WASPAS (Weighted Aggregated Sum Product Assessment). When doing research using MCDM approaches, the alternatives are frequently rated based on how well they performed throughout a specific period. MCDM approaches do not demonstrate a cause-and-effect link. This method does not identify how variables affect one another. Therefore, it cannot be used to make future predictions based on cause-and-effect relations. Yet, some policy recommendations can be made to increase the performance of low-performing countries. As a result, it is not employed for hypothesis testing. These methods make it possible to rank the top-performing options based on predetermined criteria.

The ARAS technique is a kind of MCDM tool that ranks a small number of decision alternatives, all of which must be considered simultaneously in terms of the different decision criteria. It doesn't involve any complicated computation procedures. The primary benefit of the ARAS approach is that it helps prioritize alternatives by calculating the degree of alternative utility by comparing the variant to the (ideally) best one. It is, therefore, quite convenient to rank and evaluate the other possibilities when this method is employed (Goswami, 2021:4).

The CRITIC and ARAS techniques were employed to evaluate the human capital performance of Latin American and Turkish countries through a hybrid analytical model. The CRITIC method identified the significance of human capital criteria, while the ARAS method ranked countries based on their performance. The study analyzed data from 2019 to 2021 to assess the progress of these nations over the reviewed period. Subsequent chapters include a literature review, data description, detailed explanations of CRITIC and ARAS methods, findings, and a conclusion. This approach highlights a comprehensive methodology to effectively assess and compare human capital metrics.

1. LITERATURE REVIEW

The CRITIC-based ARAS approach has been applied in a wide range of scientific and social science fields as a multi-criteria decision-making technique. Here is a summary of research on this approach's application in assessing human capital performance and various other areas.

The "old EU-14" and "new EU-13" countries' levels of human capital development were compared by Brodny and Tutak (2024). A novel research methodology was developed that employs the COPRAS method to calculate the human capital evaluation index and the CRITIC method to estimate the weights of the indicators characterizing the studied human capital. This capital's impact on economic growth, innovation, and unemployment was assessed using an econometric model. The results reveal significant differences in human capital between the EU-27 countries and the "old EU-14" and "new EU-13" categories. Sieng and Yussof (2015) analyze Malaysia and other chosen nations regarding human capital accomplishment using the non-traditional TOPSIS technique, with education as the primary indicator of human capital. According to the results,

Malaysia is performing well compared to its ASEAN peers, but more work needs to be done to catch up to the industrialized countries. Balcerzak (2016) provided a multi-criterion macroeconomic analysis of the quality of human capital in EU countries. The research was carried out from 2001 to 2012. Hellwig's taxonomic measure of development, which is a continuous pattern throughout the entire period, is used in the study. Hellwig's method is quite similar to the TOPSIS approach, which is currently commonly used in MCDM and is based on the concept of resemblance to an ideal solution. The countries were separated into homogenous subsets using the natural breaks approach once the relative measure for the quality of human capital was obtained. The main advantage of applied techniques is their great methodological flexibility. Chou et al. (2019) assessed the performance of Southeast Asian nations in terms of human resources in science and technology (HRST) using fuzzy AHP (Analytic Hierarchy Process) and fuzzy TOPSIS. According to the fuzzy TOPSIS study, Taiwan, South Korea, and Singapore all have comparable HRST performance goals. In other words, these three nations outperform other Southeast Asian nations in terms of that. The E-7 and G-7 nations' human capital performance was evaluated by Güzel and Murat (2014). The TOPSIS technique was used to assess the factors believed to have an impact on the nation's human capital. Additionally, the association between TOPSIS and HDI (Human Development Index) rankings was ascertained using Spearman's Ranking Correlation analysis. The United States of America had the best human capital performance, while India had the worst, according to the analysis's findings. Furthermore, an analysis of the correlation between the HDI ranking and the human capital ranking produced using the TOPSIS approach revealed that the rankings overlapped as anticipated. Dinçer et al. (2021) assess the E7 economies' human capital potential. The MOORA (Multi-Objective Optimization Ratio Analysis) approach was used to rank the countries after the Fuzzy DEMATEL (Decision Making Trial and Evaluation Laboratory) method was used to assess four dimensions and twenty-one criteria. According to the study's findings, distribution and knowledge acquisition are the most crucial factors, while the unemployment rate and the supply of skilled labor are given the most weight. According to the data, Mexico and Brazil have the lowest human capital capacities, while Russia and India have the most. For low-ranking nations, technical investments and efficient training initiatives are advised. After summarizing the studies on human capital in the literature, studies using CRITIC-ARAS methods in different fields will now be discussed.

Şenol and Ulutaş (2018) examined data from businesses on the Istanbul Stock Exchange that are involved in the Chemical Petroleum Rubber and Plastic Products industry. The CRITIC and ARAS techniques were used to create the company ranking. The weights of the criterion were determined using the CRITIC approach, and the performance of the companies in the criteria was ranked using the ARAS method. When accounting-based performance criteria and market-based performance criteria were considered separately, it was concluded that the benefit values and performance rankings between companies were different, and the Spearman correlations regarding the ranking of the two performance criteria were low. Özkan and Ağ (2021) used the CRITIC and ARAS techniques to measure the corporate sustainability performance of industrial businesses that are traded on Borsa İstanbul. Six businesses were scored independently based on their economic, environmental, and social performance after their corporate sustainability performance was assessed using seven economic, environmental, and social criteria. Boskovic et al. (2021) sought a solution to the problem of mobile network selection for customers by using CRITIC and ARAS methods in a hybrid way, in line with six criteria determined by expert opinion. The criteria were weighted using the CRITIC method, and then mobile network operators were ranked according to their performance values. Thus, mobile network operators that provide maximum benefit for customers were determined. George et al. (2021) evaluated the suppliers of a manufacturing company with CRITIC and ARAS methods. Accordingly, four criteria were used, and the performance of fourteen suppliers was evaluated. As a result of the study, the suppliers were ranked according to the benefits they provided to the manufacturing company, and the best suppliers were identified. Szymczyk et al. (2023) measured the entrepreneurial performances of the countries by using the indicators that constitute the global entrepreneurship monitor. First, the weights of the indicators were ascertained using the CRITIC method. Then, entrepreneurial performances were compared using ARAS, WASPAS, and MAIRCA Techniques. Görmüş (2021) used the CRITIC method to weigh the financial performance indicators of insurance companies traded on the Istanbul Stock Exchange. The financial performance of six companies was evaluated by six criteria. Subsequently, an evaluation was made using TOPSIS and ARAS methods. The financial performance structures of the companies were similar in both methods. Özdemir and Mauruf (2020) conducted a performance analysis for the polyclinics of a private hospital operating in Ankara. In the analysis, the number of patients, the number of examinations, the average patient satisfaction score, and the number of complaints criteria were weighted by the CRITIC method. Then, the ARAS method was used to rank the activity performances. Arsu (2020) evaluated EU countries in terms of renewable energy and environmental performance in the study. Accordingly, the determined criteria were weighted using the CRITIC method, and the ranking was obtained using the ARAS method. It was concluded that Russia showed the highest performance. Kargı (2022) conducted a digital reading level analysis for 38 OECD countries. Importance weights of the determined criteria were created with the CRITIC method. Then, the digital reading level ranking was obtained with the ARAS method. The first five countries in the ranking were determined as Luxembourg, USA, Switzerland, Korea, and Iceland. Yerdelen (2023) analyzed the performance

of transportation-related revenue and expense items in Türkiye's balance of payments from 2012 to 2021. The importance levels were determined using the CRITIC method. Accordingly, it was determined that the most important criterion was passenger transportation. In ARAS and WAPRAS analyses, the performance ranking was revealed. The highest performance was obtained in 2013, and the lowest performance was obtained in 2012. Bircan (2022) evaluated the financial performances of businesses in the logistics industry in the Fortune 500 list covering the COVID-19 pandemic period and its aftermath. First, the criteria were weighted using the CRITIC method, and then the financial performances of the companies were analyzed by period using the ARAS method. The best performance ranking was obtained as Netlog, Ekol, Alişan, Borusan, and Horoz. Doğan (2022) analyzed Türkiye's macroeconomic performance between 2010 and 2020. The seven criteria determined in the study (growth rate, GDP per capita, unemployment, foreign direct investment inflow, interest rate, inflation rate) were weighted using the CRITIC method, and then annual performances were ranked using the ARAS method. According to the results, Türkiye's macroeconomic performance was best in 2012 and worst in 2020. Altan (2022) ascertained the optimal portfolio by the integrated CRITIC-ARAS method. Five portfolios were organized with the themes of Blockchain technologies, renewable energy, healthcare companies, electric vehicles, and the digital gaming sector with data from 2021. The method suggested that the optimal theme among the thematic portfolios was healthcare companies.

2. DATA AND METHODOLOGY

2.1. Data

This study uses the CRITIC and ARAS techniques to rank Türkiye and the Latin American nations according to their human capital performance. An integrated CRITIC-ARAS method is used. The CRITIC Method determines the criteria's objective importance. The ARAS Method has been used to measure each country's human capital performance. The World Bank Database is the source of the dataset. Seven human capital criteria from 2019, 2020, and 2021 were employed in the computations for each country. The absence of data for all Latin American countries makes using more indicators and the most recent data impossible.

Criteria for assessing a nation's human capital performance include the following: The infant mortality rate (per 1,000 live births), unemployment rate (percentage of the total labor force), average life expectancy at birth, total (years), labor force participation rate (percentage of the total population aged 15-64), current health expenditure (percentage of GDP), internet users (percentage of the total population) and population aged 15-64 (percentage of the total population). The majority of these criteria are recognized as indicators of human capital by international organizations, including the World Bank, the UN, and the OECD, and they are typically employed in empirical studies on human capital (Yu,2015:163). The human capital criteria, along with abbreviations and orientations, are listed in Table 1.

Table 1: *Criteria, Abbreviations, and Orientations*

No.	Criteria	Abbreviation	Orientation
1	Mortality rate, infant (per 1,000 live births)	MR	Minimum
2	Unemployment, total (% of total labor force)	UN	Minimum
3	Current health expenditure (of % GDP)	CHE	Maksimum
4	Individuals using the Internet (% of population)	IU	Maksimum
5	Labor force participation rate, total (% of total population ages 15-64)	LFPR	Maksimum
6	Life expectancy at birth, total (years)	LE	Maksimum
7	Population ages 15-64 (% of total population)	PA 15-64	Maksimum

Source: *Worldbank Database*

The criteria in Table 1 with the numbers 3, 4, 5, 6, and 7 are benefit criteria; the greater the performance score, the larger the criterion value. Cost criteria are represented by the numbers 1 and 2, where a lower criterion value corresponds to a greater performance score. The following are the definitions and directions of each criterion. The definitions of criteria were taken from the World Bank Meta Data Glossary.

Mortality rate, infant (per 1,000 live births): The number of newborns who pass away before turning one year old per 1,000 live births in a particular year is known as the infant mortality rate. In the table, it is abbreviated as MR. The mortality rate must be oriented at the lowest possible level. It indicates that minimal rates are preferable to maximum rates.

Unemployment, total (% of total labor force): The percentage of the labor force that is unemployed yet still looking for work is known as unemployment. The unemployment rate represents the percentage of the labor force that is jobless. The entire number of employed and unemployed individuals is known as the labor force. There is an implied maximum employment rate

from the minimum unemployment rate. Thus, the unemployment rate must be oriented toward the minimum level. The table uses the UN to represent unemployment.

Current health expenditure, total (% of GDP): The combination of governmental and private health spending is known as total health expenditure. It does not cover the provision of water and sanitation, but it does cover family planning, nutrition, emergency help for health, and preventive and curative health care. In the table, it is referred to as CHE. The health expense variable needs to be oriented at the maximum level. Higher values are, therefore, preferable to lesser ones.

Individuals using the internet (% of population): Anyone who has used the internet as a percentage of the population, regardless of where they are, is considered an internet user. They can use a computer, a smartphone, a PDA, a gaming console, a digital television, and more to access the internet. The table uses IU as its denominator. People who use the internet should be oriented to the maximum.

Labor force participation rate, total (% of total population ages 15-64): The percentage of people between the ages of 15 and 64 who are economically active—that is, all those who provide labor for the production of goods and services within a certain period—is known as the labor force participation rate. In the table, it is referred to as LFPR. The labor force participation rate must be oriented at its highest possible level.

Life expectancy at birth, total (years): The number of years a newborn baby would live if the mortality trends at its birth continued to exist is known as the life expectancy at birth. In the table, it is abbreviated as LE. The life expectancy at birth variable must be oriented at its highest level. It implies that greater values are preferable to lower ones.

Population ages 15-64 (% of total population): The de facto definition of population, which includes all inhabitants regardless of citizenship or legal status, is the basis for population statistics. The table shows that it is abbreviated as PA 15-64. The orientation of this indicator should be maximum.

2.2. The CRITIC Method

The CRITIC technique was initially documented in a study carried out in 1995 by Diakoulaki et al. Using this technique, actual data for each evaluation criterion is compiled to create objective weights. The most significant aspect of the CRITIC technique is not the expert opinions' subjective outcomes but rather its objective weighting, which is established by combining the inter-criteria correlation and the standard deviation of the criteria (Kargı, 2022:365). The following lists the procedures to be followed when using the CRITIC technique. (Diakoulaki et al., 1995: 765):

Step 1: In the first step, a decision matrix of size *mxn* is created as in Equation (1) to show i alternatives and j criteria.

$$X = \begin{bmatrix} x_{01} & x_{0j} & \dots & x_{0n} \\ x_{i1} & x_{ij} & \dots & x_{in} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{mj} & \dots & x_{mn} \end{bmatrix}; \; i = 0,1,\dots,m \; and \; j = 1,2,\dots,n \tag{1}$$

Step 2: At this step, the formulas in Equation (2) for the benefit criterion and Equation (3) for the cost criteria in the decision matrix are used to carry out the normalization process.

$$r_{ij} = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} \; ; \; i = 0,1,\dots,m \; and \; j = 1,2,\dots,n \tag{2}$$

$$r_{ij} = \frac{x_j^{max} - x_{ij}}{x_j^{max} - x_j^{min}} \; ; \; i = 0,1,\dots,m \; and \; j = 1,2,\dots,n \tag{3}$$

Step 3: After the normalization process, Equation (4) is used to calculate the correlation coefficient between the criteria pairs in order to ascertain the degree of association between the criteria.

$$\rho_{jk} = \frac{\sum_{i=1}^{m} \left(r_{ij} - \bar{r}_j\right)(r_{ik} - \bar{r}_k)}{\sqrt{\sum_{i=1}^{m} \left(r_{ij} - \bar{r}_j\right)^2 \cdot \sum_{i=1}^{m} (r_{ik} - \bar{r}_k)^2}}; k = 1,2,3, \dots, n \quad (4)$$

Step 4: Equation (5) is used to get the standard deviation of each criterion.

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m} (r_{ij} - \bar{r}_j)^2}{m-1}} \quad (5)$$

Step 5: At this stage, the total information values of each criterion are calculated by Equation (6) using the values calculated in Equation (4) and Equation (5).

$$C_j = \sigma_j \sum_{k=1}^{n} (1 - \rho_{jk}) \, (j, k = 1,2, \dots, n) \quad (6)$$

Step 6: In the last stage, the importance weights of each criterion are calculated by Equation (7).

$$w_j = \frac{C_j}{\sum_{k=1}^{n} C_j} (j, k = 1,2, \dots, n) \quad (7)$$

2.3. The ARAS Method

One technique for assessing and prioritizing options in MCDM problems is the ARAS method. It was created by scholars Zavadskas and Turskis from Lithuania, and it stands out for its capacity to assess utility functions impartially. This approach ranks the alternatives by comparing their utility values to those of a reference (ideal) alternative. The ARAS Method contains the following steps (Dadelo et al., 2012):

Step 1: Creating the Decision Matrix:

The first step is to generate the decision matrix X, where n is the number of criteria and m is the number of possibilities. The created decision matrix is shown in Equation (8).

$$\mathrm{X} = \begin{bmatrix} x_{01} & x_{0j} & \dots & x_{0n} \\ x_{i1} & x_{ij} & \dots & x_{in} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{mj} & \dots & x_{mn} \end{bmatrix} \quad (8)$$

The x_{ij} element in the X decision matrix shows the performance value of the *i*th alternative in the *j*th criterion, while the x_{0j} element shows the optimal value of the *j*th criterion. Suppose the optimal value of the criterion is unknown in the decision problem. In that case, the optimal value is calculated using Equations (9) and (10) depending on whether the criterion has a benefit (higher is better) or cost (lower is better) feature.

For benefit-oriented criteria: $$x_{0j} = \max_i x_{ij} \quad (9)$$

For cost-oriented criteria: $$x_{0j} = \min_i x_{ij} \quad (10)$$

Step 2. Creating the Normalized Decision Matrix

In the ARAS method, the $\bar{X}$ normalized decision matrix consists of $\overline{x}_{ij}$ values. The $\overline{x}_{ij}$ values are calculated in 2 ways depending on whether the criterion shows benefit or cost characteristics. If higher criterion performance values are considered better (benefit-oriented), the normalized values are calculated using Equation (11).

$$\overline{x}_{ij} = \frac{x_{ij}}{\sum_{i=0}^{m} x_{ij}} \tag{11}$$

If lower criterion performance values are considered better (cost-oriented), the normalization process is carried out in two steps. In the first step, performance values are converted to benefit-oriented using Equality (12), and in the second step, the normalized value is calculated using Equality (13).

$$x_{ij}^{*} = \frac{1}{x_{ij}} \tag{12}$$

$$\overline{x}_{ij} = \frac{x_{ij}^{*}}{\sum_{i=0}^{m} x_{ij}^{*}} \tag{13}$$

After the normalized values are calculated, they are written in the matrix form shown in Equation (14) to obtain the $\bar{X}$ normalized decision matrix.

$$\bar{X} = \begin{bmatrix} \overline{x}_{01} & \overline{x}_{0j} & \dots & \overline{x}_{0n} \\ \overline{x}_{i1} & \overline{x}_{ij} & \dots & \overline{x}_{in} \\ \dots & \dots & \dots & \dots \\ \overline{x}_{m1} & \overline{x}_{mj} & \dots & \overline{x}_{mn} \end{bmatrix}; i = 0,1,\dots,m \; and \; j = 1,2,\dots,n \tag{14}$$

Step 3. Creating the Weighted Normalized Decision Matrix

The normalized decision matrix $\bar{X}$ is transformed into a weighted normalized decision matrix $\hat{X}$ using the wj criterion weights. The wj criterion weights should be between 0 and 1 ($0 < wj < 1$). In addition, the weight sums of the criteria are limited, as in Equation (15).

$$\sum_{j=1}^{n} w_j = 1 \tag{15}$$

Then, the elements of the normalized decision matrix are multiplied by the criteria weights to determine the elements of the weighted normalized decision matrix $\hat{x}_{ij,}$ and thus, the weighted normalized decision matrix $\hat{X}$ is formed. These operations are shown in Equation (16) and Equation (17).

$$\hat{x}_{ij} = \overline{x}_{ij} \cdot w_{ij} \tag{16}$$

$$\hat{X} = \begin{bmatrix} \hat{x}_{01} & \hat{x}_{0j} & \dots & \hat{x}_{0n} \\ \hat{x}_{i1} & \hat{x}_{ij} & \dots & \hat{x}_{in} \\ \dots & \dots & \dots & \dots \\ \hat{x}_{m1} & \hat{x}_{mj} & \dots & \hat{x}_{mn} \end{bmatrix}; \; i = 0,1,\dots,mj = 1,2,\dots,n \quad (17)$$

Step 4: Determination of Optimality Function Values (S_i) of Alternatives:

In the last step of the ARAS method, the optimality values of all alternatives are calculated. The formula presented in Equation (18) is used to determine the optimality values of the alternatives.

$$S_i = \sum_{j=1}^{n} x_{ij}; \;\; i = 0,1,\dots,m \quad (18)$$

The S_i value is the optimum value of the ith alternative. As the S_i value increases, the performance of the alternatives increases. Finally, the Si values of all alternatives are divided by the optimal value of S_0 to determine the K_i benefit values. The Ki value is calculated with the help of Equation (19).

$$K_i = \frac{s_i}{s_0}; i = 0,1,\dots,m \quad (19)$$

The relative effectiveness of the utility function values of the alternatives can be calculated by using the K_i ratios that take values in the range [0,1]. In this direction, the alternatives are evaluated by ranking their values from biggest to smallest.

3.FINDINGS

In this section, the CRITIC method determined the criteria weights to measure the human capital performance of Türkiye and Latin American countries between 2019, 2020, and 2021. Then, the countries were ranked according to their performance using the ARAS method. All calculations related to the CRITIC and ARAS methods were carried out with the help of the Excel program. The data in this part of the study were compiled from the World Bank database.

3.1. Results of the CRITIC Method

The CRITIC Method provides objective weighting of criteria. The weights of the criteria show the importance level of each criterion. The importance levels of the criteria obtained by the CRITIC Method can be seen in Table 2.

Table 2: *Importance levels of criteria by CRITIC Method*

Criteria	2019 Value	Rank	Criteria	2020 Value	Rank	Criteria	2021 Value	Rank
UN, total	0,281	**1**	UN, total	0,281	**1**	UN, total	0,281	**1**
CHE (% of GDP)	0,146	2	LFPR, total	0,18	2	LFPR, total	0,164	2
IU (% of population)	0,143	3	IU (% of population)	0,127	3	IU (% of population)	0,134	3
LFPR, total	0,14	4	CHE (% of GDP)	0,126	4	CHE (% of GDP)	0,126	4
PA 15-64	0,105	5	LE, total (years)	0,102	5	LE, total (years)	0,107	5
LE, total (years)	0,096	6	PA 15-64	0,096	6	PA 15-64	0,1	6
MR, infant	0,09	**7**	MR, infant	0,087	**7**	MR, infant	0,088	**7**

The unemployment rate is the most important criterion, and the Infant mortality rate has been the least important criterion for all years studied. Asking experts for their opinions on the criteria weights is one strategy used in MCDM analysis. However,

because subjectivity is involved, this situation may be criticized. The CRITIC technique was used because it enables the objective determination of the criteria weights. The methodology employed identified the infant mortality rate as the least significant criterion and the unemployment rate as the most significant criterion across all years studied. The other criteria's relative importance changed with time.

3.2. Results of the ARAS Method

The rankings and values of the nations according to their performance in human capital over the years under review are displayed in Table 3.

Table 3: *Values and Rankings of Counties by ARAS Method*

Countries	2019 Values	Rank	Countries	2020 Values	Rank	Countries	2021 Values	Rank
Cuba	1,4597	1	Cuba	1,5065	1	Cuba	1,4521	1
Chile	1,1429	2	Chile	1,1509	2	Chile	1,15	2
Uruguay	1,1324	3	Uruguay	1,1505	3	Uruguay	1,1496	3
Costa Rica	1,0627	4	Argentina	1,067	4	Argentina	1,0647	4
Argentina	1,0444	5	Costa Rica	1,063	5	Costa Rica	1,0451	5
Mexico	0,9996	6	Brazil	1,0137	6	Ecuador	1,0382	6
Peru	0,99	7	Mexico	1,0071	7	Mexico	1,0094	7
Ecuador	0,9874	8	Ecuador	1,0015	8	El Salvador	0,9935	8
Brazil	0,981	9	Paraguay	0,9738	9	Brazil	0,9816	9
Panama	0,9515	10	Colombia	0,9614	10	Peru	0,9783	10
Paraguay	0,9402	11	El Salvador	0,9598	11	Guatemala	0,9762	11
Colombia	0,9358	12	Türkiye	0,9568	12	Paraguay	0,9597	12
El Salvador	0,9341	13	Peru	0,9505	13	Türkiye	0,9575	13
Guatemala	0,9245	14	Dominican Republic	0,9484	14	Colombia	0,9568	14
Türkiye	0,9222	15	Panama	0,9451	15	Panama	0,9347	15
Dominican Republic	0,9151	16	Guatemala	0,9273	16	Nicaragua	0,9187	16
Bolivia	0,8704	17	Nicaragua	0,9141	17	Dominican Republic	0,9114	17
Nicaragua	0,8658	18	Bolivia	0,878	18	Bolivia	0,9095	18
Venezuela, RB	0,8213	19	Venezuela, RB	0,8423	19	Honduras	0,8409	19
Honduras	0,8173	20	Honduras	0,8227	20	Venezuela, RB	0,8211	20
Haiti	0,6258	21	Haiti	0,6498	21	Haiti	0,6407	21
Guinea	0,5925	22	Guinea	0,6255	22	Guinea	0,6261	22

According to Table 3, Cuba has performed the best in terms of human capital in all the years reviewed. Chile and Uruguay follow Cuba in the second and third rank, respectively. Guinea has had the worst performance in all the years under review, and Haiti follows Guinea. The third-worst countries are Honduras in 2019 and 2020 and Venezuela in 2021. Türkiye has the 15^{th} rank in 2019, 12^{th} in 2020, and 13^{th} in 2021 among the 22 countries.

4.CONCLUSION

The most significant forces behind economic development and productivity are human and social capital. A nation must boost its production in order to raise and expand per capita output and consumption, raising living standards in the process. In a globalized economy where nations vie for resources and markets, the demand for greater efficiency is even more pressing. Public policy should focus on the expansion, enhancement, and effectiveness of human capital utilization since productivity growth is becoming more and more dependent on the creation and use of new technologies (Yu, 2015:171).

A methodology that combines the CRITIC and ARAS approaches is used to compare countries in Latin America and Türkiye. This study might have been completed without using the CRITIC technique if the criteria weights had been determined by consulting an expert. This scenario, however, might have been criticized as subjectivity would have been involved. Since the CRITIC method is one of the objective weight determination techniques employed extensively in recent years, a hybrid approach called the CRITIC-ARAS model was developed to reduce the potential critiques that may be directed at this problem. CRITIC method provides that for every year under study, the infant mortality rate has been the least significant criterion, while

the unemployment rate is the most significant.

According to the ARAS method results, every year examined, Cuba has done the best in terms of human capital. Chile and Uruguay rank second and third, respectively, after Cuba. Throughout the years under study, Guinea has performed the worst, followed by Haiti. Honduras in 2019 and 2020, as well as Venezuela in 2021, rank third. Among the 22 nations, Türkiye ranks 15th in 2019, 12th in 2020, and 13th in 2021.

There are certain restrictions on the results. The total economic performance of the nations is not depicted. In some years, some criteria are used to determine the ranking. Changing the criteria and the years under study will affect the ranking. The final result is an evaluation of the state of nations in a specific year. On the basis of their performance, it is feasible to offer recommendations regarding the policies that nations ought to adhere to. The reasons why certain nations perform better than others can be explained by some recent econometric research based on cause-and-effect relations. In addition, besides the CRITIC-ARAS method, some other MCDM methods can also be used in future studies.

The following suggestions can be put into practice to support human capital development in low-performing nations. (ASEAN, 2019: 2): In addition to boosting collaboration through joint initiative pursuit, nations should pledge to increase public and multi-sectoral investments in nutrition and healthy diets. To guarantee that education promotes students' flexibility, critical thinking, teamwork, and entrepreneurship, it should focus on learning objectives, competencies, and skills in education. In order for people of all ages to prosper and contribute to the future economy and national competitiveness by being a member of a workforce that is both productive and flexible, countries should provide the opportunities and surroundings necessary for this to happen.

Macroeconomic policies must be implemented in human capital-poor nations, especially to lower unemployment and increase labor force participation. The percentage of GDP allocated to health care should also be raised in order to promote a healthier generation, a lower death rate, and a longer lifespan. In addition, providing universal, excellent elementary and secondary education must be the government's main priority. Programs that are specifically designed to meet market demands can aid in closing the skills gap. Increasing access to inexpensive healthcare guarantees a healthy workforce. Laws that encourage talented foreigners to contribute to their native nations help lessen the impacts of brain drain.

AUTHOR DECLARATIONS

Declarations of Research and Publication Ethics: This study has been prepared in accordance with scientific research and publication ethics.

Ethics Committee Approval: Since this research does not include analyzes that require ethics committee approval, it does not require ethics committee approval.

Author Contributions: Each author made an equal contribution to the research.

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