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Digitalization, Education And Employment Nexus Within The Scope of Life Long Learning: CRITIC Based Gray Relational Analysis Application[1]

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Abstract

The European Union has developed many policies, decisions, strategies and projects on lifelong learning and has set some targets, especially in education, employment and competitiveness. Today's technological developments and the effects of these developments on education and employment cannot be ignored. In this study, within the scope of the objectives of lifelong learning in the EU, the technological developments in the EU countries, education and employment indicators and their performances are evaluated and the countries that come to the fore and fall behind are discussed.

The aim of this study is to evaluate the performance of EU countries with the CRITIC-based Gray relational analysis method with some technology, education and employment data that are important within the scope of lifelong learning in the digitalized world. In particular, the education variables of individuals at higher education level who are educated with digital skills brought by our age and close to taking part in business life, employment of new graduates, unemployment with advanced education, the share of government expenditures spent on education in GDP, the share of the ICT Sector in GDP, which shows the effects of technology on employment, and the share of ICT experts in total employment. etc. variables are included in the scope of the study. With the help of the variables included in the study, according to the findings of

[1] This study is derived from the summary paper presented by the author at the "9th International Conference on Lifelong Education and Leadership".

the CRITIC method, it was seen that the most important first five criteria were students enrolled in Higher Education (12,11%), leave education and training early (9.32%), the share of the ICT Sector in GDP (8.38%), highly educated unemployment (8.08%), Total unemployment rate (-7.08%).

However, in the Gray Relational Analysis findings using the weights obtained by the CRITIC method, Sweden, Finland, Spain, Denmark, Malta, Germany took the lead in the performance ranking by providing the balance of technology, education and employment, it has been found that countries such as Poland, Latvia, Croatia, and Slovenia are also in the last place.

Key Words: Lıfelong Learnıng, Digitalization, Employment, GIA Method.

Jel Cods: A20,C19, C44, D83, I3, O33.

Yaşam Boyu Öğrenme Kapsamında Dijitalleşme, Eğitim ve İstihdam İlişkisi: CRITIC Tabanlı Gri İlişkisel Analiz Uygulaması

Özet

Avrupa Birliği yaşam boyu öğrenme konusunda birçok politikalar, kararlar, stratejiler ve projeler geliştirerek özellikle, eğitim, istihdam ve rekabet edebilirlik konularında bazı hedefler belirlemiştir. Günümüzde yaşanan teknolojik gelişmeler ve yaşanan gelişmelerin eğitim ve istihdama etkisi göz ardı edilemez. Bu çalışmada AB'de yaşam boyu öğrenmenin hedefleri kapsamında AB ülkelerinde yaşanan teknolojik gelişmeler, eğitim ve istihdam göstergeleriyle performansları değerlendirilerek ön plana çıkan ve geri planda kalan ülkeler değerlendirilmiştir.

Bu çalışmanın amacı dijitalleşen dünyada yaşam boyu öğrenme kapsamında önem teşkil eden bazı teknoloji, eğitim ve istihdam verileriyle AB ülkelerinin CRİTİC tabanlı Gri ilişkisel analiz yöntemiyle performans değerlendirmesi yapmaktır. Özellikle çağımızın getirdiği dijital becerilerle eğitim alan ve iş hayatında yer almaya yakın yükseköğretim düzeyindeki bireylerin eğitim değişkenleri, yeni mezun istihdamı, ileri eğitimli işsizlik, eğitime harcanan devlet harcamalarının GSYİH içindeki payı, teknolojinin istihdamdaki etkilerini gösteren BİT Sektörünün GSYİH içindeki payı ve BİT uzmanlarının toplam istihdamdaki payı vb. değişkenler çalışma kapsamına dahil edilmiştir. Çalışmaya dahil edilen değişkenler yardımıyla, CRİTİC yöntemi bulgularına göre, en önemli ilk beş kriterin Yükseköğretime kayıtlı öğrenciler (%12,11), Eğitim ve öğretimden erken ayrılanlar (%9,32), BİT Sektörünün GSYİH içindeki payı (%8,38), İleri eğitimli işsizlik (%8,08), Toplam işsizlik oranı (- %7,08) olduğu görülmüştür. Bununla birlikte, CRİTİC yöntemiyle elde edilen ağırlıklar kullanılarak Yapılan Gri İlişkisel Analiz bulgularında ise İsveç, Finlandiya, İspanya, Danimarka, Malta, Almanya'nın teknoloji, eğitim ve istihdam dengesini sağlayarak performans sıralamasında önde yer aldıkları, Polonya, Letonya, Hırvatistan, Slovenya gibi ülkelerin de sonlarda yer aldıkları bulgusuna ulaşılmıştır.

Anahtar Kelimeler: Yaşamboyu Öğrenme, Dijitalleşme, İstihdam, GIA Yöntem.

1.Introduction

Today, the incredible development of Information and Communication Technologies (ICT) has affected every sector and individual from different aspects. The fact that technology has become a part of our daily lives has also changed the skills that individuals need to acquire and the knowledge and skills that the business world seeks in individuals they want to employ. In addition, the investments made by countries in the name of education in order to raise qualified individuals and ensure that they live in prosperity are also very important in this process. Of course, it is necessary to provide a balance between the skills that individuals acquire in higher education in terms of having a profession in the society and reinforcing their intellectual knowledge and skills, in order to meet the needs of the age and without worrying about the future of the youth.

Looking at the past, it has been seen that technological developments have great effects on social structures and social roles of individuals. Technological developments, along with these effects, have also caused changes in employment and wages. Considering the effects experienced so far, it is seen that the technological changes experienced with digitalization are closely related to the long-term workforce demand and the education needed to raise digitally equipped individuals.

Industry 4.0, which is described as a revolution in digitalization, has had many effects in many areas of life and one of the areas where its effects are seen the most has been education (Öz & Özdamar, 2020). In the Industry 4.0 revolution, eight features that are at the forefront of ensuring the sustainability of education and increasing the quality are mentioned. These; global citizenship skills, innovation and creativity skills, technology skills, interpersonal skills, personalized and self-paced learning, accessible and inclusive learning, problem solving and collaborative learning, and finally lifelong student-centered learning (WEF, 2019). Considering these foreground issues, it is necessary for countries to keep up with the digital transformation and to meet social needs according to the developments in order for the decisions and policies taken based on lifelong learning to be adopted by all segments of the society. In higher education institutions trying to keep up with the digital transformation process in society, it is a necessity to train qualified individuals by adapting to the change in order to compete in the global arena. In this process, while meeting the needs of the society, the desire of young people to be employed in a job in which they specialize without worrying about the future should not be forgotten. This adaptation process, on the other hand, necessitates digital transformation, correct definition and following a correct transformation strategy.

Technological changes in the business world require employers to have some technological skills and knowledge with the features they seek in individuals to be employed. Digital skills, which are among the skills that educators and scientific experts have stated as the most important skills, have become very important in lifelong learning with the increase in online education opportunities recently (European Commission, 2013). Acquiring digital skills is closely related not only in the field of education, but also in many fields, especially in the economic, political and socio-cultural fields. So much so that the level of having digital skills is often associated with employability (Pirzada & Khan, 2013; Leahy, D., & Wilson, 2014; Van Laar et al., 2020).

When the literature is examined, it has been observed that the basic skills and characteristics that the individual needs in lifelong learning are generally as follows: Desire for continuous learning, feeling responsible for individual learning, learning to learn, reading comprehension, basic counting skills, written and verbal communication skills, ability to use information technologies, effective learning strategies, ability to develop oneself, effective use of problem solving and critical thinking skills, research skills, social skills (Adams, 2007; Sahin et al., 2010).

Digital competencies addressed in the adopted revised resolutions; It includes confident, critical and responsive use and interaction with digital technologies for learning, participation at work and in society. Information and data literacy competencies are; communication and collaboration, digital content creation (including programming), security (including digital well-being and cybersecurity-related competencies), and problem-solving skills (Schola Europaea, 2018:29).

As a result of the development of information and communication technologies (ICT), remarkable developments are observed in the daily and business lives of individuals; It is obvious that ICT contributes to the welfare of countries, companies and individuals (YASED, 2012:131). In addition, investments in information and communication technologies such as health and education investments positively affect the human development index scores of countries and contribute to the economic development of countries (Gholami et al., 2010:79). Similarly, the sufficient level of ICT infrastructure of the countries and the quality of the individuals who will use this technology contribute to the global development of the countries (Rencber, 2018: 294).

It has been stated that technological change has multifaceted effects on work and employment. While discussing the relationship between digitalization and employment, it is thought that there may be job loss as digitalization replaces some jobs with its positive contributions (Atkinson and Wu, 2017; UNDP, 2017; Petropoulos, 2018; Özcan, 2019). McGuinness et al. (2021), contrary to the idea that the technological transformation implemented in EU countries makes workers unskilled; It has been found that technological transformation increases the dynamic skills of employees. However, it has been found that individuals with creative, critical, analytical thinking and problem solving skills are more likely to be white and gold-collar employees in their working life (Surawski, 2019).

Çolak and Ege (2013) evaluated the country's situation by developing growth performance indexes for 2020 EU strategy targets with some growth indicators such as early school leavers, higher education education, employment rate. Şentürk (2015) examined the relationship between education level, unregistered employment and employment rates for Turkey and emphasized that the state should increase the number of educated employees with policies that will create new opportunities for employment and that the employees should be qualified by giving the necessary trainings. Zoroja and Pejic Bach (2016) clustered the ICT usage and global competitiveness index data of EU member and candidate countries for 2011 using the k-means method, In order to determine the difference between these clusters, they reached the conclusion that there is a significant relationship between the index and indicators with the ANOVA method.

Fossen & Sorgner (2018) investigated the effects of the new wave of digitalization and artificial intelligence on individual transitions in the US labor market and found that an individual's current occupation is associated with a greater risk of digitization, a higher likelihood of changing occupations or being unemployed. Taş (2018) evaluated the positive/negative effects of Industry 4.0 on working life and employment. As a result of the study, in addition to many advantages such as making life easier, increasing work efficiency, and facilitating job control due to technological developments, employment problems such as unemployment and loss of income may be encountered and solutions to these problems are discussed.

Stavytskyy et al. (2019) analyzed the Digital Economy and Society Index (DESI), which characterizes the development of the digital economy. In the study, the effect of consumption index and unemployment on DESI was tried to be determined by panel regression method by using data from 28 European countries in the period of 2013-2018. The results showed that approximately 98% of the current value of DESI is determined by previous trends and a rapid break in the development of the digital economy is unlikely. Ersöz and Özmen (2020) examined the effects of the problems encountered in the digital transformation process of enterprises on employees, and with the increase of technological transformation in the business world, directing the enterprises to the necessary technological trainings in order to adapt to the digital order in order to eliminate the risk of unemployment when employees do not have the necessary digital knowledge and skills, and reached the conclusion that the power to use information technologies should be increased. Radosavljević, Anđelković & Krasulja (2020) investigated the effect of digitalization of the employment process in companies on their work and It has been concluded that technological developments close some jobs but create new, less labor-intensive jobs that require creativity and critical thinking. In their study, Reljic, Evangelista, & Pianta (2021) looked at the relationship between the diffusion of digital technologies, employment and skills, using sector-level data from six major European economies (Germany, France, Spain, Italy, the Netherlands and the United Kingdom) over the period 2009–2014.

When the literature is examined, it is seen that there are many studies that make use of MCDM methods while addressing the relationship between digitalization, technology, education and employment.

Dinçer (2011) evaluated country performances with TOPSIS and WSA methods for EU member and candidate countries with five macroeconomic variables, including unemployment criteria. Brauers et al. (2013), 27 EU member countries used the MULTIMOORA method with their 2010 data and some education, economic and demographic indicators including employment, unemployment and higher education variables and evaluated which countries are better prepared for the EU 2020 strategies. Rençber (2018) measured the ICT development of the provinces in

Turkey for the period 2012-2016 with 11 indicators, including ICT access, use and capabilities, and ranked the provinces according to these developments using the PROMETHEE method.

Ture et al. (2018) Evaluated the performances of 27 EU countries with VIKOR and TOPSIS methods, with 22 criteria including some indicators such as economic, financial, demographic, educational and innovation within the scope of 2020 EU strategies. Oralhan and Büyüktürk (2019) compared the innovation performances of countries with TOPSIS and MOORA methods, using 10 indicators including human resources, innovative environment, employment effects and the values obtained from the 2018 European Innovation Index Scoring table of 28 EU member and some candidate countries. Türe (2019) evaluated the welfare scores of 34 OECD countries with the entropy-based gray relational analysis (GIA) method for a 15-year period (2000-2014) with some quality of life indicators such as work-life balance, education-skills.

Yakut (2020), criteria weights were determined with the Entropy method using some data showing the ICT usage of OECD countries for the period 2017-2019 and the ICT development of the countries was compared with the MOORA and WASPAS methods. Arsic and Gajic (2021) measured the advanced digital technology levels of EU countries with the Entropy supported TOPSIS method. Koca (2021) evaluated the digital transformation performances of EU countries with the 2018 Digital Transformation Scoreboard data. In the study in which the ARAS method was used, it was concluded that the most successful countries in terms of digital transformation performance were Finland, Denmark and Sweden. Torkayesh and Torkayesh (2021), using indicators such as developed countries, G7 countries, ICT employment obtained from OECD data sets, ICT product exports, ICT investment, ICT added value and internet access, were weighted with the LBWA method and country performance values were determined by the MARCOS method. Çınarlıoğlu (2022), within the scope of the Digital Economy and Society Index (DESI) methodology, the EU countries determined their performance in 2021 using the Entropy method, one of the MCDM techniques and with the MABAC method, the performance rankings of the countries were made. Ecemiş and Coşkun (2022) evaluated the use of information technologies in regions in Turkey for the period of 2014-2021 with the PSI-based WEBDA method, which is one of the MCDM methods. Kaya et al, (2023), evaluated the performance of countries with cyclical economy variables related to social growth of EU countries for 2019, such as criteria-weighted income distribution, new graduate employment rate, young people who are neither in education nor in employment with CRITIC and MEREC methods.

2.Methodlogy

In the study, the performances of EU member countries were evaluated by using the Criteria Importance Through Intercritera Correlation (CRITIC) based Gray Relational Analysis (GRA) method, with technology usage, education and employment data. In this section, CRITIC and GRA methods are briefly mentioned.

3.1. Criteria Importance Through Intercritera Correlation (CRITIC) Method

Multi-Criteria Decision Making (MCDM) methods are widely used in the academic and business world. MCDM is the ranking of decision alternatives based on a set of criteria (Deng et al., 2011; 6985). The importance weights of the criteria considered while ranking the alternatives are determined with the help of objective or subjective methods. The CRITIC method, which entered the literature with the study of Diakoulaki et al. (1995), is one of the objective weighting methods. In this method, both the standard deviation of the criteria and the correlation coefficient, which shows the relationship with other criteria, are taken into account when calculating the weighting coefficients for the criteria (Ünlü et al., 2017; 71).

In the CRITIC method, firstly, the values of the decision variables are normalized by using equality (1) for the benefit criterion and equality (2) for the cost criterion. Afterwards, the correlation coefficient values of each criterion with the other criteria are calculated using the equation (3). Finally, criteria weights are obtained by using equation (4) and equation (5) (Jahan et al., 2012: 413).

$$r_{ij} = \frac{x_{ij} - x_j^{min}}{x_j^{max} - x_j^{min}} \qquad (1)$$

$$r_{ij} = \frac{x_{ij}^{max} - x_{ij}}{x_{ij}^{max} - x_{ij}^{min}} \qquad (2)$$

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

$$w_j = \frac{c_j}{\sum_{k=1}^{n} c_k}, \quad j = 1, \dots, n \qquad (4)$$

$$c_j = \sigma_j \sum_{k=1}^{n} \left(1 - \rho_{jk}\right), \quad j = 1, \dots, n \qquad (5)$$

3.2. Gray Relational Analysis (GRA) Method

The GRA method, which Deng (1982) brought to the literature, is used to analyze systems with limited or incomplete information, similar to fuzzy set theory. The Gray Relationship concept in the method is used for the state uncertainty between the elements in the system. Gray Relationship Analysis is used to measure the relationship between criteria according to the level of similarity between units or the difference in development trends (Feng e Wang, 2000: 136). The GRA method is an important classification, rating and decision-making method used for performance measurements of units. One of the most important advantages of this method is that satisfactory results can be achieved using a small amount of data (Ayçin, 2019: 132-133).

The steps of the GRA method are as follows (Wen, 2004: 21-27).

Step 1: Creating the decision matrix.

$$X = \begin{bmatrix} x_1(1) & x_1(2) & \dots & x_1(n) \\ x_2(1) & x_2(2) & \cdots & x_2(n) \\ \vdots & \vdots & \ddots & \vdots \\ x_m(1) & x_m(2) & \dots & x_m(n) \end{bmatrix} \qquad (6)$$

Step 2: Creating the reference series

The reference series is created using equation (7). The value of x_0 (j) in the equation is j. represents the largest value of the criterion among the normalized values.

$$x_0 = \left(x_0(j)\right), \qquad j = 1, \dots, n \qquad (7)$$

Step 3: Normalization process and obtaining the normalized matrix

Since the data belonging to the criteria have different units, the normalization process is applied to make the data comparable. After the normalization process, all values belonging to the criteria take a value between 0 and 1. The normalization process can be in three different situations.

I. Benefit status: Equation (8) is used in the normalization process, since a benefit-oriented criterion is required to take the maximum value.

$$x_i^* = \frac{x_i(j) - x_i(j)^{min}}{x_i(j)^{max} - x_i(j)^{min}} \qquad (8)$$

ii. Cost status: Equation (9) is used in the normalization process since the criterion is required to be the minimum value in cost-oriented criteria.

$$x_i^* = \frac{x_i(j)^{max} - x_i(j)}{x_i(j)^{max} - x_i(j)^{min}} \qquad (9)$$

iii. Optimal situation: Equation (10) is used when considering the ideal value.

$$x_i^* = \frac{x_i(j) - x_{0b}(j)}{x_i(j)^{max} - x_{0b}(j)} \qquad (10)$$

Step 4: Creating the absolute value matrix

By using equation (11), the absolute difference between the normalized values of the reference series and the values of the normalized decision matrix is found and the absolute value matrix shown in equation (12) is obtained.

$$\Delta_{0i} = x_0^*(j) - x_i^*(j) \qquad (11)$$

$$\Delta_{0i} = \begin{bmatrix} \Delta_{01}(1) & \Delta_{01}(2) & \dots & \Delta_{01}(n) \\ \Delta_{02}(1) & \Delta_{02}(2) & \cdots & \Delta_{02}(n) \\ \vdots & \vdots & \ddots & \vdots \\ \Delta_{0m}(1) & \Delta_{0m}(2) & \dots & \Delta_{0m}(n) \end{bmatrix} \qquad (12)$$

Step 5: Creating the gray relational coefficient matrix

It is calculated using equation (13). The "ζ" in the formula is expressed as the contrast control coefficient or the discriminant coefficient. The value of this coefficient is between 0 and 1. The closer the value is to 1, the higher the contrast, and the closer to 0, the lower the contrast. In many studies, the contrast coefficient was generally taken as 0.5 (Ayçin, 2019: 138).

Step 6: Calculating gray relationship degrees

Gray relational grades, which represent the measure of similarity between the reference series and the compared series, are calculated using equation (14) if the criterion weights are of equal importance. If there are criteria with different weights, this value is calculated with the help of equation (15). In this equation, w_i (j) is j. stands for criteria weight.

$$\Gamma_{0i} = \frac{1}{n}\sum_{j=1}^{n} \gamma_{0i}(j) \qquad (14)$$

$$\Gamma_{0i} = \sum_{j=1}^{n} [w_i(j).\gamma_{0i}(j)] \qquad (15)$$

3.Dataset and Findings

The aim of this study is to measure and rank performance by using CRITIC-based GRA approach for 2020 according to some education, technology and employment criteria of EU Countries. For this purpose, education, technology and employment data were evaluated especially for university-level and newly graduated youth who are currently preparing to enter the business life, and youth unemployment and education indicators of young people who play an active role in the digitalization process were used. In the study, all EU member states were taken as an alternative set.

Table 1. The criteria set used in the study.

Code	Variable	Source
	Education	
E1	Early leavers from education and training (%)	Eurostat
E2	Adult participation in learning (%)	Eurostat
E3	Students enrolled in higher education	Eurostat
E4	Share of government expenditures on education in GDP (%)	WDI
E5	Employee participation rate in education (%)	Eurostat
	Technology	
T1	Internet usage of people(%)	Eurostat
T2	Internet users for online course(%)	Eurostat
T3	Share of ICT Sector in GDP (%)	WDI
T4	Share of ICT specialists in total employment (%)	WDI
T5	People who use the internet to search for and apply for jobs (%)	Eurostat
	Employment	
em1	New graduate employment rate	Eurostat
em2	Young people who are neither in employment nor in education	Eurostat
em3	Young people who are neither in employment nor in education	Eurostat
em4	highly educated unemployment	WDI

The optimization aspect of the criteria discussed in the study is given in Table 2. Optimization aspects of the criteria were taken into account with the creation of the decision matrix. and the normalized matrix was obtained with the help of equation (1) and equation (2).

Table 2. Normalized matrix

	E1	**E2**	**E3**	**E4**	**E5**	**T1**	**T2**	**T3**	**T4**	**T5**	**em1**	**em2**	**em3**	**em4**
	min	**mak**	**mak**	**mak**	**mak**	**mak**	**mak**	**mak**	**mak**	**mak**	**min**	**mak**	**min**	**min**
Belgium	0,572464	0,231884	0,156988	0,886978	0,247492	0,749825	0,567599	0,226721	0,535714	0,298178	0,786667	0,754717	0,802817	0,801775
Bulgaria	0,231884	0,021739	0,06697	0,230958	0,023411	0	0,134033	0,84413	0,232143	0,051774	0,766667	0,641509	0,401408	0,897436
Czechia	0,608696	0,163043	0,095104	0,486486	0,187291	0,61193	0,230381	0,374494	0,392857	0,043784	1	0,873315	0,943662	1
Denmark	0,485507	0,688406	0,091728	0,805897	0,782609	1	0,521368	0,283401	0,625	1	0,8	0,773585	0,887324	0,678501
Germany	0,427536	0,242754	1	0,383292	0,374582	0,847018	0,328283	0,251012	0,482143	0,086609	0,926667	0,93531	0,830986	0,88856
Estonia	0,543478	0,565217	0,011437	0,855037	0,628763	0,663158	0,714064	0,726721	0,803571	0,472675	0,713333	0,668464	0,774648	0,669625
Ireland	0,797101	0,362319	0,070052	0	0,471572	0,731579	0,501554	0,566802	0,678571	0,52381	0,78	0,663073	0,56338	0,733728
Greece	0,884058	0,112319	0,242903	0,329238	0,143813	0,279298	0,39122	0,006073	0	0,168424	0	0	0,612676	0
Spain	0	0,362319	0,653271	0,366093	0,397993	0,808772	0,898213	0	0,321429	0,439118	0,14	0,396226	0,429577	0,131164
France	0,57971	0,434783	0,837524	0,589681	0,525084	0,712632	0,540404	0,307692	0,446429	0,341323	0,64	0,539084	0,619718	0,626233
Croatia	1	0,07971	0,047113	0,599509	0,086957	0,286316	0,322067	0,362348	0,303571	0,309364	0,673333	0,54717	0,549296	0,61144

Italy	0,210145	0,224638	0,618264	0,287469	0,230769	0,273333	0,393939	0,222672	0,285714	0,275168	0,553333	0,051213	0	0,614398
Cyprus	0,326087	0,134058	0,013979	0,727273	0,143813	0,724211	0,600233	0,161943	0,196429	0,139981	0,666667	0,638814	0,394366	0,639053
Latvia	0,637681	0,202899	0,02199	0,70516	0,250836	0,657544	0,243201	0,497976	0,303571	0,232023	0,633333	0,652291	0,908451	0,439842
Lithuania	0,753623	0,224638	0,030255	0,214288	0,314381	0,452632	0,506216	0,121457	0,232143	0,311601	0,606667	0,528302	0,647887	0,736686
Luxembourg	0,565217	0,554348	0	0,459459	0,571906	0,992982	0,719114	0,587045	0,767857	0,325344	0,72	0,690027	0,950704	0,68146
Hungary	0,282609	0,148551	0,084846	0,407862	0,177258	0,512632	0,351593	0,568826	0,321429	0,369128	0,9	0,735849	0,633803	0,957594
Malta	0,246377	0,362319	0,002936	0,68059	0,508361	0,585965	0,628205	1	0,428571	0,304251	0,88	1	0,753521	0,84714
Netherlands	0,652174	0,644928	0,284172	0,540541	0,87291	0,837193	0,551282	0,263158	0,696429	0,550016	0,846667	0,927224	1	0,885602
Austria	0,572464	0,387681	0,126685	0,48403	0,468227	0,609474	0,480575	0,087045	0,446429	0,23458	0,773333	0,902965	0,802817	0,816568
Poland	0,768116	0,097826	0,422471	0,513514	0,160535	0,456842	0,14258	0,115385	0,267857	0,029402	0,96	0,749326	0,788732	0,947732
Portugal	0,514493	0,326087	0,113913	0,469288	0,344482	0,284211	0,418803	0,204453	0,357143	0,313519	0,706667	0,560647	0,767606	0,567061
Romania	0,028986	0	0,16374	0,144963	0	0,291228	0	0,212551	0,089286	0	0,766667	0,587601	0,112676	0,920118
Slovenia	0,862319	0,268116	0,021171	0,653563	0,331104	0,576842	0,240093	0,168016	0,428571	0,236497	0,84	0,752022	0,922535	0,828402
Slovakia	0,608696	0,065217	0,040018	0,371007	0,073579	0,693333	0,235431	0,295547	0,392857	0,327261	0,726667	0,752022	0,647887	0,79783
Finland	0,565217	0,952899	0,08815	0,683047	1	0,941754	1	0,524291	1	0,931288	0,66	0,716981	0,816901	0,714004

Sweden	0,601449	1	0,136285	1	0,956522	0,944561	0,752525	0,787449	0,982143	0,723873	0,606667	0,849057	0,971831	0,67357

In this section, the correlation matrix of the criteria calculated with the help of equation (3) is given in Table 3. When the values in the table are examined, some criteria (E2*E5, E2*T1, E2*T2, E2*T4, E2*T5, E5*T4, E5*T5, E4*is3, E5*is3, T1*T4, T2*T5, em1*em2, emp1*emp4, em2*emp4) appear to be closely related.

Table 3. Correlation coefficients of the criteria

Criteria	E1	E2	E3	E4	E5	T1	T2	T3	T4	T5	em1	em2	em3	em4
E1	1													
E2	0,078	1												
E3	-0,245	-0,031	1											
E4	0,159	**0,521**	-0,184	1										
E5	0,102	**0,980**	0,0163	**0,475**	1									
T1	0,057	**0,705**	0,079	**0,477**	0,720	1								
T2	-0,080	**0,770**	0,013	**0,411**	0,747	0,640	1							
T3	-0,134	0,318	**-0,367**	0,235	0,294	0,083	0,179	1						
T4	0,163	**0,889**	-0,115	**0,485**	**0,871**	**0,732**	**0,655**	**0,471**	1					
T5	0,098	**0,840**	-0,154	0,407	**0,823**	**0,613**	**0,686**	0,231	**0,738**	1				
em1	0,036	-0,029	-0,167	0,121	0,028	0,112	-0,339	0,328	0,245	-0,108	1			

em2	0,034	0,286	-0,215	0,365	0,346	0,475	0,034	0,391	**0,479**	0,133	**0,779**	1		
em3	**0,523**	**0,503**	-0,217	**0,543**	**0,5426**	**0,576**	0,241	0,185	**0,565**	0,325	0,330	**0,636**	1	
em4	-0,061	-0,067	-0,150	-0,014	-0,023	0,011	-0,359	0,306	0,192	-0,157	**0,938**	**0,710**	0,169	1

Table 4. CRITIC method weighting results and criteria importance rankings

	Γ_{0i}	Sıra
E1	0,093246	2
E2	0,057958	13
E3	0,121124	1
E4	0,065658	7
E5	0,060407	11
T1	0,060404	12
T2	0,068098	6
T3	0,083888	3
T4	0,050375	14
T5	0,064588	8
em1	0,07088	5
em2	0,060538	10
em3	0,061978	9
em4	0,080857	4

In the findings obtained as a result of the application of the CRITIC method, the most important first five criteria are students enrolled in higher education (12.11%), those who leave education and training early (9.32%), the share of the ICT sector in GDP (8.38%), unemployment with advanced education (8.08%), total unemployment rate (- 7.08%).

The weights of the criteria were calculated using Equation 3, Equation 4 and Equation 5, and the results are given in Table 4.

With the help of Equation (11)-(12), the absolute value matrix was created. Afterwards, the gray relational coefficient matrix was created with the help of equality (13) using the contrast coefficient (which was taken as 0.5), and finally, with the help of equations (14) and (15), the gray relation degrees were calculated and the alternatives were ranked. The results are in Table 5.

Table 5. Gray relational degrees and their order

Countries	Degree value	Rank	Countries	Degree value	Rank
Belgium	0,474797674	13	Lithuania	0,415554771	26
Bulgaria	0,449616759	20	Luxembourg	0,511890629	10
Czechia	0,425600671	23	Hungary	0,451909359	19
Denmark	0,564037886	4	Malta	0,546368528	5
Germany	0,538005534	6	Netherlands	0,516255603	8
Estonia	0,52767858	7	Austria	0,454664012	17
Ireland	0,462886614	15	Poland	0,412764125	27
Greece	0,477394171	12	Portugal	0,434219553	21
Spain	0,606839242	3	Romania	0,456991764	16
France	0,515806373	9	Slovenia	0,422756814	24
Croatia	0,417716233	25	Slovakia	0,43096747	22
Italy	0,496077704	11	Finland	0,638614142	2
Cyprus	0,47001829	14	Sweden	0,648996564	1
Latvia	0,453097473	18			

Table 3 shows that Sweden, Finland, Spain, Denmark, Malta, Germany, Estonia, the Netherlands and France take the first place. When we look at the common characteristics of these countries, which took place before other countries in the ranking, it is seen that Sweden, Finland and Denmark have high values in maximization-oriented criteria, Spain has low values in minimization-oriented criteria, and Malta is important in some both-sided criteria. appear to have values. It is seen that Poland, Latvia, Croatia, Slovenia, Czechia, Slovakia, Portugal and Bulgaria take the last place. It is seen that these countries have minimum values in maximization-oriented values and close to maximum values in minimization-oriented criteria.

4.Conclusion

Lifelong learning; It is expressed as all kinds of learning activities undertaken throughout life in order to develop knowledge, skills and competencies in a personal, social, and/or employment-related perspective (Duman, 2003). As it can be understood from the definition, lifelong learning includes all of the education, training and learning activities that enable the development of knowledge and competences. The aim of lifelong learning is to enable individuals to adapt to the knowledge-based society and to ensure their active participation in all phases of life, socially and economically, by improving their knowledge and skills while continuing their lives.

Information, which is the source of change in the digital information age and digital societies, has reached incredible dimensions with globalization. The fact that this change and transformation is inevitable has given different responsibilities to both countries and individuals, as the education system has the capacity to respond to these changes. For this reason, although lifelong learning exists for the development of individuals and societies, it is foreseen that the outcomes of this learning should be handled separately in terms of individuals and societies.

It would be appropriate for individuals to consider lifelong learning in a personal, social and professional context. Individuals can achieve their personal, social and professional development through lifelong learning. In a personal context, lifelong learning aims to enable the individual to perform better in the field of interest and to ensure his own personal development. The individual is exposed to a number of physical, psychological and sociological factors during this development. In the social context, lifelong learning aims to bring together a group to share knowledge and improve existing knowledge for a specific purpose. In this process, the individual develops social skills and communicates with other individuals. In the professional context, lifelong learning aims to develop functional knowledge so that the individual can perform better in the profession. In this sense, universities should cooperate with institutions, organizations and other organizations (Dowling et al., 2004). From a social point of view, it is seen that lifelong learning has many socio-economic outcomes. Increasing the level of welfare, power gained by increasing the level of social knowledge and skills, competitiveness, economic power gained with the increase in human capital power, systematizing learning in learning societies, etc. appears to have contributed a lot. However, while there may be many negative outcomes such as not being able to benefit from the conveniences brought by innovations, social exclusion, job loss for individuals who cannot adapt to developments in lifelong learning, it is inevitable for societies that are closed to innovations and learning to encounter many negative social and economic situations. However, for individuals who cannot adapt to developments in lifelong learning, there may be many negative outcomes such as not being able to benefit from the conveniences brought by innovations, social exclusion, and job loss, moreover, it is inevitable for societies that are closed to innovation and learning to encounter many negative social and economic situations.

In the globalizing economy, with education being seen as an important competitive advantage, the need for employees who can improve their professional skills and adapt to new conditions is also increasing. With the developing technologies, the development of human resources, that is, the workforce that is highly qualified and motivated for lifelong learning, becomes more important than before. This situation increases the importance of higher education institutions especially in creating and providing employment and professional development.

In this study, performance evaluation of EU countries with CRITIC-based Gray relational analysis method was made with some technology, education and employment data that are important within the scope of lifelong learning in the digitalized world. In particular, the education variables of individuals at higher education level who are educated with digital skills brought by our age and close to taking part in business life, employment of new graduates, unemployment with advanced education, the share of government expenditures spent on education in GDP, the share of the ICT Sector in GDP, which shows the effects of technology on employment, and the share of ICT experts in total employment. etc. variables are included in the scope of the study. As a result of the study, according to the findings of the CRITIC method, the most important first five criteria are students enrolled in higher education (12.11%), those who leave education and training early (9.32%), the share of the ICT sector in GDP (8.38%), unemployment with advanced education. (8.08%), Total unemployment rate (-7.08%). However, in the Gray Relational Analysis findings using the weights obtained by the CRITIC method, Sweden, Finland, Spain, Denmark, Malta, Germany took the lead in the performance ranking by providing the balance of technology, education and employment, it has been found that countries such as Poland, Latvia, Croatia, and Slovenia are also in the last place.

According to the findings of the study, it is seen that Sweden, Finland and Denmark are in a better position than other countries in terms of maximization-oriented criteria, namely students enrolled in higher education, the share of the ICT sector in GDP, online education expenditures and government expenditures on education, that is, investments in education and technology are at the forefront. It has been seen that Spain, which has low values in the minimization-oriented criterion, is in better condition than other countries by minimizing the total and advanced education unemployment rates. However, it is seen that Malta has important values in some criteria in both directions. It is seen that Poland, Latvia, Croatia, Slovenia, Czechia and some countries, which are in the last place in the performance ranking, have minimum values in maximization-oriented values and close to maximum values in minimization-oriented criteria, in other words, the importance given to education and technology is less and unemployment rates are higher compared to other countries.

In the light of the findings of the study, following investments and policies that support education and training in some countries, especially by integrating technology into education, will bring new employments to individuals, increasing knowledge and skills. Therefore, in lifelong learning, the development of countries will be possible with a different perspective created by technological developments.

Bibliography

Adams, D., 2007. “Lifelong learning skills and attributes: The perceptions of Australian secondary school teachers”, Issues in Educational Research, 17(2), ss. 149-160.

Arsić, S., & Gajić, M., 2021. “Industry 4.0: Assessıng the Level of Advanced Digital Technologies in the EU Countrıes Usıng Integrated Entropy–Topsis Methods”, In International Scientific Conference, UNITECH, 2, ss. 133.

Atkinson, R.D. ve Wu, J. (2017), False Alarmism: Technological Disruption and the US Labor Market, 1850-2015, *Information Technology & Innovation Foundation ITIF*, May.

Brauers, W. K., Balezentis, A., & Balezentis, T., 2012.” European Union member states preparing for Europe 2020. An application of the MULTIMOORA method”, Technological and Economic Development of the Economy, 18, ss. 567–587.

Chan, J. W., & Tong, T. K., 2007. “Multi-criteria material selections and end-of-life product strategy: Grey relational analysis approach”, Materials & Design, 28(5), ss. 1539-1546.

Çark, Ö., 2020. “Dijital Dönüşümün İşgücü ve Meslekler Üzerindeki Etkileri”, International Journal of Entrepreneurship and Management Inquiries, 4(1), ss. 19-34.

Çınaroğlu, E., 2022. “Entropi Destekli MABAC Yöntemi ile AB Ülkeleri Dijital Dönüşüm Performansı Analizi”, Nevşehir Hacı Bektaş Veli Üniversitesi SBE Dergisi, (Dijitalleşme Özel Sayısı), ss. 18-34. https://doi.org/10.30783/nevsosbilen.1122529

Çolak, M. S., & Ege, A., 2013. “An assessment of EU 2020 strategy: Too far to reach?”, Social Indicators Research, 110, ss. 659–680. https://doi.org/10.1007/s11205-011-9950-2.

Deng, Y., & Chan, F. T., 2011. “A new fuzzy dempster MCDM method and its application in supplier selection”, Expert Systems with Applications, 38(8), ss. 9854-9861. https://doi.org/10.1016/j.eswa.2011.02.017.

Diakoulaki, D., Mavrotas, G., & Papayannakis, L., 1995. “Determining objective weights in multiple criteria problems: The critic method”, Computers & Operations Research, 22(7), ss. 763-770. https://doi.org/10.1016/0305-0548(94)00059-H

Dinçer, S. E., 2011. “Multi-criteria analysis of economic activity for European Union member states and candidate countries: TOPSIS and WSA applications”, European Journal of Social Sciences, 21(4), ss. 563-572.

Dowling, D., Dowling, S., Dowling, C., Fisser, P., Grabowska, A., Hezemans, M., Kendall, M. vd., 2004. “Lifelong Learning in the Digital Age (Focus Group Report)”, IFIP International Federation for Information Processing, 137, ss. 1-49.

Duman, A., 2003. “Bazı Eğitim Bilimi Kavramlarına İlişkin Genel Bir Değerlendirme”. Muğla Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 10, ss. 7-8.

Ecemiş, O., & Coşkun, A., 2022. “Türkiye’de bilişim teknolojileri kullanımının ÇKKV yöntemleriyle incelenmesi: 2014-2021 dönemi”, Avrupa Bilim ve Teknoloji Dergisi, (37), ss. 81-89. https://doi.org/10.31590/ejosat.1134753.

Ersöz, B., & Özmen, M., 2020. “Dijitalleşme ve Bilişim Teknolojilerinin Çalışanlar Üzerindeki Etkileri”, Bilişim Teknolojileri Online Dergisi, 11(42), ss. 170-179. https://doi.org/10.5824/ajite.2020.03.007.x

European Commission., 2013. “Survey of schools: ICT in education. Benchmarking access, use and attitudes to technology in Europe's schools”.

Feng, C. M., & Wang, R. T., 2000. “Performance evaluation for airlines including the consideration of financial ratios”, Journal of Air Transport Management, 6(3), ss. 133-142.

Fossen, F. M., & Sorgner, A., 2018. “The effects of digitalization on employment and entrepreneurship”, In conference proceeding paper, IZA–Institute of Labor Economics.ss. 1-31. https://doi.org/10.1016/S0969-6997(00)00003-X

Gholami, R., Higón, D. A., Hanafizadeh, P., & Emrouznejad, A. (2010). Is ICT the key to development?. *Journal of Global Information Management (JGIM),* 18(1), 66-83.

Jahan, A., Mustapha, F., Sapuan, S. M., Ismail, M. Y., & Bahraminasab, M., 2012. “A framework for weighting of criteria in ranking stage of material selection process”, The International Journal of Advanced Manufacturing Technology, 58, ss. 411-420. DOI 10.1007/s00170-011-3366-7

Kaya, S. K., Ayçin, E., & Pamucar, D., 2023. “Evaluation of social factors within the circular economy concept for European countries”, Central European Journal of Operations Research, 31(1), ss. 73-108. https://doi.org/10.1007/s10100-022-00800-w.

Koca, G., 2021. AB Ülkelerinin Dijital Dönüşüm Performanslarının ARAS Yöntemi ile İncelenmesi. Dijital Dönüşüm ve İşletmecilik, Efe Akademi, 7-24.

Leahy, D., & Wilson, D., 2014. “Digital skills for employment. In Key Competencies in ICT and Informatics”, Implications and Issues for Educational Professionals and Management: IFIP WG 3.4/3.7 International Conferences, KCICTP and ITEM 2014, Potsdam, Germany, July 1-4, 2014, Revised Selected Papers (pp. 178-189). Springer Berlin Heidelberg.

McGuinness, S., Pouliakas, K. ve Redmond, P., 2021, “Skills-Displacing Technological Change And İts İmpact On Jobs: Challenging Technological Alarmism?”, Economics of Innovation and New Technology, 32(3), ss. 370-392. https://doi.org/10.1080/10438599.2021.1919517

Oralhan, B., & Büyüktürk, M. A., 2019. “Avrupa Birliği ülkeleri ve Türkiye’nin inovasyon performansının çok kriterli karar verme yöntemleriyle kıyaslanması”, Avrupa Bilim ve Teknoloji Dergisi, (16), ss. 471-484. https://doi.org/10.31590/ejosat.571284

Oz, O., & Ozdamar, N., 2020. “Academic's Views on Industry 4.0 within the Scope of Open and Distance Education”, Asian Journal of Distance Education, 15(2), ss. 58-85.

Özcan, R., 2019. “Robotların Yükselişi İşsizlik ve Gelir Üzerine Etkileri”, Öneri Dergisi, 14(51), ss. 1-17, https://doi.org/10.14783/maruoneri.vi. 522005

Petropoulos, G., 2018. “The Impact of Artificial Intelligence on Employment, Max Neufeind”, Jacqueline O’Reilly ve Florian Ranft (ed.), Praise for Work in the Digital Age Challenges of the Fourth Industrial Revolution, 119-132.

Radosavljević, D., Anđelković, M., & Krasulja, N., 2020. “Digitalization of the employment process in companies”, Economics, Finance and Management Review, (1), ss. 80-85. https://doi.org/10.36690/2674-5208-2020-1-80-85.

Reljic, J., Evangelista, R., & Pianta, M., 2021. “Digital technologies, employment, and skills”. Industrial and Corporate Change, 00, ss.1–22. DOI: https://doi.org/10.1093/icc/dtab059

Rençber, Ö. F., 2018. “İllerin Bilgi ve İletişim Teknolojileri Gelişmişliklerine Göre Sıralanması: Promethee Yöntemi İle Örnek Uygulama”, Pamukkale Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, (33), ss. 293-312. https://doi.org/10.30794/pausbed.425451

Sahin, M., Akbaslı, S., & Yelken, T. Y., 2010. “Key competences for lifelong learning: The case of prospective teachers”. Educational Research and Reviews, 5(10), ss. 545-556.

Schola Europaea, 2018. “Key competences for lifelong learning in the European schools”. Office of the Secretary-General of the European Schools, Pedagogical Development Unit: Brussels, Belgium, 72.

Stavytskyy, A., Kharlamova, G., & Stoica, E. A., 2019. “The analysis of the digital economy and society index in the EU”. TalTech Journal of European Studies, 9(3), ss. 245-261. https://doi.org/10.1515/bjes-2019-0032.

Surawski, B., 2019. “Who is a “knowledge worker”–clarifying the meaning of the term through comparison with synonymous and associated terms”. Management, 23(1), ss. 105-133. https://doi.org/ 10.2478/ manment-2019-0007

Şentürk, F., 2015. “Türkiye'de İşgücü Piyasası ve İstihdamın Yapısı”, Sosyal Güvence Dergisi, (7), ss. 113-143.

Torkayesh, A. E., & Torkayesh, S. E., 2021. “Evaluation of information and communication technology development in G7 countries: An integrated MCDM approach”. Technology in Society, 66, 101670. https://doi.org/10.1016/j.techsoc.2021.101670

Türe, H., 2019. “OECD ülkeleri için refah ölçümü: Gri ilişkisel analiz uygulaması”, Ankara Hacı Bayram Veli Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 21(2), ss. 310-327.

UNDP, 2017, “Technological Change and the Future of Jobs”. Erişim: https://www.undp.org/sites/g/files/zskgke326/files/2023-02/2017_Technological%20Change%20and%20the%20Future%20of%20Jobs_en_digital.pdf

Van Laar, E., Van Deursen, A. J., Van Dijk, J. A., & de Haan, J., 2020. “Determinants of 21st-century skills and 21st-century digital skills for workers: A systematic literature review”, Sage Open, 10(1), 2158244019900176. https://doi.org/10.1177/2158244019900176.

WEF., 2019. Platform for shaping the future of the new economy and society. Schools of the future: Defining new models of education for the fourth industrial revolution. https://www3.weforum.org/docs/WEF_Schools_of_the_Future_Report_2019.pdf

Yakut, E., 2020. “OECD ülkelerinin bilgi ve iletişim teknolojileri gelişmişliklerinin MOORA ve WASPAS yöntemiyle değerlendirilerek kullanılan yöntemlerin Copeland yöntemiyle karşılaştırılması”. Atatürk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 24(3), ss. 1275-1294.

YASED. 2012. “2023 hedefleri yolunda bilgi ve iletişim teknolojileri”, İstanbul: Uluslararası Yatırımcılar Derneği, ss. 18-24.

Zoroja, J., & Pejic Bach, M., 2016. “Impact of information and communication technology to the competitiveness of European countries-cluster analysis approach”. Journal of theoretical and applied electronic commerce research, 11(1), ss. 1-10. DOI: 10.4067/S0718-18762016000100001.