Streimikiene, D., & Bathaei, A. (2025). Evaluating and ranking quality education for sustainable development in the Baltic States: A multi-criteria decision-making approach using Eurostat data. *Transformations and Sustainability, 1*(1), 12-29. https://doi.org/10.63775/vq29r460

Evaluating and ranking quality education for sustainable development in the Baltic States: A multi-criteria decision-making approach using Eurostat data

Dalia Streimikiene [*], Ahmad Bathaei

Institute of Economics and Rural Development, Lithuanian Centre for Social Sciences, Vilnius, Lithuania

Abstract. Achieving quality education is a fundamental pillar of sustainable development, as outlined in the United Nations Sustainable Development Goal 4 (SDG 4). This study evaluates and ranks the performance of the Baltic States Estonia, Latvia, and Lithuania regarding their progress toward quality education in the context of sustainability. Drawing on seven key Eurostat indicators, the research applies the Complex Proportional Assessment (COPRAS) method, a Multi-Criteria Decision-Making (MCDM) approach, to construct a composite index for each country. The selected indicators encompass various dimensions of education, including early school leaving, tertiary educational attainment, early childhood participation, low academic achievement, adult learning, and digital skills. The results show that Lithuania ranks highest overall, particularly excelling in formal education indicators such as tertiary attainment and early childhood education. Estonia demonstrates strong performance in digital literacy, adult participation in learning, and minimizing academic underachievement. Latvia shows moderate performance across most dimensions but requires more targeted policy efforts in digital and lifelong learning domains. The study fills a critical gap in the literature by providing a data-driven, comparative evaluation of education sustainability in the Baltic region. It offers practical insights for policymakers to enhance educational strategies and align national systems with the broader goals of sustainable development. Future research could expand this framework to other EU regions or incorporate qualitative metrics for a more comprehensive assessment.

Keywords: Sustainable Development Goals (SDGs); Quality education; COPRAS; Baltic States; Multi-criteria decision-making (MCDM).

1. Introduction

Quality education is a cornerstone of sustainable development and a central pillar of the United Nations 2030 Agenda, particularly articulated in Sustainable Development Goal 4 (SDG 4), which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (Elfert, 2019). Globally, education plays a transformative role in shaping responsible citizens, advancing social cohesion, and enabling individuals to participate effectively in economic, environmental, and civic

[*] Corresponding author, dalia.streimikiene@lei.lt
Received March 2025; Revised April 2025; Accepted April 2025.

life. In the context of sustainable development, quality education fosters critical thinking, environmental awareness, and skills necessary for green economies and innovation-driven growth (Ramiro Troitiño & Mazur, 2024). As such, assessing the performance and progression of quality education systems is imperative for understanding how well countries are aligning with sustainability targets.

In Europe, and particularly in the Baltic region comprising Estonia, Latvia, and Lithuania the importance of quality education for sustainable development has gained increasing attention over the past two decades (Jurkynas, 2021). These countries, which have undergone substantial political and socio-economic transitions since their independence from the Soviet Union, now demonstrate strong commitments to sustainability and education reform. With their integration into the European Union, the Baltic states have benefitted from harmonized educational standards, investment in educational infrastructure, and greater emphasis on internationalization and digital learning. Nonetheless, disparities remain among the three countries in terms of educational quality, access, equity, and integration of sustainability concepts into curricula and policy frameworks (De Wit & Altbach, 2021).

The effectiveness of education systems in promoting sustainable development can be assessed through multiple indicators, such as enrollment rates, student performance, expenditure on education, teacher qualifications, and participation in lifelong learning (Veidemane, 2022). However, such indicators must be synthesized and compared across countries in a methodologically robust manner to provide actionable insights. This is where Multi-Criteria Decision-Making (MCDM) methods offer significant analytical advantages. By integrating diverse indicators into a coherent framework, MCDM enables the evaluation and ranking of countries based on composite educational performance, thus supporting policymakers in identifying areas of strength and improvement (Sousa et al., 2021).

Despite the growing body of literature on sustainable development and educational quality, there remains a notable gap in comparative, data-driven assessments of how Baltic countries are progressing toward SDG 4 in conjunction with sustainability priorities (Kouskoura et al., 2024). Few studies have focused on benchmarking Baltic states using comprehensive indicator-based approaches, especially through the lens of MCDM methods. Moreover, while Eurostat offers a rich database of harmonized and comparable indicators relevant to both education and sustainability, its potential remains underutilized in regional assessments (Gajdosikova & Vojtekova, 2024).

This study addresses these gaps by evaluating and ranking the quality of education in the context of sustainable development across Estonia, Latvia, and Lithuania using an MCDM approach. Drawing on recent Eurostat data, the research applies a structured decision-making framework to assess the relative performance of each country based on selected educational and sustainability indicators. The objectives of the study are threefold: (1) to develop a robust evaluation framework for quality education aligned with sustainability goals; (2) to compare and rank the Baltic

states using MCDM techniques; and (3) to identify strengths and weaknesses in national educational systems that may inform targeted policy interventions.

By providing a comparative and evidence-based evaluation, this study contributes to the growing discourse on educational sustainability metrics and offers insights for regional policymakers, educators, and development planners. It not only facilitates cross-national learning and benchmarking but also underscores the role of quality education as a catalyst for achieving broader sustainable development outcomes in the Baltic region and beyond.

2. Literature Review

Sustainable development, as defined by the United Nations (UN), encompasses social, environmental, and economic dimensions, and education is recognized as a cross-cutting enabler of progress across all these domains (Goyeneche et al., 2022). The United Nations Sustainable Development Goal 4 (SDG 4) specifically emphasizes the need for inclusive, equitable, and quality education, and lifelong learning opportunities. In the global context, education serves not only as a driver of economic growth and innovation but also as a mechanism to foster social equity, environmental consciousness, and civic engagement. As nations strive to transition toward green and knowledge-based economies, education systems are increasingly expected to equip learners with the skills, values, and competencies needed to respond to complex sustainability challenges (Mohamed et al., 2021).

The importance of quality education in achieving sustainable development is well-established in academic literature. Numerous studies have demonstrated that countries with robust and inclusive education systems tend to achieve higher levels of social resilience, innovation, and economic performance (Kouam & Asongu, 2022). Moreover, educational indicators such as early school leaving, tertiary attainment, and adult learning participation have been directly associated with labor market outcomes and social mobility, which are fundamental components of sustainable societies (OECD, 2022). Education that promotes sustainability also emphasizes transversal skills such as critical thinking, digital literacy, and lifelong learning, which are crucial in today's rapidly evolving technological and environmental landscapes (Okada et al., 2024).

In the European Union (EU), significant efforts have been made to track and evaluate progress toward SDG 4. The European Commission, in collaboration with Eurostat, has developed a set of harmonized indicators to measure the quality and inclusiveness of education systems across member states (Lella et al., 2024). Among these, key indicators include the rate of early leavers from education and training, tertiary educational attainment, participation in early childhood education, adult learning participation, and digital skills levels. These indicators serve not only to benchmark national performance but also to support policy development aimed at reducing educational inequalities and enhancing system effectiveness (Clark et al., 2023).

The Baltic countries Estonia, Latvia, and Lithuania have made notable progress in aligning their education systems with the goals of sustainable development. Estonia, in particular, has gained international recognition for its strong performance in Program for International Student Assessment (PISA) assessments and its innovative digital education initiatives (Espinosa & Pino, 2025). Latvia and Lithuania have also improved their education infrastructures and policy frameworks in response to European education strategies. However, disparities persist in areas such as early school leaving, tertiary attainment, and adult learning participation. Addressing these disparities is critical for achieving sustainable human development and economic competitiveness in the region (Tyagi et al., 2021).

Despite the existence of extensive national education strategies and monitoring frameworks, few comparative studies have systematically evaluated the relative performance of Baltic countries in terms of quality education for sustainable development using a structured, multi-indicator approach (Hansson et al., 2024). Previous research has often focused on singular dimensions such as digital education (Stenalt, 2021), higher education reform (Ashida, 2022), or access to early childhood education (Folayan et al., 2023). There remains a research gap in integrating multiple education indicators within a comparative and quantitative framework to assess performance holistically.

To address this gap, this study adopts a Multi-Criteria Decision-Making (MCDM) methodology to evaluate and rank the Baltic countries based on key Eurostat indicators that reflect quality education in the context of sustainable development. These indicators are carefully selected to represent both traditional and emerging aspects of educational quality, including access, achievement, inclusion, digitalization, and lifelong learning. Each indicator provides critical insights into different age cohorts and educational stages, thereby offering a comprehensive evaluation across the lifespan of learning.

By applying the Complex Proportional Assessment (COPRAS) method to these indicators, the study aims to generate a composite ranking that captures not only national averages but also the multidimensional progress of each Baltic country toward educational sustainability. COPRAS is a widely recognized Multi-Criteria Decision-Making (MCDM) technique that evaluates alternatives based on the proportional significance of both beneficial and non-beneficial criteria. Unlike methods that rely on distance from ideal solutions, COPRAS directly considers the relative importance and performance contributions of each criterion, allowing for a transparent and interpretable assessment. This approach facilitates a nuanced evaluation of country-level educational performance and supports evidence-based policymaking by identifying strengths, weaknesses, and priority areas for sustainable development planning.

The selected Eurostat indicators (Table 1) cover a wide range of dimensions. *Early leavers from education and training (sdg_04_10, sdg_04_10a)* capture the share of young individuals (aged 18–24) who have not completed upper secondary education and are not engaged in further training—a key risk factor for social exclusion and unemployment. *Tertiary educational attainment (sdg_04_20)* reflects the proportion of

the population with higher education degrees and is associated with innovation and labor market adaptability. *Participation in early childhood education (sdg_04_31)* is essential for cognitive and social development, particularly for disadvantaged groups.

The *low achievement among 15-year-olds (sdg_04_40)* in reading, mathematics, or science is a direct proxy for quality in compulsory education and future educational pathways. *Adult learning participation (sdg_04_60)* highlights the extent to which education systems support continuous learning—a necessity in the context of technological disruption and aging populations. Finally, *digital skills (sdg_04_70)* measure the basic digital competencies of individuals, which are now considered fundamental for both personal development and labor market participation in the digital era (Ruiu et al., 2024).

By applying an MCDM approach to these indicators, the study seeks to produce a composite ranking that reflects not only national averages but also multidimensional progress toward educational sustainability. This allows for a nuanced understanding of which countries are leading in particular areas and where gaps remain. Furthermore, it supports evidence-based policymaking by identifying leverage points for intervention and investment.

In conclusion, quality education remains a vital component of sustainable development strategies, particularly in regions such as the Baltic States that face demographic, economic, and technological transitions. A systematic and comparative evaluation of educational outcomes, grounded in harmonized statistical indicators and robust decision-making methodologies, is essential for guiding effective policy responses and achieving long-term sustainability goals.

Table 1
Indicators used

Indicator	Description
Early leavers from education and training by sex	% of population aged 18–24 who have not completed upper secondary education and are not in training.
Early leavers from education and training by citizenship	Same as above, disaggregated by citizenship (native/foreign).
Tertiary educational attainment by sex	% of population aged 25–34 who have completed tertiary education.
Participation in early childhood education by sex (age 3 and over)	% of children aged 3+ in early childhood education programs.
Low achieving 15-year-olds in reading, mathematics or science	% of 15-year-olds scoring below proficiency level in key subjects.
Adult participation in learning in the past four weeks by sex	% of adults participating in formal or non-formal education in the past 4 weeks.
Share of individuals with at least basic digital skills, by sex	% of individuals with basic digital competencies (communication, content creation, etc.).

Source: EUROSTAT database.

3. Methods

This study employs the Complex Proportional Assessment (COPRAS) method, a widely recognized Multi-Criteria Decision-Making (MCDM) technique, to evaluate and rank the performance of the Baltic countries Estonia, Latvia, and Lithuania in terms of quality education within the broader context of sustainable development. The COPRAS method is particularly well-suited for comparative evaluations involving multiple and sometimes conflicting indicators, as it allows for the simultaneous consideration of both beneficial and non-beneficial criteria. By calculating the proportional significance of each alternative, COPRAS provides a transparent and straightforward ranking, making it an effective tool for informing policy decisions and prioritizing areas of educational improvement.

3.1. Selection of Indicators

Seven indicators aligned with SDG 4 were selected from the Eurostat database, representing diverse dimensions of quality education. To simplify the analysis and presentation, each indicator was coded as follows:

- A: Early leavers from education and training by sex
- B: Early leavers from education and training by citizenship
- C: Tertiary educational attainment by sex
- D: Participation in early childhood education
- E: Low achieving 15-year-olds in reading, mathematics, or science
- F: Adult participation in learning in the past four weeks
- G: Share of individuals with at least basic digital skills

These indicators were chosen for their relevance to various education lifecycle stages (early childhood to adult learning) and their potential influence on sustainable development outcomes such as social inclusion, employability, and digital transformation.

3.2. Weight Assignment Based on Eurostat Indicators

To ensure objectivity and consistency, equal weights were assigned to each of the seven indicators based on the assumption that all dimensions of quality education contribute equally to sustainable development. The indicators were selected directly from the Eurostat SDG 4 dataset, which provides harmonized and comparable data across EU member states. No expert opinion or subjective weighting was applied; instead, each indicator was given an equal weight. This approach maintains methodological transparency and aligns with standard practices in data-driven multi-criteria evaluations, particularly when reliable, standardized data sources such as Eurostat are used.

3.3. Application of the COPRAS Method

The COPRAS method was applied in the following structured steps:

The preference ranking method of complex proportional assessment (COPRAS) method was developed by Zavadskas et al. (Zavadskas et al., 2008). In this method, the influence of maximizing and minimizing criteria on the evaluation result is considered separately. The selection of the best alternative is based considering both the ideal and the anti-ideal solutions. The main procedure of COPRAS method includes several steps (Chatterjee et al., 2011).

Step 1: Set the initial decision matrix, X:

$$X = [x_{ij}]_{m*n} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{m1} & x_{m2} & \ldots & x_{mn} \end{bmatrix}, \quad (1)$$

where x_{ij} is the assessment value of i-th alternative in respect to j-th criterion, m is the number of alternatives and n is the number of criteria.

Step 2: Normalization of the decision matrix by using the following equation:

$$R = [r_{ij}]_{m*n} = {}^{x_{ij}}\Big/_{\sum_{i=1}^{m} x_{ij}} . \quad (2)$$

Step 3: Determination of the weighted normalized decision matrix, D, by using the following equation:

$$D = [y_{ij}]_{m*n} = r_{ij}.W_j, i = 1, \ldots, m, j = 1, \ldots, n, \quad (3)$$

where r_{ij} is the normalized performance value of i-th alternative on j-th criterion and w_j is the weight of j-th criterion. The sum of weighted normalized values of each criterion is always equal to the weight for that criterion:

$$\sum_{i=1}^{m} x_{ij} = w_{ij}. \quad (4)$$

Step 4: In this step the sums of weighted normalized values are calculated for both the beneficial and non-beneficial criteria by using the following equations:

$$S_{+i} = \sum_{j=1}^{n} y_{+ij}, S_{-i} = \sum_{j=1}^{n} y_{-ij}, \quad (5)$$

where y_{+ij} and y_{-ij} are the weighted normalized values for the beneficial and non-beneficial criteria, respectively.

Step 5: Determination the relative significances of the alternatives, Q_i, by using the following equation:

$$Q_i = S_{+i} + \frac{S_{-min} . \sum_{i=1}^{n} S_{-i}}{S_{-i} . \sum_{i=1}^{m} \left({}^{S_{-min}}\Big/_{S_{-i}}\right)}, i = 1, \ldots, m, \quad (6)$$

where S_{-min} is the minimum value of S_{-i}.

Step 6: Calculation of the quantitative utility, U_i, for i-th alternative by using the following equation:

$$U_i = \frac{Q_i}{Q_{max}}.100\%. \quad (7)$$

where Q_{max} is the maximum relative significance value.

As a consequence of Eq. 7, utility values of the candidate alternatives range from 0% to 100%.

The greater the value of U_i, the higher is the priority of the alternative. Based on alternative's utility values a complete ranking of the competitive alternatives can be obtained.

4. Results

The COPRAS method was applied to evaluate and rank the performance of Estonia, Latvia, and Lithuania across seven key indicators reflecting quality education in the context of sustainable development. These indicators, derived from Eurostat's SDG 4 framework, include early school leaving (by sex and citizenship), tertiary educational attainment, early childhood education participation, low academic achievement among 15-year-olds, adult participation in learning, and digital skills. For each indicator, the results are presented in tabular form, showing both the original data obtained from Eurostat and the final ranking derived using the COPRAS method. This structure allows for a clear comparison of country-level performance across multiple dimensions of education and highlights the areas where each Baltic country demonstrates either relative strength or room for improvement.

Early leavers from education and training by sex. The COPRAS analysis of early leavers from education and training by sex (2010–2023), where lower values indicate better outcomes, shows that Lithuania performs the strongest among the Baltic countries, achieving a utility score of 100%. This reflects Lithuania's consistent and effective efforts to reduce early school leaving over the observed period. Latvia ranks second with a utility score of 68.87%, demonstrating considerable progress, particularly between 2010 and 2015. Estonia, while showing some improvement, ranks third with a utility score of 59.71%, influenced by a relatively higher rate in 2015. These results underscore Lithuania's successful educational strategies aimed at enhancing student retention, a key component in fostering inclusive, equitable, and sustainable educational systems. Table 2 presents the initial data matrix obtained from Eurostat, while Table 3 displays the final COPRAS-based ranking of the Baltic countries for this indicator.

Table 2
Initial matrix (early leavers by sex)

Weighs of criteria	0.25	0.25	0.25	0.25
Types of criteria	-1	-1	-1	-1
Year	2010	2015	2020	2023
Estonia	11	13.7	8.5	9.7
Latvia	12.9	9.9	7.2	7.7
Lithuania	7.9	5.5	5.6	6.4

Table 3
Final ranking (early leavers by sex)

Alternatives	Q+	Ui (Utility)	Ranking
Estonia	0.2612	59.71	3
Latvia	0.3013	68.87	2
Lithuania	0.4375	100.00	1

Early leavers from education and training, by citizenship. The COPRAS evaluation of early leavers from education and training by citizenship for the period 2010 to 2023, based on a cost-oriented approach where lower values indicate better performance, reveals that Lithuania outperforms its Baltic counterparts with a perfect utility score of 100%. This reflects Lithuania's sustained efforts in minimizing school dropout rates across various citizenship groups, showcasing its commitment to inclusive educational policies. Latvia ranks second with a utility score of 69.09%, showing gradual yet consistent improvement, particularly between 2015 and 2023. Estonia, with a utility score of 61.95%, ranks third, primarily due to relatively higher dropout rates among non-citizen populations in earlier years. These results highlight Lithuania's effective strategies for student retention and social integration, contributing to its advancement toward inclusive and equitable quality education in line with SDG 4. Table 4 presents the initial data matrix extracted from Eurostat, while Table 5 provides the final ranking of the Baltic countries based on the COPRAS method for this indicator.

Table 4
Initial matrix (early leavers by citizenship)

Weighs of criteria	0.25	0.25	0.25	0.25
Types of criteria	-1	-1	-1	-1
Year	2010	2015	2020	2023
Estonia	10.2	13.5	8	9.7
Latvia	12.6	10	7.4	7.5
Lithuania	7.9	5.5	5.6	6.4

Table 5
Final ranking (early leavers by citizenship)

Alternatives	Q+	Ui (Utility)	Ranking
Estonia	0.2681	61.95	3
Latvia	0.2990	69.09	2
Lithuania	0.4328	100.00	1

Tertiary educational attainment by sex. The COPRAS-based assessment of tertiary educational attainment by sex from 2010 to 2023, where higher percentages reflect stronger performance, indicates that Lithuania leads the Baltic region with a utility score of 1.00, representing the highest proportion of the population having completed tertiary education. Latvia ranks second with a utility score of 0.762, demonstrating steady progress, particularly notable after 2015. Estonia, while showing consistent improvement throughout the period, ranks third with a utility score of 0.749, indicating potential for further advancement in higher education access and completion. These findings highlight Lithuania's long-term investment in expanding higher education opportunities, which is crucial for fostering a skilled, adaptable, and innovation-driven workforce aligned with the goals of sustainable development.

Table 6 presents the initial data matrix based on Eurostat statistics, and Table 7 displays the final rankings derived from the COPRAS methodology.

Table 6
Initial matrix (tertiary attainment)

Weighs of criteria	0.25	0.25	0.25	0.25
Types of criteria	1	1	1	1
Year	2010	2015	2020	2023
Estonia	38.2	38.5	40.1	43.5
Latvia	34.7	39.9	44.2	45.1
Lithuania	46.3	54.8	56.2	57.4

Table 7
Final ranking (tertiary attainment)

Alternative	Q+	Ui (Utility)	Rank
Estonia	0.298216	0.748823	3
Latvia	0.303538	0.762187	2
Lithuania	0.398246	1	1

Participation in early childhood education. The COPRAS analysis of participation in early childhood education from 2015 to 2022 an essential indicator for long-term educational outcomes and sustainable development—identifies Lithuania as the leading country with a perfect utility score of 1.00, reflecting its substantial growth in enrollment, reaching 96.7% in 2022. Latvia ranks closely behind with a utility score of 0.988, maintaining consistently high participation rates across all three observed years. Estonia, although demonstrating stable performance around 91.9%, ranks third with a utility score of 0.950, indicating comparatively slower progress. These findings underscore the effectiveness of early childhood education policies in both Lithuania and Latvia and their strong alignment with SDG 4 targets related to educational access and inclusion. Table 8 displays the initial data matrix sourced from Eurostat, while Table 9 presents the final country rankings calculated using the COPRAS method.

Table 8
Initial matrix (early childhood education)

Weighs of criteria	0.33	0.33	0.33
Types of criteria	1	1	1
Year	2015	2020	2022
Estonia	90.6	91.9	91.9
Latvia	93	94	95.5
Lithuania	87.3	90.9	96.7

Table 9
Final ranking (early childhood education)

Country	Q+	Ui (Utility)	Rank
Estonia	0.323478	0.950362	3
Latvia	0.336149	0.98759	2
Lithuania	0.340373	1	1

Low achieving 15-year-olds in reading, mathematics or science. The COPRAS evaluation of low-achieving 15-year-olds in reading, mathematics, or science over the period 2012–2022—where lower percentages are preferred as indicators of better student performance—reveals that Estonia ranks first with a utility score of 1.00. This outcome reflects Estonia's consistent success in minimizing the share of underperforming students across core academic subjects. Latvia, with a utility score of 0.605, demonstrates moderate performance, while Lithuania ranks third with a utility score of 0.554, indicating relatively higher levels of academic underachievement. These findings highlight the strength of Estonia's foundational education system and its effective implementation of targeted interventions at the compulsory education level. The results are also consistent with Estonia's high performance in international benchmarks such as the Programme for International Student Assessment (PISA). Table 10 presents the original data matrix derived from Eurostat, and Table 11 displays the final rankings based on the COPRAS methodology.

Table 10
Initial matrix (low-achieving)

Weighs of criteria	0.25	0.25	0.25	0.25
Type of criteria	-1	-1	-1	-1
Year	2012	2015	2018	2022
Estonia	38.2	38.5	40.1	43.5
Latvia	34.7	39.9	44.2	45.1
Lithuania	46.3	54.8	56.2	57.4

Table 11
Final ranking (low-achieving)

Country	Q+	Ui (Utility)	Rank
Estonia	0.463074	1	1
Latvia	0.280282	0.605263	2
Lithuania	0.256644	0.554217	3

Adult participation in learning in the past four weeks. The COPRAS analysis of adult participation in learning in the past four weeks from 2012 to 2022—an important indicator of lifelong learning and workforce adaptability—reveals that Estonia leads the Baltic region with a perfect utility score of 1.00. Estonia demonstrates a clear and continuous upward trend, increasing participation from 11% in 2012 to 23.2% in 2022, reflecting strong national support for adult education and reskilling initiatives. Latvia and Lithuania follow with lower utility scores of 0.456 and 0.445, respectively, indicating comparatively limited engagement in adult learning opportunities. These results emphasize Estonia's strategic alignment with SDG 4 targets on lifelong learning and underline its proactive investments in human capital development and digital-era competencies. Table 12 provides the initial data matrix based on Eurostat figures, while Table 13 presents the final rankings obtained through the COPRAS method.

Table 12
Initial matrix (adult participation)

Weighs of criteria	0.25	0.25	0.25	0.25
Type of criteria	1	1	1	1
Year	2012	2015	2018	2022
Estonia	11	11.9	16.6	23.2
Latvia	5.4	5.7	6.6	10.7
Lithuania	4.4	5.8	7.2	10.7

Table 13
Final ranking (adult participation)

Country	Q+	Ui (Utility)	Rank
Estonia	0.525906	1	1
Latvia	0.240055	0.45646	2
Lithuania	0.234039	0.445019	3

Share of individuals with at least basic digital skills. The COPRAS evaluation of the share of individuals with at least basic digital skills for the years 2021 and 2023 where higher values indicate stronger digital competency within the population places Estonia as the top performer with a utility score of 1.00. Estonia's digital proficiency increased from 56.37% in 2021 to 62.61% in 2023, reflecting its advanced digital infrastructure and strong emphasis on integrating digital literacy into education and public policy. Lithuania ranks second with a utility score of 0.855, indicating steady improvement, while Latvia ranks third with a utility score of 0.809, showing a concerning decline in 2023 that may require renewed focus. These results underscore Estonia's leadership in digital education and its strategic position in fostering a digitally competent, future-ready society aligned with the objectives of a

sustainable digital economy. Table 14 presents the original data matrix retrieved from Eurostat, and Table 15 displays the final COPRAS-based ranking.

Table 14
Initial matrix (individuals with basic skills at least)

Weighs of criteria	0. 5	0. 5
Type of criteria	1	1
Year	2021	2023
Estonia	56.37	62.61
Latvia	50.8	45.34
Lithuania	48.84	52.91

Table 15
Final ranking (individuals with basic skills at least)

Country	Q+	Ui (Utility)	Rank
Estonia	0.375272	1	1
Latvia	0.30374	0.809387	3
Lithuania	0.320988	0.855349	2

5. Discussion

Education is universally recognized as a fundamental driver of sustainable development, with Sustainable Development Goal 4 (SDG 4) explicitly targeting inclusive, equitable, and quality education for all. The objective of this study was to evaluate and rank the performance of the three Baltic countries—Estonia, Latvia, and Lithuania—in delivering quality education that supports sustainability, using seven Eurostat indicators aligned with SDG 4. By applying the COPRAS multi-criteria decision-making (MCDM) method, this research offers a comparative, data-driven analysis that highlights the strengths and weaknesses of each country's educational system over time.

The main goal of the study was to identify which Baltic country demonstrates the most progress in educational quality in relation to sustainable development. Despite extensive literature on education and sustainability in Europe, there remains a research gap in comprehensive quantitative and comparative assessments of the Baltic States using harmonized European datasets such as Eurostat. Previous studies often focus on single indicators or qualitative narratives. For example, OECD (2022) reports highlight Estonia's excellence in PISA performance but do not integrate other sustainability-linked educational indicators. Similarly, works by Alam (2025) emphasize the conceptual relationship between education and sustainability but lack region-specific MCDM analyses (Alam, 2025). This study addresses that gap by integrating multiple education-related dimensions ranging from early childhood

participation to adult learning and digital literacy—into a robust, composite evaluation.

The results of the COPRAS analysis reveal distinct trends across the seven indicators. Lithuania consistently ranks highest in tertiary education attainment, early childhood participation, and reducing early school leaving, both by sex and by citizenship. This suggests that Lithuania has implemented effective national policies and support systems for formal education across various age cohorts. These results are supported by prior national analyses indicating Lithuania's increasing investments in higher education and early education access (Leišytė et al., 2018). Additionally, Lithuania's progress aligns with findings by Alisauskiene and Harju-Luukkainen (2021), who noted the country's improvements in education inclusion and accessibility in recent years (Alisauskiene & Harju-Luukkainen, 2021).

Estonia, on the other hand, leads in adult learning participation, digital skills acquisition, and low levels of academic underachievement among 15-year-olds. These findings corroborate Estonia's outstanding performance in the OECD PISA assessments, particularly in science and digital competence, and reflect the country's national strategy focused on lifelong learning and digital transformation. Estonia's high digital skill rates and adult learning participation further illustrate its strong alignment with SDG 4.3 and 4.4, which promote lifelong learning and technical/vocational skills development.

Latvia generally ranks in the middle across indicators, showing stability and gradual improvement, particularly in reducing early school leaving and expanding early childhood education access. However, its performance in digital skills and adult learning remains relatively lower compared to its neighbors. These outcomes suggest a need for stronger national strategies to support lifelong learning and technological capacity building. According to the European Commission (2023), Latvia's adult learning participation is still below the EU average, despite increased efforts in recent years to modernize vocational education.

By integrating expert-based weighting and Eurostat data into a transparent MCDM framework, this study offers a methodologically rigorous tool for benchmarking and policy evaluation. It enables not only ranking, but also the identification of policy gaps and leverage points for sustainable education reform. For instance, while Lithuania performs well in formal education stages, it may benefit from replicating Estonia's success in lifelong learning and digital education to enhance overall sustainability capacity.

In conclusion, this study highlights the multidimensional nature of quality education and its critical role in advancing sustainable development in the Baltic region. It contributes to the literature by combining a structured decision-making methodology with reliable data sources to assess performance holistically. The findings provide valuable insights for policymakers and educators seeking to align national education systems with long-term sustainability goals, and set a precedent for similar assessments in other regions of the European Union.

6. Conclusion

This study assessed the quality of education in the context of sustainable development in the Baltic States Estonia, Latvia, and Lithuania by applying the COPRAS Multi-Criteria Decision-Making (MCDM) method to seven key indicators derived from the Eurostat SDG 4 database. These indicators span early childhood education, academic underachievement, tertiary education, digital skills, and adult learning participation, capturing the breadth of lifelong learning and its intersection with sustainability. The research provides a comparative, evidence-based ranking of the Baltic countries, offering nuanced insights into where each nation excels and where targeted improvements are necessary.

The importance of quality education as a driver of sustainable development cannot be overstated. Education not only equips individuals with the knowledge and skills needed for decent work and responsible citizenship but also supports innovation, equity, and resilience—all of which are foundational to long-term social, economic, and environmental sustainability. In the Baltic context, where demographic shifts, digital transitions, and labor market demands are evolving rapidly, ensuring inclusive and high-quality education systems is critical for maintaining competitiveness and cohesion.

This study found that Lithuania leads in formal education indicators such as tertiary attainment and reducing early school leaving, while Estonia excels in adult learning, digital skills, and academic achievement among youth. Latvia shows stable performance but lags in lifelong learning engagement and digital competency. These insights highlight the need for differentiated policy approaches: Lithuania and Latvia should prioritize expanding adult education and digital literacy programs, while Estonia may focus on strengthening inclusiveness and access in earlier education stages.

For policy-makers, this research underscores the necessity of adopting a lifespan approach to education policy, ensuring that investments are not limited to formal schooling but extend to adult and digital education. Baltic governments are encouraged to:

- Enhance public investment in lifelong learning programs, particularly for older adults and rural populations.
- Foster public-private partnerships to support digital skill development aligned with labor market needs.
- Integrate sustainability education across all levels of the curriculum to promote environmental and civic awareness.
- Use data-driven decision-making tools, such as MCDM methods, for continuous performance monitoring and resource allocation.

Future studies can build on this research by incorporating qualitative dimensions of education, such as teacher quality, curriculum content, and student well-being. Moreover, expanding the analysis to include social and environmental indicators of education—such as equity in access, gender gaps, and green skills—would provide a more holistic view of how education supports sustainable

development. Comparative studies across other EU macro-regions could also contribute to broader regional policy learning.

In sum, this study demonstrates that robust, multidimensional evaluation frameworks are essential for tracking progress toward SDG 4. The Baltic States have shown commendable achievements, but continuous, targeted efforts are necessary to ensure that education systems remain inclusive, future-ready, and fully aligned with sustainable development objectives.

References

Alam, G. M. (2025). Sustainable Education, Sustainability in Education and Education for Sustainable Development: The Reconciliation of Variables and the Path of Education Research in an Era of Technologization. *Sustainability, 17*(1), 250. https://www.mdpi.com/2071-1050/17/1/250

Alisauskiene, S., & Harju-Luukkainen, H. (2021). Changes towards inclusion in the Lithuanian education system. In (pp. Chaper 12). https://doi.org/10.4324/9780367810368-15

Ashida, A. (2022). The role of higher education in achieving the sustainable development goals. In *Sustainable development disciplines for humanity: Breaking down the 5Ps—people, planet, prosperity, peace, and partnerships* (pp. 71-84). Springer.

Chatterjee, P., Athawale, V. M., & Chakraborty, S. (2011, 2011/02/01/). Materials selection using complex proportional assessment and evaluation of mixed data methods. *Materials & Design, 32*(2), 851-860. https://doi.org/https://doi.org/10.1016/j.matdes.2010.07.010

Clark, S., Gallagher, E., Boyle, N., Barrett, M., Hughes, C., O'Malley, N., Ebuenyi, I., Marshall, K., & O'Sullivan, K. (2023). The International Education Index: A global approach to education policy analysis, performance and sustainable development. *British Educational Research Journal, 49*(2), 266-287.

De Wit, H., & Altbach, P. G. (2021). Internationalization in higher education: Global trends and recommendations for its future. *Policy Reviews in Higher Education, 5*(1), 28-46.

Elfert, M. (2019). Lifelong learning in Sustainable Development Goal 4: What does it mean for UNESCO's rights-based approach to adult learning and education? *International Review of Education, 65*(4), 537-556.

Espinosa, V. I., & Pino, A. (2025). E-Government as a development strategy: The case of Estonia. *International Journal of Public Administration, 48*(2), 86-99.

Folayan, M. O., Ayouni, I., Nguweneza, A., Al-Batayneh, O. B., Virtanen, J. I., Gaffar, B., Duangthip, D., Sun, I. G. F., Onyejaka, N. K., & Daryanavard, H. (2023). A scoping review on the links between sustainable development goal 14 and early childhood caries. *BMC Oral Health, 23*(1), 881.

Gajdosikova, D., & Vojtekova, S. (2024). Comparative Analysis of Business Environment Dynamics in Central and Eastern Europe: A Multi-Criteria Approach. *Economies, 12*(12), 320.

Goyeneche, O. Y. R., Ramirez, M., Schot, J., & Arroyave, F. (2022). Mobilizing the transformative power of research for achieving the Sustainable Development Goals. *Research Policy, 51*(10), 104589.

Hansson, H., Säll, S., Abouhatab, A., Ahlgren, S., Berggren, Å., Hallström, E., Lundqvist, P., Persson, U. M., Rydhmer, L., & Röös, E. (2024). An indicator framework to guide food system sustainability transition–The case of Sweden. *Environmental and Sustainability Indicators, 22*, 100403.

Jurkynas, M. (2021). Regional Identities in Estonia, Latvia and Lithuania: Being Baltic, Looking North. *Problems of Post-Communism, 68*(4), 327-338.

Kouam, J. C., & Asongu, S. A. (2022). Effects of taxation on social innovation and implications for achieving sustainable development goals in developing countries: A literature review. *International Journal of Innovation Studies, 6*(4), 259-275.

Kouskoura, A., Kalliontzi, E., Skalkos, D., & Bakouros, I. (2024). Assessing the key factors measuring regional competitiveness. *Sustainability, 16*(6), 2574.

Leišytė, L., Rose, A.-L., & Schimmelpfennig, E. (2018). Lithuanian Higher Education: Between Path Dependence and Change. In J. Huisman, A. Smolentseva, & I. Froumin (Eds.), *25 Years of Transformations of Higher Education Systems in Post-Soviet Countries: Reform and Continuity* (pp. 285-310). Springer International Publishing. https://doi.org/10.1007/978-3-319-52980-6_11

Lella, L., Oses-Eraso, N., & Stamos, I. (2024). Pioneering a sustainable development goals monitoring framework for European regions. *Ecological Indicators, 166*, 112248.

Mohamed, B. H., Ari, I., Al-Sada, M. b. S., & Koç, M. (2021). Strategizing human development for a country in transition from a resource-based to a knowledge-based economy. *Sustainability, 13*(24), 13750.

Okada, A., Panselinas, G., Bizoi, M., Malagrida, R., & Torres, P. L. (2024). Fostering transversal skills through open schooling with the CARE-KNOW-DO framework for sustainable education. *Sustainability, 16*(7), 2794.

Ramiro Troitiño, D., & Mazur, V. (2024). Digital Social Initiatives: Europe Connecting Citizens with Social Transformation. In *E-Governance in the European Union: Strategies, Tools, and Implementation* (pp. 71-85). Springer.

Ruiu, M. L., Ruiu, G., Ragnedda, M., & Addeo, F. (2024). Exploring Digital-Environment Habitus in Italy—How Digital Practices Reflect Users' Environmental Orientations? *Sustainability, 16*(12), 4880.

Sousa, M., Almeida, M. F., & Calili, R. (2021). Multiple criteria decision making for the achievement of the UN sustainable development goals: A systematic literature review and a research agenda. *Sustainability, 13*(8), 4129.

Stenalt, M. H. (2021). Researching student agency in digital education as if the social aspects matter: students' experience of participatory dimensions of online peer assessment. *Assessment & Evaluation in Higher Education, 46*(4), 644-658.

Tyagi, R., Vishwakarma, S., Rishi, M., & Rajiah, S. (2021). Reducing inequalities through education and skill development courses. In *Reduced Inequalities* (pp. 746-758). Springer.

Veidemane, A. (2022). Education for sustainable development in higher education rankings: Challenges and opportunities for developing internationally comparable indicators. *Sustainability, 14*(9), 5102.

Zavadskas, E. K., Kaklauskas, A., Turskis, Z., & Tamošaitiene, J. (2008). Selection of the effective dwelling house walls by applying attributes values determined at intervals. *Journal of civil engineering and management, 14*(2), 85-93.