Araştırma Makalesi / Research Article

Evaluating Innovation, Quality of Life and Sustainability in OECD Countries: A Vikor Approach

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Abstract

This study evaluates how well OECD countries (Organisation for Economic Co-operation and Development) balance innovation, quality of life, and environmental sustainability while accounting for per capita CO_2 emissions and cost-of-living pressures. Using 2022–2024 data, Global Innovation Index, Environmental Performance Index, and Quality-of-Life Index are benefit criteria; CO_2 emissions and Cost of Living Index are cost criteria. Weights are derived objectively by CRiteria Importance Through Intercriteria Correlation (CRITIC); compromise ranking is obtained via VIšekriterijumska optimizacija i KOmpromisno Rangiranje (VIKOR) (v=0.5). Finland, Netherlands, Sweden, Estonia, and Denmark achieve the best overall performance, whereas innovation leaders United States (32nd), Israel (35th), and Australia (34th) rank low due to high carbon intensity and affordability issues. Results show that trade-offs between innovation-driven growth and socio-environmental goals are largely policy-dependent, with the Nordic-Continental European model offering the most successful integrated approach.

Keywords: *Innovation, Industrialization, Sustainable Development, VIKOR*
JEL Codes: *O3, O14, Q01*

OECD Ülkelerinde Yenilik, Yaşam Kalitesi ve Sürdürülebilirliğin Değerlendirilmesi: Bir Vikor Yaklaşımı

Öz

Bu çalışma, OECD ülkelerinde (Organisation for Economic Co-operation and Development) yenilik, yaşam kalitesi ve çevresel sürdürülebilirliği eş zamanlı dengeleme başarısını, kişi başı CO_2 emisyonu ve yaşam maliyeti baskılarını da dikkate alarak değerlendirmektedir. 2022-2024 verileriyle Küresel Yenilik Endeksi, Çevresel Performans Endeksi ve Yaşam Kalitesi Endeksi fayda kriteri; CO_2 emisyonu ve Yaşam Maliyeti Endeksi maliyet kriteri olarak alınmıştır. Ağırlıklar CRiteria Importance Through Intercriteria Correlation (CRITIC), sıralama VIšekriterijumska optimizacija i KOmpromisno Rangiranje (VIKOR) (v=0.5) yöntemiyle belirlenmiştir. Finlandiya, Hollanda, İsveç, Estonya ve Danimarka en iyi uzlaşma performansını sergilerken; ABD (32.), İsrail (35.) ve Avustralya (34.) yüksek karbon yoğunluğu ve yaşam maliyeti nedeniyle geride kalmıştır. Bulgular, yenilik odaklı büyümenin çevresel ve sosyal hedeflerle çelişkisinin büyük ölçüde politika tercihi olduğunu ve Nordik modelin bu dengeyi en başarılı şekilde sağladığını ortaya koymaktadır.

Anahtar Sözcükler: *Yenilik, Sanayileşme, Sürdürülebilir Kalkınma, VIKOR*

JEL Kodları: *O3, O14, Q01*

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Bu çalışma, 30 Ekim-01 Kasım 2025'te düzenlenen IV. Uluslararası Finans, Ekonomi ve Sürdürülebilir Politikalar Kongresi'nde (ICOFESP) sunulan bildirinin gözden geçirilmiş ve genişletilmiş tam metnine dayanmaktadır.

https://doi.org/ 10.33203/mfy.1830836

Geliş Tarihi/Submitted : 2025-11-26
Kabul Tarihi/Accepted : 2025-12-30

1. Introduction

In today's global economy, innovation, quality of life, and environmental sustainability are the primary elements that need to happen for long-term social and economic progress. These three things often work against each other. Innovation leads to better technology, more productive work, and a competitive edge (Schumpeter, 1942; Romer, 1990). A high quality of life is a sign that economic growth has really made people's health, safety, education, happiness, and buying power better. On the other hand, environmental sustainability makes sure that this kind of progress doesn't make it difficult for future generations to meet their own needs (World Commission on Environment and Development, 1987; United Nations, 2015). The 2030 Agenda for Sustainable Development implies that these areas are linked by a number of Sustainable Development Goals (SDGs), such as SDG 8 (decent work and economic growth), SDG 9 (industry, innovation, and infrastructure), SDG 10 (reduced inequalities), and SDG 13 (climate action). This shows that real prosperity requires a symphony of all three areas at the same time.

But these goals don't always work well together. Historically, growth driven by rapid innovation has been linked to more resource extraction, more energy use, more greenhouse gas emissions, and a bigger gap between the rich and the poor (Jackson, 2009; Hickel & Kallis, 2020). Some well-known examples are: The United States and Israel are always two of the most innovative countries in the world (World Intellectual Property Organization, WIPO, 2024), but their CO_2 emissions per person and cost-of-living indexes are still much higher than the OECD average. This makes life harder for a lot of people in those countries. Carbon-intensive growth models can raise living standards for a short period in some resource-rich countries. But when the prices of goods change, the environments in these countries get worse and their economy becomes unstable. This is the biggest problem for advanced OECD economies. As the world becomes more divided, supply chains break down, and digital and AI improvements happen, these countries need to stay at the top of the tech world and stay competitive. They already obliged under the Paris Agreement to cut carbon emissions and keep living costs low. But inflation, housing problems, and wage stagnation in some areas are making it hard to fulfill those obligations. These tensions have gotten more severe after the pandemic. Potential benefits in green technology is promising getting real output from that takes time. In addition to that, rise of cost of living from 2021 to 2023 showed welfare gains from innovation can be lost when energy prices rise or real wages stay stagnant.

The Global Innovation Index (GII), the Environmental Performance Index (EPI), and the OECD Better Life Index are all good at finding leaders in one area. The problem is they don't work well when goals are at contradictions with each other. For instance, Switzerland, Sweden, and the United States are all in the top 10 countries in the world for coming up with new ideas, but they are only average when it comes to being affordable or good for the environment. Countries with good environmental records, like Costa Rica (which is not an OECD country), can sometimes fall behind when it comes to coming up with new ideas. So, single-dimension rankings send policy signals that aren't complete and might be wrong. They show "winners" in one area yet hiding big problems in others. Because of this, policymakers don't have a full set of tools to see which countries really find the best balance between all three pillars at the same time. This leaves a big hole in what we know and what we do. Composite indices, such as the Happy Planet Index or the Sustainable Development Goals Index, attempt to encompass a broader scope. But in this case they employ equal or random weights and fail to utilize compromise-oriented algorithms to explicitly represent conflicting criteria. Multi-criteria decision-making (MCDM) methods, particularly compromise ranking methods such as VIKOR, are superior as they seek solutions that are "closest to the ideal" and "farthest from the worst," even when the criteria diverge (Opricovic & Tzeng, 2004, 2007).

This study seeks to fill this gap by posing the main research question: How can we systematically assess and rank the overall performance of OECD countries in harmonizing innovation capacity, social well-being (quality of life), and environmental sustainability. And still considering the environmental pressures and financial implications that innovation-driven growth frequently creates? We used the CRITIC and VIKOR methods to analyze 36 OECD member countries in order to address this inquiry. We use five carefully chosen indicators: the Global Innovation Index (benefit), the Quality-of-Life Index (benefit), the Environmental Performance Index (benefit), the Cost of Living Index (cost), and the CO_2 emissions per capita (cost). The CRITIC method finds objective criterion weights by looking at how strong the contrast is and how much disagreement there is between indicators. The VIKOR method, makes a compromise ranking that shows both group utility (average performance) and individual regret (avoiding extreme weaknesses).

The suggested framework combines innovation capacity, actual quality-of-life outcomes, sustainability performance, and the two most important "pressures" (carbon intensity and cost-of-living burden) to give a better and more useful evaluation than the ones we have now. There are unexpected results. The US, Australia, and Israel, which are known for being innovative, are near the bottom of the compromise list. In contrast, Nordic and some Continental European models are the best at making new ideas last and improve people's lives.

This paper aimed to bring new insight for both methodological and practical use. It offers VIKOR-based compromise ranking that looks at the relationship between innovation, quality of life, and sustainability across all OECD member countries. The ranking has clear policy implications for countries that want to move beyond the "grow dirty, clean up later" model that has been common in development since the 20th century.

2. Literature Review

For years, economic, environmental, and development research has focused on innovation, quality of life, and environmental sustainability. Schumpeterian growth theory, which holds that creative destruction drives long-term economic growth (Schumpeter, 1942), and endogenous growth models, which hold that knowledge spillovers and human capital boost productivity. These frameworks were expanded to include environmental constraints (World Commission on Environment and Development, 1987). The UN's Sustainable Development Goals (SDGs) strengthened this triple-bottom-line strategy by integrating innovation (SDG 9), well-being (SDG 3, 8, 10), and environmental preservation (SDGs 13-15) (United Nations, 2015).

The Porter Hypothesis suggests that real progress fueled by innovation has to go hand-in-hand with protecting the environment. According to Porter and van der Linde (1995), tough but smartly designed environmental regulations can actually spark innovation, lower long-term compliance costs, and make companies more competitive overall—that's the "strong" version. At the very least (the "weak" version), these rules force some level of innovation to happen. Evidence from Chinese provinces shows a clear rise in green patents, which supports the weaker version of the hypothesis. However, researchers don't see evidence for the strong version, mainly because the upfront costs of complying with these regulations remain pretty high (Ming-jun & Jian-ya, 2025). Environmental regulations may foster eco-innovation in affluent nations while establishing pollution sanctuaries in developing countries (Rousselière et al., 2024). The premise holds for renewable energy transitions in the OECD, although carbon leakage and rebound effects reduce net benefits (Dechezleprêtre & Sato, 2017).

The effect of innovation on the "quality of life" is also complicated. Thanks to the technology earnings, health, and leisure possibilities has improved over time. Yet, new studies show declining gains and disparities due to innovation as well. The Easterlin Paradox states that growth above a certain income level does not increase happiness (Easterlin, 2017), yet innovation in urban knowledge economies may increase cost-of-living issues (Vergara-Perucich, 2019). Silicon Valley and Israel are usually considered as usual suspects when it come to innovation with excellent GII rankings despite housing affordability and work-life imbalance (WIPO, 2024). Studies using quality-of-life indicators shows us that innovation benefits are not evenly dispersed. They favour trained workers, which marginalises others and undermines society (Aghion et al., 2016).

Innovation-based green development is also under review. According to the Environmental Kuznets Curve (EKC), wealth and pollution are inverted-U, with innovation accelerating the decrease (Stern, 2017). Recent data from after 2015 raises real doubts about whether high-income countries can fully separate economic growth from environmental damage. Sure, there's some "relative" decoupling happening—emissions grow more slowly than the economy—but actually achieving absolute reductions in CO_2 while demand keeps rising is tricky and hard to prove (Hickel & Kallis, 2020). In addition to that, the rising cost of living makes things even more bearable. As cities grow and new technologies and ideas reward certain skills more than others, housing and education become much more expensive. That often cancels out any quality-of-life gains people might expect from economic progress (Haberl et al., 2020).

Aware of these challenges and trade-offs, researchers are turning to composite indices (which combine multiple factors into one score) and multi-criteria decision-making (MCDM) tools to get a more nuanced and thorough picture of what's really going on. Traditional composites like the UNDP, OECD, and SDG Index offer overall ratings but utilize random equal weighting and can't handle contradictory criteria. MCDM methods solve this by letting people weigh pros and cons and balance (Mardani et al., 2015). Since 2000, over 500 MCDM sustainability applications evaluated. Energy and environmental areas use VIKOR, Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), and Analytic Hierarchy Process (AHP) most (Kumar et al., 2017).

When different goals or criteria pull in opposite directions, the VIKOR method helps find a solution that's as close as possible to the ideal—one that maximizes overall group benefits while minimizing the worst drawbacks for any single factor (Opricovic & Tzeng, 2004, 2007). It's been applied to things like planning renewable energy projects, measuring eco-efficiency, and ranking countries on sustainability. For instance, researchers have used VIKOR to evaluate environmental performance across Europe, assess energy sustainability in the G20 nations, and compare environmental quality in OECD countries (Kırda & Aytekin, 2023; Dang & Dang, 2020). Hybrid approaches that integrate VIKOR with objective weighing methods like CRITIC (Diakoulaki et al., 1995) are becoming increasingly popular to eliminate subjectivity. CRITIC-VIKOR hybrids are used for risk assessment, sustainable supply chains, and renewable energy site selection (Amin et al., 2022). Environmental measurements are utilized with innovation indexes like the Global Innovation Index. Governance quality weakly yet positively affects GII-EPI ratings (Machado, 2024). Few individuals see quality of life, cost of living, CO_2 per capita, and affordability as compromise considerations.

Despite these modifications, gaps remain large. Most MCDM studies simply assess energy or environmental sustainability. They ignore how cost and innovation pressures influence these domains. OECD-specific applications seldom combine GII, EPI, QoL, carbon intensity, and cost of living into a single model or use VIKOR's compromise logic to explain trade-offs. This paper proposes a CRITIC-weighted VIKOR framework that distinguishes benefits and costs, making it a better policy rating tool than single-dimension or additive composites.

3. Methodology

As of 2024, this study covers 36 of the 38 OECD member countries (excluding South Korea and Costa Rica due to incomplete data for key indicators), including longstanding members like the US, Japan, Germany, and newer entrants like Colombia. The OECD sample is suitable for this research because these nations have high economic development, institutional maturity, democratic governance, and market-based policies, but vary in innovation intensity, environmental strategies, and social welfare models. Trade-offs and best-practice compromise solutions may be identified due to development stage homogeneity and result heterogeneity. OECD nations are good laboratories for investigating balanced innovation-driven sustainable development because they face considerable policy pressure to conform with the UN Sustainable Development Goals (SDGs), the Paris Agreement, and the European Green Deal (for EU members).

A cross-sectional dataset predominantly representing performance in 2022–2023 was collected from the most current, comparable, and authoritative sources in the first half of 2024. The compromise-oriented VIKOR technique requires competing criteria (benefit vs. cost), therefore the five indicators were carefully picked to balance theoretical significance, empirical robustness, data availability for 36 nations, and the stated necessity for them. Using three benefit criteria (to be maximized) and two cost criteria (to be reduced), the technique may directly represent the tensions in the study topic.

Determining the weights of evaluation criteria is a crucial part of any multi-criteria decision-making (MCDM) process, since these weights directly impact the final ranking and can introduce bias if set subjectively. To ensure objectivity, this study uses the Criteria Importance Through Intercriteria Correlation (CRITIC) method, developed by Diakoulaki et al. (1995). CRITIC assigns weights based on the data's own properties—specifically, the intensity of contrast (measured by standard deviation) and the level of conflict between criteria (measured by correlation coefficients). This avoids the subjectivity found in expert-driven methods like Analytic Hierarchy Process (AHP) or Delphi. This issue can be a result of stakeholder preferences (Vidal et al., 2011).

CRITIC is well-suited for this research for several reasons. The five indicators in this study have mixed directions (three benefit, two cost) and various levels of correlation—for example, GII and EPI are weakly positively correlated, while CO_2 emissions per capita show little or negative correlation with QoL and Cost of Living. CRITIC leverages these differences to give more weight to criteria that provide clearer distinctions and unique information. In fields like sustainability and innovation, objective weighting prevents overemphasis on popular dimensions and supports transparent, data-driven trade-offs (Mardani et al., 2015). Finally, CRITIC has been widely validated in environmental and socio-economic studies. This also includes combining methods like VIKOR (Mahmood & Naeem, 2023).

The CRITIC procedure follows these standardized steps (Diakoulaki et al., 1995; extended formulations in Rostamzadeh et al., 2018):

Step 1 – Construct the Decision Matrix

Define all the alternatives and evaluation criteria and present their performance values in a matrix.

$$1.\ D = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix}, i = 1, 2, \ldots, m\ ve\ j = 1, 2, \ldots, n.$$

Step 2 – Normalize the Decision Matrix

For benefit criteria:

$$2.\ x_{ij} = \frac{x_{ij} - Min\{x_{ij}\}}{Max\{x_{ij}\} - Minx_{ij}}$$

For cost criteria:

$$3.\ x_{ij} = \frac{Max\{x_{ij\}} - x_{ij}}{Max\{x_{ij}\} - Min\{x_{ij\}}}$$

Step 3 – Find the correlation coefficients among the normalized evaluation criteria obtained in the second step are calculated.

$$4.\ r_{jk} = \frac{\sum_{i=1}^{m}(x_{ij} - \bar{x_j})\,(x_{ik} - \bar{x_k})}{\sqrt{\sum_{i=1}^{m}(x_{ij} - \bar{x_j})^2}\,\sqrt{\sum_{i=1}^{m}(x_{ik} - \bar{x_k})^2}}$$

Step 4- Find the total amount of information contained in each criterion.

In this step, the information content C_j is calculated using the standard deviation (σ_j) of the column values in the normalized decision matrix.

$$5.\ C_j = \sigma_j \sum_{k=1}^{n}(1 - r_{jk})$$

The VIKOR (VIšekriterijumska optimizacija i KOmpromisno Rangiranje) approach, proposed by Opricovic (in 1998) and further developed in Opricovic & Tzeng (in 2004, 2007), was chosen as the base ranking approach because it specifically aims for compromise solutions in conflict situations involving multiple criteria—exactly what happens in this case, where innovation, life quality, and sustainability are in conflict with each other. By comparison, while it is true that methods like weighted sum are additive, which can camouflage shortcomings, while outranking methods like ELECTRE can generate outcomes that are not strictly comparable, like different but nonequivalent cars, VIKOR rankings are well rounded, attempting to both maximize collective utility (mean performance) and, simultaneously, minimize individual regrets (minimum performance). Preventing catastrophic outcomes in any one criterion (such as climate crisis, stability, etc.) is, in effect, as valued in these situations as being optimal (Opricovic & Tzeng, 2004; Vadivel et al., 2023).

The compromise viewpoint of VIKOR is based on aggregation in the Lp metric in compromise programming. It has been widely used for sustainability evaluation and increasingly integrated with weighting based on objective criteria, such as CRITIC weights (Amin et al., 2022).

The full VIKOR algorithm applied here (v = 0.5 for balanced strategy) comprises six steps:

Step 1 – Construct the Decision Matrix A_{38X5} matrix f_{ij} was built from raw indicator values (no pre-normalization needed beyond direction handling).

Step 2 – Determine the Best and Worst Values for Each Criterion
For benefit criteria:

6. $f_j^* = \max f_{ij}\,,\ f_j^- = \min f_{ij}$

For cost criteria (reverse):

7. $f_j^* = \min f_{ij}\,,\ f_j^- = \max f_{ij}$

Step 3 – Compute the S and R Values

• S_i :Group utility measure (overall distance from the ideal)

S_i represents the overall (aggregated) distance of alternative i from the ideal solution across all criteria. It shows how well the alternative does on average compared to the ideal values and how well it does as a whole.

• R_i :Individual regret measure (worst criterion performance)

R_i denotes the maximum regret (the worst deviation) of alternative i among all criteria. It focuses on the most disadvantageous criterion for that alternative.

8. $S_i = \sum_j w_j \frac{f_j^* - f_{ij}}{f_j^* - f_j^-}$

9. $R_i = \max_j \left[w_j \frac{f_j^* - f_{ij}}{f_j^* - f_j^-} \right]$

Step 4 – Compute the VIKOR Index Q_i

The $Q_i$value expresses the overall compromise position of each alternative by balancing two aspects: its average performance across all criteria and its worst-performing criterion. Instead of focusing solely on overall utility or only on the maximum regret, $Q_i$blends both perspectives into a single measure.

$$10.\ Q_i = v\frac{S_i - S^*}{S^- - S^*} + (1 - v)\frac{R_i - R^*}{R^- - R^*}$$

v = 0.5 balances majority (utility) vs. minority (regret) concerns. Alternative v values (0–1) were tested; v=0.5 yielded most stable results.

Sensitivity analysis was conducted by parameter v between 0.3 and 0.7. The top 10 positions remained highly stable. Minor changes in the ordering happened in the lower half of the ranking.

Step 5 – Rank Alternatives Sort by ascending Q_i (primary), S_i, R_i (secondary).

Step 6 – Verify Acceptable Advantage and Stability DQ = 1/(m−1) = 1/37 ≈ 0.027 The top-ranked alternative (Finland) satisfied: $Q(2^{nd}) - Q(1^{st}) > DQ$ (acceptable advantage) and ranked first in both S and R (acceptable stability).

4. Variables and Data

4.1. Global Innovation Index (GII) – Benefit standard (maximization)

It is widely accepted that the GII is the best way to measure a country's ability to innovate. The 2024 edition looks at 132 economies (including all 38 OECD members) using 81 indicators grouped into seven pillars: institutions, human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, and creative outputs. The GII score, which ranges from 0 to 100, takes into account both inputs and outputs of innovation. It is part of the core innovation variable because it covers the whole ecosystem, from R&D spending and patenting to the export of creative goods and digitalization. This lets us see if countries can do well even if they aren't the best at innovation.

4.2. Environmental Performance Index (EPI) – Criterion for benefit (maximize)

The 2024 Environmental Performance Index was put together by the Yale Center for Environmental Law & Policy and Columbia University (Block et al., 2024). The EPI ranks 180 countries. They consider 58 performance indicators in 11 issue areas. In the 2024 edition, climate change mitigation took 40% of the weight. Some groups are air quality, sanitation, biodiversity and habitat, ecosystem services, fisheries, agriculture, water resources, and heavy metals. The score (0–100) tells you how close you are to meeting the policy goals. We chose the EPI because it looks at environmental outcomes and policy effectiveness instead of just inputs (like spending). This makes it a good stand-in for actual sustainability and ecological resilience, which are becoming more important because of green policies that are driven by innovation.

4.3. Quality-of-Life Index (QoL) – Benefit standard (maximize)

An empirical formula is used to figure out Numbeo's Quality of Life Index composite index (Numbeo, 2024b). It includes eight sub-indices: purchasing power (including local purchasing power compared to the cost of living), safety, health care quality, climate, cost of living (inversely), property price to income ratio, traffic commute time, and pollution (air and water). The index is constantly updated with data from the crowd and official sources. Researches show that the index is responsive and covers both objective and subjective well-being dimensions (Girardi et al., 2024). Its' partly perception-based insights bring more timely results than periodic surveys (like the OECD Better Life Index) and shows how innovation and productivity can improve people's daily lives.

4.4. CO_2 Emissions per Capita (metric tons) – Cost criterion (minimize)

This indicator shows how much fossil CO_2 is released in a certain area (not including changes in land use) divided by the population at the middle of the year (Global Carbon Project, 2024). CO_2 per capita is better than total emissions because it takes into account the size of the population and shows how carbon-intensive a person's lifestyle and economic activity are. Countries with efficient, innovative, low-emission systems (like those that use advanced renewables, electrification, and circular economy practices) tend to do well here. This makes it an indirect measure of successful green innovation while directly punishing carbon-heavy growth models (Crippa et al., 2024).

4.5. Cost of Living Index—Cost criterion (minimize)

The index takes the prices of more than 50 items, like groceries, transportation, utilities, and rent, and combines them based on how much people use them. High values mean that people cannot buy as much as before (Numbeo, 2024a). This is a serious issue in cities. Competition for talent drives up the cost of housing and services. The model uses this indicator to see if the benefits of innovation are shared by most of the people or vice versa.

Table 1

Summary of Indicators, Direction, Conceptual Role, and Rationale

Variable	Direction in VIKOR	Conceptual Role	General Rationale for Inclusion
Global Innovation Index (GII)	Maximize	Innovation Capacity	Benchmark variable that shows how well countries can make and spread new technologies; tests whether non-innovation indicators can indirectly measure innovative capacity.
Quality-of-Life Index (QoL)	Maximize	Social Well-Being	Measures how well people are living and how happy they are; shows how much improvements in health, safety, and purchasing power are due to new ideas.
Environmental Performance Index (EPI)	Maximize	Sustainability Outcomes	Shows how well the environment is managed and how resilient it is to change—two things that are becoming more and more connected

			to policy design that is based on innovation and long-term socio-economic stability.
CO_2 Emissions per Capita	Minimize	Environmenta l Pressure	Shows how much carbon is released during growth; countries with efficient, low-emission systems tend to have better policies for innovation and sustainability; and it is a direct punishment for unsustainable development paths.
Cost of Living Index	Minimize	Economic Affordability	High living costs hurt welfare and competitiveness; they are the opposite of real purchasing power; they show how well innovation and productivity gains can lead to affordable living conditions instead of inflationary pressures.

Combining benefit and cost criteria, along with objective CRITIC weighting (see Section 5), ensures that the subsequent VIKOR analysis genuinely reveals compromise solutions rather than rewarding unilateral excellence. All indicators exhibit complete coverage for the 36 OECD countries, required no imputation, and were entered into the decision matrix in their raw form (the VIKOR method handles normalization internally during computation of utility and regret scores). The dataset's cross-sectional nature provides a snapshot of performance at a point when post-COVID recovery, energy crises, and accelerating climate policy implementation were actively shaping national outcomes.

This indicator selection is parsimonious yet comprehensive: five variables avoid multicollinearity issues common in larger MCDM applications while covering the core theoretical triad (innovation, quality of life, sustainability) plus the two most salient pressures that generate. Alternative indicators (e.g., Gini coefficient for inequality, renewable energy share, or GDP per capita) were considered but excluded to maintain model focus and interpretability; preliminary correlation analysis confirmed that the chosen variables provide distinct discriminatory power (as later validated by the high CRITIC weight on CO_2 emissions per capita).

4.6. Limitations of the Data Sources

Numbeo's Quality of Life and Cost of Living indices are convenient,up-to-date and cover all 36 OECD countries. However, they are based on crowd-sourced data, which could lead to perception biases or inconsistencies when compared to official statistical sources like the OECD Better Life Index. This trade-off was made to get a full and up-to-date dataset (as of mid-2024), but it is a limitation of the study that should be kept in mind when looking at the results.

5. Results

After constructing the decision matrix and applying min–max normalization, the correlation coefficients among the criteria were computed as shown in Table 2

Table 2

Correlation coefficients among evaluation criteria

	GII Overall Score	EPI Overall Score	QoL Index	CO_2 Emissions per capita	Cost Of Living Index
GII Overall Score	1				
EPI Overall Score	0,17	1			
QoL Index	0,70	0,3	1		
CO_2 Emissions per capita	-0,19	-0,32	-0,42	1	
Cost Of Living	0,74	0,20	0,63	-0,0033	1

Table 2 presents how the criteria relate to one another, which matters because the CRITIC methods use both the variability of each criteria and the degree of correlation among them. Keeping these relationships in mind, Table 3 summarizes the calculation steps of the CRITIC approach-including standard deviations, conflict levels, information content, and the resulting weights.

Table 3

Summary of CRITIC calculations

	GII Overall Score	EPI Overall Score	QoL Index	CO_2 Emissions per capita	Cost of Living Index
σ_j	0.26	0.25	0.24	0.28	0.19
$\sum_{k=1}^{n}(1-r_{jk})$	2.59	3.61	2.77	4.94	2.44
C_j	0.67	0.92	0.65	1.38	0.47
Critic Weights	0.16	0.22	0.16	0.34	0.11

After obtaining the information content values and the weights in Table 3, the next step is to make sense of what these results imply. For this reason, Table 4 provides short interpretations for each variable's weight, highlighting which criteria are more distinctive and how they shape the overall evaluation.

Table 4

Criterion weights of each variables

Variables	**Weight**	**Interpretation**
CO_2 emissions per capita	0.34	Highest discriminatory power; high variation across OECD and low correlation with innovation/QoL
EPI Overall Score	0.22	Strong contrast, moderate conflict
GII Overall Score	0.16	Moderate weight despite importance—relatively high correlation with EPI
QoL Index	0.16	Balanced with GII
Cost of Living Index	0.11	Lowest weight—lower variation in OECD context

The importance of the CO_2 emissions per capita measure cannot be overemphasized, with a weightage of 0.34, and thus confirms the major challenge that "carbon intensity is the major differentiator among OECD countries, while there is converging similarity in both innovation and quality-of-life factors." It objectively justifies the role of cost factors as "pressures" rather than simple costs. The equal weights for GII and QoL measures (0.16 each) highlight equal roles played by both factors, while the increased importance of EPI, with 0.22 weights, emphasize the importance of sustainability measures differentiators. The lower weights for Cost of Living at 0.11 highlight lower differences among the high-income countries in the OECD but highlight importance in discouraging innovatively dear locations worldwide.

The sensitivity analysis further validated the robustness of the results, as no normalization technique or the treatment of outliers resulted in a variation of the weights by more than 0.03, which is well within acceptable margins. The objective weights were used directly as inputs into the VIKOR method, thereby ensuring the ranking of the compromise solution is based on objective priorities and not on equal assumptions.

Computations were performed in R (package 'MCDM'). The resulting Q_i values produced the ranking in Table 5, with all conditions satisfied up to rank 12 (full compromise set available from author). Sensitivity tests varying v (0.3–0.7) changed only lower ranks marginally, confirming robustness.

VIKOR's strength here lies in penalizing extreme weaknesses: high-innovation but high-emission countries (e.g., United States, Australia) suffer high R_i despite decent S_i, dropping them in Q-ranking. This reveals true compromise leaders-countries close to ideal on all fronts without catastrophic regret on any.

The application of the CRITIC-weighted VIKOR method produced a clear and robust compromise ranking of 36 OECD countries (Table 5). Finland emerges as the undisputed leader (Q = 0.000), followed closely by the Netherlands (Q = 0.052), Sweden (Q = 0.068), Estonia (Q = 0.104), and Denmark (Q = 0.119). The top 10 is completed by Germany, Austria, Japan, Norway, and Czech Republic. Switzerland (12th) and Luxembourg (11th) also found place in high ranks.

Nordic countries occupy four of the top five positions, with Estonia - a digital frontrunner – breaking the Nordic monopoly in 4th place. Continental European countries (Netherlands, Germany, Austria, Czech Republic) and Japan confirm that mature, coordinated market economies with strong green policies achieve the best balance.

At the lower end, Mexico ranks last (36th), followed by Israel (35th), Australia (34th), Türkiye (33rd), and the United States (32nd). Other notable low performers include New Zealand (30th), Canada (28th), and surprisingly, Ireland (22nd), despite its very high GII score.

The acceptable advantage condition (DQ ≈ 0.027) is satisfied throughout the entire ranking list, and the top 15 countries also fulfil the acceptable stability condition in both S and R, confirming the reliability of the compromise solution.

Table 5

Final VIKOR Compromise Ranking of OECD Countries

Country	Rank	Country	Rank	Country	Rank
Finland	1	Lithuania	13	Greece	25
Netherlands	2	United Kingdom	14	Chile	26
Sweden	3	Iceland	15	Spain	27
Estonia	4	Slovenia	16	Canada	28
Denmark	5	Portugal	17	France	29
Germany	6	Hungary	18	New Zealand	30
Austria	7	Slovakia	19	Colombia	31
Japan	8	Latvia	20	United States	32
Norway	9	Poland	21	Türkiye	33
Czech Republic	10	Ireland	22	Australia	34
Luxembourg	11	Belgium	23	Israel	35
Switzerland	12	Italy	24	Mexico	36

The acceptable advantages and stability conditions were satisfied for the top-ranked countries. Note: South Korea and Costa Rica were excluded from the ranking due to incomplete data availability for one or more indicators, resulting in a final sample of 36 countries).

6. Discussion

The findings of the study strongly support the main hypothesis, namely that high-level innovation performance does not necessarily imply strong overall performance when taken together with sustainability of the environment and affordability.

Conventional innovation leaders like the USA (32nd), Israel (35th), Australia (34th), and Ireland (22nd) see a tremendous fall in the compromise index because of their overall high CO_2 emission levels and cost-of-living indices. Take the case of the USA, which stands 9th among innovation leaders on the GII but continues to register CO_2 emission levels that are over twice the average OTCA levels and a cost of living index that is almost 80 (with New York set at 100), thus causing a dramatic deterioration in its Q index value because of high group utility (S) and individual regret value (R). Israel, which always stands out in the innovation ranks, fares worse because of housing costs and energy intensity levels that far outstrip other nations.

In contrast, however, the Nordic-Baltic group of innovation leaders (Finland, Sweden, Estonia, Denmark, Lithuania 13th, Latvia 20th) shows how successfully a high-quality innovation environment can be combined with excellent environmental performance and low costs of living. The examples of Finland and Estonia, specifically, are very enlightening here: Finland ranks 6th in GII, first in EPI 2024, and has CO2 emissions per capita below 8 tons, and it keeps a reasonable cost of living because of a strong social safety net. The striking example of Estonia's 4th place indicates how a high level of digitization, combined with moderate salaries and EU's green regulation, can quickly lead smaller economies to innovation leader levels.

By contrast, the success stories in Continental Europe (Netherlands 2nd, Germany 6th, Austria 7th, Czech Republic 10th) offer a blueprint: ambitious renewable energy policies, a circular economy, top vocational training ensuring that so-called skill premiums do not feed through into higher living costs, and progressive tax systems that maintain purchasing power. Japan's 8th place ranking, despite its demographics, proves the benefit of an early focus on energy-saving and transportation infrastructure investment.

The large weight assigned to CO_2 intensity per capita by CRITIC (0.34) is highly decisive and practically important: through 2024-2025, carbon intensity remains the single most important criterion in separating more or less comparable wealthy countries. The opportunity costs of a delayed decarbonization of electricity and industry sectors (for example, Australia, Canada, United States) in the compromise ranking are very high even if innovation and quality of life rankings are outstanding.

The key takeaway is where a high level of innovation performance fails to correlate to a high level of balanced outcomes. The regularly touted innovation superpowers, Switzerland (ranked 12th overall), United States (32nd overall rank), Israel (35th overall rank), Ireland (22nd overall rank), and Australia (34th overall rank), trail significantly further back when sustainability results, carbon intensity, and affordability considerations are taken into account. Their respective problems lie within CO_2 emissions per capita and affordability crises, which undermine the welfare dividends of innovations.

On the other hand, the leadership role of Nordic states, as well as some Baltic/Continental European countries, in the top positions in the compromise index ranking—Finland (ranked 1st), Netherlands (ranked 2nd), Sweden (ranked 3rd), Estonia (ranked 4th), Denmark (ranked 5th), Germany (ranked 6th), and Austria (ranked 7th)—shows that high performance in every area is by no means impractical in 2024-25. These countries show that it is possible to achieve ambitious climate commitments, comprehensive social safety nets, green and compact cities, as well as innovation hubs focused on green-tech, ICT, and other emerging technologies, without conflict, but by finding synergies instead. The CRITIC weighting scheme, which favors CO_2 emission per capita (giving it a weight of 0.34) above all other factors, further highlights that in 2024-25, lowering CO_2 emissions remains the most effective way for any developed country to distinguish itself among peers. Those countries that pursued zero-carbon, electrification, circular economy strategies from inception (the Nordics, Germany, Austria) now reap compound benefits in environmental performance, affordability, and sustained innovative capacity.

The most significant takeaway is that the conflict between innovation and sustainability is, in large part, an illusion that can be overcome by wise policy mixes. The best performers demonstrate that innovation agendas can focus on green innovation, efficiency, and inclusivity instead of resource extractive innovation. The Nordic solution is not imitable; it is based on institutional choices such as strict environmental policy, progressive redistribution, educational and R&D investments, and spatial policies that preclude housing bubbles that other OECD member countries could choose as well. On a more general level, however, it is clear that the CRITIC-VIKOR methodology is a useful and intuitive tool for policymakers in its own right. Unlike traditional composite indices that often obscure pitfalls through averages of any sort, a compromise method such as this is specifically designed to emphasize elements of greatest regret to be utilized for a country's national sustainable development strategies or SDG tracking and peer reviews within OECD settings. These and other such frameworks could easily be incorporated to track performance annually with changing weights to account for shifting interests (more regarding biodiversity or AI and ethics, for instance).

Such results cast doubt on the prevailing narrative in some corners of the policy world that aggressive action on climate change and the cost of living has a deleterious impact on competitiveness and innovation. In fact, the countries that top this well-rounded index tend to be among the most competitive and resilient economies in the world.

7. Conclusion

This research aimed to find a solution for a basic problem: how to properly assess the innovation capability, general well-being (life quality), and sustainable development of OECD nations, considering the pressures induced by growth, specifically carbon intensity and cost of living pressures. The method of CRITIC weighted VIKOR compromise ranking was used on the OECD dataset from 2022 to 2024 to conduct the first integrated analysis on this specific trio of factors for which not only the benefits but also the cost aspects contain contradictory information. The findings of this analysis show no room for doubt: excellent overall performance is possible, not based on innovation but on overall strategy.

The above findings have highly significant policy implications, extending far beyond the OECD membership. First, a major message for the high-innovation, high-emissions nations (United States, Canada, Australia, Korea) is to acknowledge the price they pay for postponed efforts for a low-carbon transition in the electricity, transport, and industry sectors. The message from these findings is clear: carbon-hungry growth paths are not only untenable from a sustainability viewpoint but also rapidly at odds with maintaining high standards of living and high-innovation dynamics. The recommended policies are: (i) carbon pricing and recycling for green R&D and compensatory policies, (ii) revise land-use and zoning regulations for policies to overcome the housing supply shortages, and (iii) shift the focus of the innovation strategy from generic "frontier technologies" to green innovation projects (Mazzucato, 2021).

Secondly, the middle- and lower-ranking European countries (ranked 29th: France, 27th: Spain, 24th: Italy, and 25th: Greece) must take advantage of the European Green Deal and Next Generation EU to achieve faster convergence with front-runners in northern Europe. The Estonian and Czech example has demonstrated that rapid convergence is feasible via digital and green twin transitions if national determination is integrated with EU funds.

Third, new members of the OECD (Chile: 26th, Colombia: 31st, Costa Rica, Mexico: 36th, Türkiye: 33rd) benefit most by "green leapfrogging." Instead of following models of industrialization that lock in GHG emissions, these transitional economies would focus on green infrastructure, sustainable tourism and technological services, and inclusive information and communication technologies right away.

Looking forward, the next five years (2025-2030) will reveal if the current crop of leaders has what it takes to preserve their lead in the face of geopolitical energy disruptions, AI-based disruption, and possible pushes back against pro-green agenda politics. What the initial signs of the Global Innovation Index – 2025 (WIPO, 2025) and current OECD Environmental Performance Reviews indicate is that the Nordic solution still has life in it but that care must be taken. Nations whose timelines align innovation, sustainability, and happiness will be better placed in a world that is increasingly resource-constrained.

In closing, this debunks a very contentious issue: the conflict between innovation-led development and the concerns for the social and environment spheres is far from inevitable—it lies with the chosen policy framework. Those nations opting for integration rather than fragmentation, directionality rather than neutrality, and resilience rather than development benefit from the outcomes already. The hard part for the others would no longer entail deficits in finances and technologies but plans to implement the lessons derived.

Future studies could apply such a framework in different directions as follows. Firstly, re-running such an analysis using well-being and cost of living data from different sources (e.g., OECD Better Life Index or World Bank datasets) would enable us to verify whether these results generalize when shifting from one set of sources of data to another. Secondly, introducing, for example, the Gini coefficient as an additional cost factor may enable us to grasp what impact innovation-led growth has on inequality of wealth distribution. Lastly, CO_2 emissions data on the basis of consumption, and not production, could reverse the ranking of countries, particularly those where carbon-embodied trade items exhibit large volumes.

Authorship Statement: The author has reviewed and approved the final version of the manuscript.

Conflict of Interest Statement: The author declares that there is no conflict of interest in the research, authorship, or publication processes.

Funding Statement: The author declares that no financial support or funding was received for this study.

Ethical Statement: The author declares that scientific and ethical principles were followed in this study, and all sources used have been properly cited.

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