The Interplay of Happiness and Sustainability: A Multidimensional Scaling and K-means Cluster Approach

Emmanuel Detrinidad * and Victor Raul Lopez Ruiz *

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Article

The Interplay of Happiness and Sustainability: A Multidimensional Scaling and K-Means Cluster Approach

Emmanuel Detrinidad and Víctor Raúl López-Ruiz

Faculty of Economics and Business Administration, Universidad de Castilla la Mancha, Plaza de Universidad 1 Albacete Código 02071

Abstract: This study investigates the intricate relationships between happiness, sustainability, and cultural values across 74 countries. Utilizing a multidimensional scaling (MDS) and K-means clustering approach, we analyze six happiness indices alongside the Sustainable Development Goals Index (SDGI). Our findings indicate a positive correlation between economic development, social progress, and elevated levels of both happiness and sustainability. Nevertheless, instances like the United States highlight the necessity of alternative methodologies, highlining classification of nonlinear models.The MDS analysis identifies four distinct clusters of countries, each demonstrating similar profiles in terms of happiness, sustainability, and cultural values, as per Inglehart's framework. This clustering underscores the necessity for a comprehensive perspective that integrates economic, social, and cultural dimensions to produce robust results and mitigate disparities or contradictions in subjective measures like the World Happiness Score.Future research should explore the impact of institutional frameworks, governance models, and social capital. Additionally, longitudinal studies are needed to examine how these relationships evolve in response to global challenges. We acknowledge the limitations related to data heterogeneity, the subjectivity of cluster analysis, and the exclusion of outliers, emphasizing the need for further research to enhance the generalizability and robustness of these findings.

Keywords: happiness; sustainability; cultural values; multidimensional scaling (MDS); K-means clustering; happiness indices; sustainable development goals index (SDGI)

Introduction

This article studies the relationship between the achievements of sustainability and global development indices and the self-assessment (level of satisfaction) of quality of life. The self-assessment of quality of life manifests to a certain extent the value system of the different societies linked to their degree of development (industrial and post-industrial societies), however the conventional measures used in general indices such as the WHI, GDP present counterintuitive results such as the World Happiness Report 2024 where countries such as Nicaragua and El Salvador report a higher score than countries such as Spain; United States reports a medium score with a high level of GDP per capita. On the other hand, countries such as Norway and Sweden in the post-covid measurements show changes in quality-of-life satisfaction scores where Sweden increases slightly and Norway decreases; countries such as Switzerland have a sharp drop in the happiness score

For our framework of analysis, the secularization scheme is proposed, where the security dimension play a principal goal in the stratification in human societies. Historically, this "Security", physical, social, environmental, is the emergence of forms of family organization, of the state and of governance . A good approximation to this model is what nineteenth-century sociologists called moral statistics, such as the infant mortality rate and life expectancy at birth, which largely represent the protection provided by governments to the most vulnerable groups in a society.

To try to overcome the apparent paradoxes, such as those expressed in the first paragraph of this study, resulting from the sensitivity of the indices of perception of quality of life to changes in social

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policies, radical social movements, or to the contradiction between experimental evidence Easterlin paradox the increase in wealth does not increase happiness in individuals, and ecological studies where it is found that higher personal incomes go together with higher self-reported life satisfaction , the exploration of data is proposed with multidimensional techniques such as cluster and multidimensional scaling that facilitate a global visualization of the proximity between different societies, their happiness index and their level of Sustainability.

Correspondence: conceptual framework, secularization scheme proposed by , is consistent with the finding of authors such as Bjørnskov et al. (2010), who find a positive correlation between quality of life satisfaction and quality of governance, since the achievement of high levels of security (sustainability and development) is preceded by forms of government that address the needs and development of their stakeholders populations.

The advantages of this analysis are that the quality-of-life satisfaction (WHR) variables are reliable and inexpensive indicators to measure the quality of governance and consequently the quality of sustainability in the world system.

Multiple methodological and theoretical efforts have been made to develop a comprehensive model that can explain both productivity and GDP. This model aims to incorporate the UN's proposed Development Indices for 2030 and reconcile the self-assessment of quality in society including the value system and religious factors.

As an Example, propose an approach using Data Envelopment Analysis to measure the efficiency of subjective variables in relation to GDP per capita, finding countries with greater explanatory ranges include the Nordic countries, as well as countries that we call paradoxes, Kyrgyzstan, Italy, Colombia, Guatemala, and Tunisia.

In the book Happiness, Well-being and Sustainability, Its highlight that when examining the reasons behind varying levels of life satisfaction within a nation, researchers invariably discover that a robust social safety net plays a vital role. If individuals are assured of having shelter, sustenance, employment opportunities, and healthcare even in times of financial hardship such as job loss or inability to pay rent, then they benefit from a strong safety net. Furthermore, a solid social safety net facilitates access to education without accumulating substantial debt, enables retirement without concerns about savings adequacy, allows for caregiving responsibilities without jeopardizing job security, and ensures affordable childcare options. It is not surprising that countries with well-developed social safety nets tend to be affluent nations with higher income levels, which correlates with higher levels of happiness as evidenced by life satisfaction metrics .

Latin American countries exhibit lower levels of wealth; however, happiness levels are elevated when happiness is defined and assessed in terms of positive emotions such as joy and contentment ; . This phenomenon has prompted economists and social science scholars to investigate the underlying reasons. Some of the factors they propose that contribute to the relatively high levels of happiness in Latin American and other nations, despite their GDP levels, are elucidated like the participants reported a strong emphasis on familial and social relationships. Extended family networks were prevalent, characterized by proximity and mutual support. Social interactions were frequent and imbued with warmth, fostering a sense of community. Participants derived a significant sense of purpose from interpersonal connections. Cultural norms prioritized relationship building and maintenance over individual achievement. A generally relaxed pace of life was observed, with a focus on present-day experiences rather than future aspirations.

We hypothesize that a nonlinear, multivariate approach, such as multidimensional scaling (MDS), is necessary for a comprehensive examination of the interrelationship between subjective well-being and sustainability. Given the extensive application of MDS in the study of consumer perception and preferences, we believe this method is well-suited to capturing the complexities of these constructs.

Building upon the conceptual framework proposed by , we posit that this model provides a robust foundation for understanding the determinants of subjective and material wellbeing across societies. By integrating the sustainability dimension into this framework, we aim to develop a more nuanced perceptual representation aligned with the underlying value systems as outlined in the

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cultural map. This approach offers a potential solution to the challenge of explaining the disproportionate happiness scores observed in some middle- and low-income countries, which may be attributed to methodological limitations in handling large datasets with multiple variables.

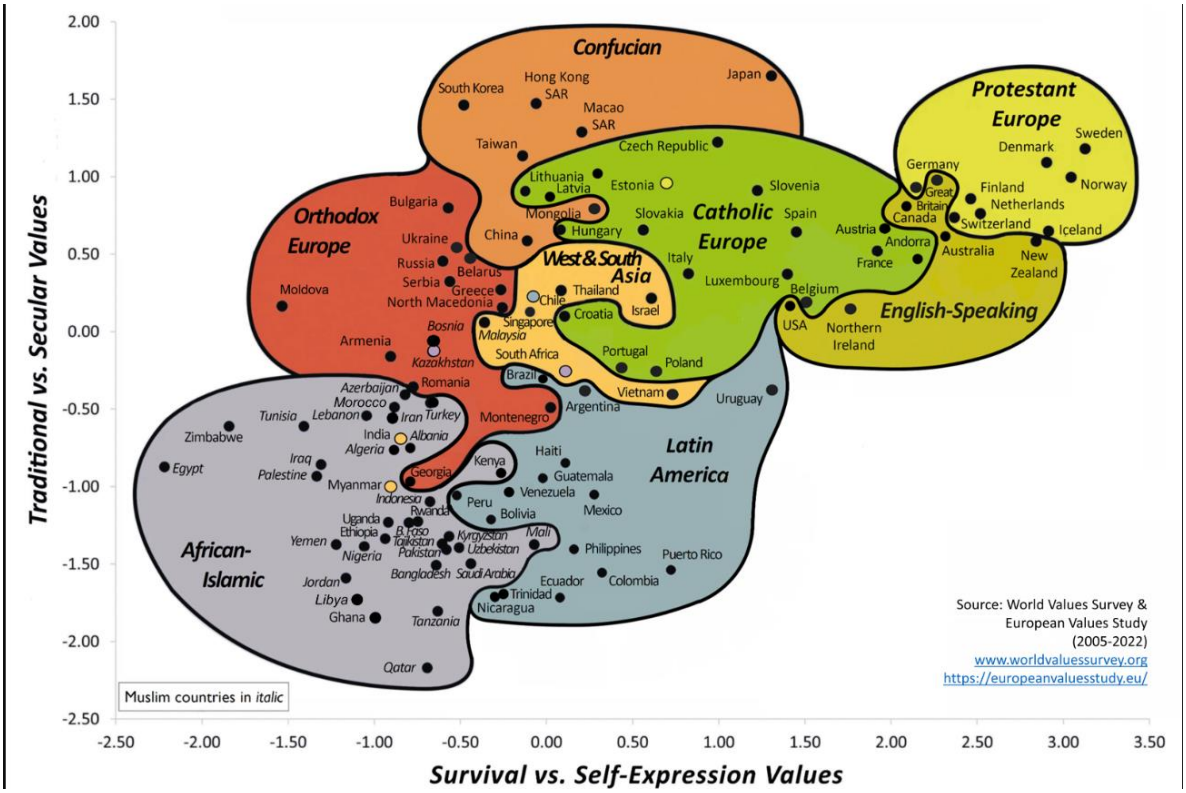

Figure 1. Cultural Map World Value Survey. Source: The Inglehart-Welzel World Cultural Map - World Values Survey 7 (2023).

To conduct this analysis, we will employ a Euclidean proximity map representation using Multidimensional Scaling (MDS) to compare our findings with the Inglehart-Welzel cultural map. Given their exploratory interest, cluster analysis and MDS, are prioritized due to their effectiveness in handling non-linear relationships within the data and working with point of cases and variables.

Methodology

Different approaches have been taken to use both the WHI and SDGI indicators with the aim of applying the combination of subjective and objective variables to be useful in the creation and implementation of public policies. In our study we explored 74 countries with 6 happiness indices variables and the SDGI index (7 variables in total) based on a proximity matrix (perceptual map), a cluster analysis, and a MDS. We tried to interpret the selected cluster on a two-dimensional map of distances to see the similarities of the countries related to the achievements of the Sustainable Development Goals and the perception of happiness related to the six selected variables.

The World Happiness Report is a collaboration between Gallup, the Oxford Wellbeing Research Centre, the United Nations Sustainable Development Solutions Network, and the WHR Editorial Board. The report is produced under the editorial control of the WHR Editorial Board.

The World Happiness Report reflects a global demand for greater attention to happiness and wellbeing as criteria for government policies. It reviews the state of happiness in the world today and shows how the science of happiness explains personal and national variations in happiness.

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Table 10. and the worst possible life is a 0. They are then asked to rate their current lives on this scale from 0 to 10. The rankings come from nationally representative samples over three years.

Table 1. World Happiness indicators.

GDP per capita	Economic production, often used as a measure of standard of living.
Social support	Having someone to count on in times of trouble.
Healthy life expectancy	A measure of the average number of healthy years a person can expect to live.
Freedom to make life choices	The degree of individual freedom experienced.
Generosity	Measured by recent donations.
Perceptions of corruption	Trust in government and business.

Source: own elaboration extracted from World happiness report, 2024.

The WHR is an annual publication that ranks countries based on their citizens' self-reported levels of happiness. The report is based on data from the Gallup World Poll, which asks respondents to rate their lives on a scale of 0 to 10. The WHR has been criticized for its methodology and focus on subjective measures of wellbeing.

Drawing upon the World Values Survey, identify two primary dimensions of cultural variation: Traditional versus Secular-Rational values, and Survival versus Self-Expression values. Societies transitioning from industrial to post-industrial economies typically exhibit a shift from traditional to secular-rational values and from survival to self-expression values. These shifts are influenced by a complex interplay of philosophical, political, and religious factors. Secular-rational values and materialism, often associated with social democratic or socialist countries, contrast with survival values more prevalent in Eastern nations. Self-expression values predominate in Western post-industrial societies.

We propose the inclusion of the Sustainability development goal indicator. This framework comprises 17 Sustainable Development Goals (SDGs) designed to eradicate poverty, hunger, and inequality; address climate change; and foster inclusive and sustainable economic growth. Unlike their predecessors, the Millennium Development Goals, the SDGs are universally applicable to all United Nations member states.

Table 1. Major Indicator and Data gaps for the SDG.

1. No Poverty	Poverty measurement, extreme poverty, income inequality, social protection coverage	Reliable and disaggregated data on income, consumption, poverty, social protection
2. Zero Hunger	Food security, undernutrition, child wasting, stunting	Comprehensive data on food production, consumption, loss, waste, and dietary diversity
3. Good Health and Wellbeing	Maternal mortality, child mortality, non-communicable diseases, mental health	Quality data on disease burden, access to healthcare, health outcomes, and social determinants of health
4. Quality Education	Learning outcomes, teacher qualifications, early childhood development	Data on educational attainment, learning achievement, and school resources, particularly at disaggregated levels
5. Gender Equality	Women's economic participation, violence against women, gender-based pay gaps	Data on women's empowerment, decision-making, and access to resources
6. Clean Water and Sanitation	Access to safe water and sanitation, water quality, wastewater treatment	Comprehensive data on water resources, sanitation coverage, and water quality monitoring

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7. Affordable and Clean Energy	Access to electricity, renewable energy, energy efficiency	Data on energy consumption, access to clean cooking fuels, and energy-related emissions
8. Decent Work and Economic Growth	Employment rates, youth unemployment, informal economy	Data on employment quality, productivity, and working conditions
9. Industry, Innovation, and Infrastructure	Infrastructure access, industrial development, technological innovation	Data on infrastructure quality, innovation capacity, and digital connectivity
10. Reduced Inequalities	Income inequality, wealth inequality, access to opportunities	Data on income distribution, social mobility, and access to public services
11. Sustainable Cities and Communities	Urbanization, housing, public transportation	Data on urban planning, air quality, waste management, and access to green spaces
12. Responsible Consumption and Production	Resource efficiency, waste management, sustainable consumption patterns	Data on material footprint, resource use, and consumer behavior
13. Climate Action	Greenhouse gas emissions, climate adaptation, disaster risk reduction	Data on climate impacts, vulnerability, and adaptation measures
14. Life Below Water	Marine pollution, overfishing, ocean acidification	Data on marine ecosystems, biodiversity, and fisheries
15. Life on Land	Deforestation, biodiversity loss, land degradation	Data on forest cover, land use change, and ecosystem services
16. Peace, Justice, and Strong Institutions	Violence, corruption, rule of law	Data on crime rates, access to justice, and government effectiveness
17. Partnerships for the Goals	International cooperation, development assistance, technology transfer	Data on financial flows, knowledge sharing, and partnerships

Source. Sustainable development report 2024.

Methodology

We merged the 6 variables of the happiness index with the sustainable development global indicator. We have selected that cases that match with the two data tables, 85 cases in total.

Conjoint multivariate analyses were carried out to investigate the relation (proximities) of the variables and cases. We found a well fitting in the result in the multidimensional scaling, with a Kruskal stress of 0.007 and a fair fit in the four clusters with a silhouette of 0.07

To explore the relationship between sustainability and wellbeing at the international level, a multidimensional scaling (MDS) analysis was conducted. Euclidean distances were calculated between countries based on their respective sustainable development index and happiness scores. Subsequently, Classical MDS was employed to project these distances into a two-dimensional space. The resulting spatial configuration provides a visual representation of country similarities and dissimilarities in terms of these two dimensions.

To further understand the underlying patterns within this spatial representation, a K-means clustering analysis was performed on the MDS coordinates. This clustering technique grouped countries based on their proximity in the MDS space, identifying distinct clusters of countries with similar governance and wellbeing characteristics. The analysis of these clusters can provide insights into the factors driving variations in governance and wellbeing across countries.

Cluster analysis is a technique used for classification of data in which data elements are partitioned into groups called clusters that represent collections of data elements that are proximate based on a distance or dissimilarity function.

Multidimensional Scaling (MDS) and K-means cluster analysis are quantitative techniques commonly employed in sustainability and subjective wellbeing research. MDS is a dimensionality reduction method that projects high-dimensional data into a lower-dimensional space, typically two or three dimensions, while preserving inter-point distances. This enables visualization and exploration of complex relationships among variables.

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In sustainability, MDS can map countries or regions based on various indicators, revealing patterns and clusters of similar sustainability profiles. Within the context of subjective wellbeing, MDS can visualize the perceptual space of wellbeing constructs.

K-means cluster analysis partitions data into a predetermined number, k, of clusters based on minimizing the within-cluster sum of squares (WCSS).

In sustainability research, K-means can identify groups of countries with comparable sustainability challenges or opportunities. For subjective wellbeing, it can classify individuals into distinct wellbeing profiles.

A combined application of MDS and K-means can provide deeper insights. MDS can reduce data dimensionality, followed by K-means clustering to identify homogeneous groups. This approach is useful in identifying key drivers of sustainability and informing policy development, as well as understanding factors influencing subjective wellbeing and designing targeted interventions.

While these techniques offer valuable insights, they have limitations. MDS is sensitive to outliers and the choice of distance metric. K-means requires specifying the number of clusters and assumes data linearity. Therefore, results should be interpreted cautiously, and complementary methods considered.

Despite these limitations, MDS and K-means remain essential tools for exploring complex relationships in sustainability and subjective wellbeing research. By understanding their strengths and weaknesses, researchers can derive meaningful insights to inform evidence-based policies and interventions.

Result and Discussions

Initially we classify four clusters encompassing 85 countries that include Europe Protestant, Europe Catholic, and Hispano-American and other regions. To enhance the suitability of the data for Multidimensional Scaling (MDS), we employed a covariance outlier technique, reducing the sample to 74 countries. Consequently, some clusters may exhibit overfitting.

A covariance estimator was employed to fit ellipses to central point's using Mahalanobis distance metrics. The contamination level (proportion of outliers) was set at 12%, with a support fraction specifying the proportion of points included in the estimate. This process resulted in the removal of 11 countries: Singapore, Mongolia, Indonesia, United Arab Emirates, Myanmar, and Bahrain, and Morocco, Tajikistan, Saudi Arabia, Bangladesh, Georgia, and India.

Upon adjusting the "convex ellipses"[1] to the centroids, it became clears those countries from Africa, the Middle East, several Asian nations and Singapore (a highly developed country with high wellbeing) were excluded from the classification results.

The results of Figure 2, reveal the four clusters resulting after the removal of the 11 outliers. Cluster one, comprising Central America, Vietnam, the Philippines, and Cambodia, exhibits the lowest scores across all happiness and sustainability indicators. These nations are characterized by high Traditional and Survival values and are confronted with challenges such as high infant mortality rates and low life expectancy.

[1] Technic that group arcs by three intuitive yet more efficient rules, followed by a validation and a more distinctive cluster scheme to further improve the accuracy.

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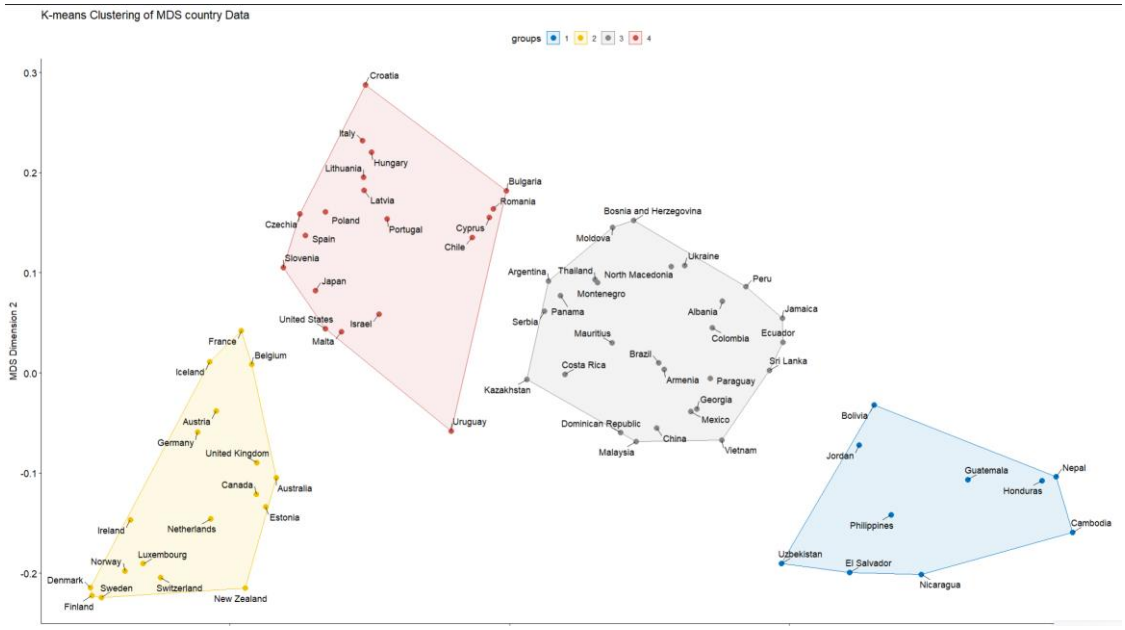

Figure 2. Multidimensional Scaling clusters with Convex ellipsis. Source. Own elaboration R software.

Cluster two encompasses predominantly Anglo-Saxon and Protestant countries, including Norway, Sweden, and the United Kingdom. These nations demonstrate exceptional performance across all variables, aligning closely with the Secular-Rational and Self-Expression values framework proposed by Ronald Inglehart.

Cluster three presents a blend of Traditional and Self-Expression values, with countries such as Colombia, Ecuador, and Thailand as representative members. While this cluster demonstrates high satisfaction with GDP per capita, social support, and health life expectancy, there is a notable mix of cultural orientations.

Finally, cluster four includes predominantly Catholic European nations, the United States, Israel, Japan, and Uruguay. These countries generally exhibit high levels of SDG achievement and life satisfaction. However, the United States diverges from this pattern with a higher inclination towards Traditional and Self-Expression values. Furthermore, the country faces declining moral statistics, rising infant mortality rates comparable to survival-oriented nations, and a decreasing life expectancy.

In Figure 3 we can appreciate the result of the multidimensional scaling distribution of countries across the four clusters, in red includes protestant and Anglo-Saxon nations, in orange comprises countries from Southern and Eastern Europe (Italy, Spain, Hungary, Latvia), USA, Japan, and Chile. Cluster denoted in blue, are predominantly composed by Sud American countries, Costa Rica, Moldova, Siri Lanka, Ukraine, Mexico, characterized by high GDP but moderate SDG achievements. Countries in green, encompassing Central America (Nicaragua, Guatemala), and several Asian nations, exhibits the lowest levels of satisfaction and SDG attainment.

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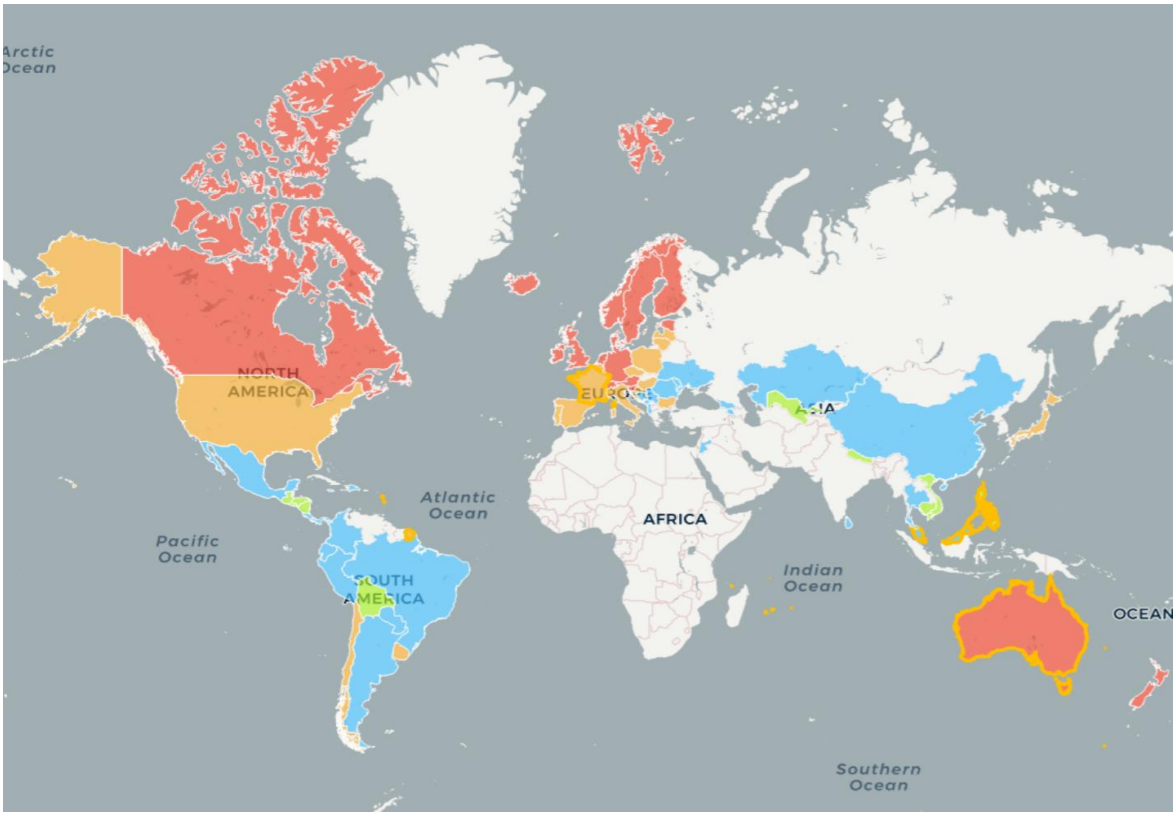

Figure 3. Countries by clusters. Source. Own elaboration orange software.

Inglehart idea that individuals tend to pursue a variety of objectives in a manner like a hierarchical structure, the more immediate basic needs such as hunger, thirst, and physical safety must be met first, as they are directly related to survival . Drawing from Abraham Maslow's concept of a hierarchy of human needs, Inglehart suggests that in times of scarcity, these materialistic needs take precedence over postmaterialist desires such as social belonging, recognition, and artistic and intellectual fulfillment. Nonetheless, once the basic survival needs are adequately fulfilled, attention will gradually shift towards these intangible goods.

Consequently, countries ranking higher in GDP, social support, healthy life expectancy, and perceived corruption also tend to achieve higher SDG scores. Generosity and freedom of choice appear less influential.

The case of the United States, as outlined by , highlights the utility of moral statistics in understanding the decline or stagnation of UN goals. According to , low distribution of resources among the most vulnerable in developed societies correlates with diminished governability. The United States has experienced a decline in moral statistics over the past decade, with infant mortality rates surpassing those of Russia and life expectancy falling below Russian levels. This deterioration is accompanied by increasing corruption, characterized by elite indifference to public interests, and a governance crisis.

While happiness indices have been well documented (Rojas et al., 2018; McLean, 2014; Diener et al., 2010), their limitations become evident when comparing diverse societies. These single indices fail to capture the multifaceted nature of happiness and neglect the influence of cultural values and sustainable development achievements.

Our multidimensional scaling (MDS) clusters demonstrate that incorporating happiness and sustainability variables provides a more nuanced understanding of how countries within different societies position themselves. This approach avoids oversimplification while maintaining methodological rigor. Furthermore, employing multivariate and non-linear statistical techniques, commonly used in ecological science, opens new opportunities for exploring the intersection of happiness and sustainability research.

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Conclusion

This study demonstrates the complex interplay between happiness, sustainability, and cultural values across different countries. We found and intuitive similarity between the cultural map and the results gotten with the multidimensional scaling

With the results we have identified distinct patterns in how nations position themselves in the world. Countries with high levels of economic development and social progress tend to exhibit higher happiness and sustainability scores, the relationship is not straightforward. The case of the United States underscores the importance of considering factors beyond economic indicators, such as moral statistics and social inequality, in understanding overall wellbeing.

Our findings suggest that a holistic approach is still necessary to comprehend the multifaceted nature of happiness and sustainability. While the traditional focus on economic growth remains relevant, it should be complemented by a broader perspective that encompasses cultural values, social cohesion, and environmental wellbeing. By integrating these elements, policymakers can develop more effective strategies to enhance the quality of life for citizens worldwide.

Future research could delve deeper into the specific factors driving the observed patterns, exploring the role of institutions, governance, and social capital in mediating the relationship between happiness, sustainability, and cultural values. Additionally, longitudinal studies could examine how these relationships evolve over time in response to global challenges such as climate change and economic inequality.

Limitations

The present study is subject to several methodological limitations. Data heterogeneity across countries, varying operationalizations of key variables, and the inherent subjectivity of cluster analysis may have influenced the findings. Additionally, the exclusion of outliers and the ecological nature of the analysis restrict the generalizability of results. Moreover, the study's focus on a limited set of cultural dimensions may have overlooked other relevant factors. It is important to acknowledge that happiness, sustainability, and cultural values are dynamic constructs, potentially limiting the temporal generalizability of the study's conclusions. Future research should address these limitations to enhance the robustness of findings.

Future studies should investigate the influence of institutional structures, governance frameworks, and social capital. Moreover, longitudinal research is essential to assess the progression of these connections in reaction to worldwide challenges. We recognize the constraints associated with data variability, the subjective nature of cluster examination, and the removal of anomalies, underscoring the necessity for additional investigation to improve the applicability and strength of these results.

Author Contributions:

Funding:

Conflicts of Interest:

Appendix A

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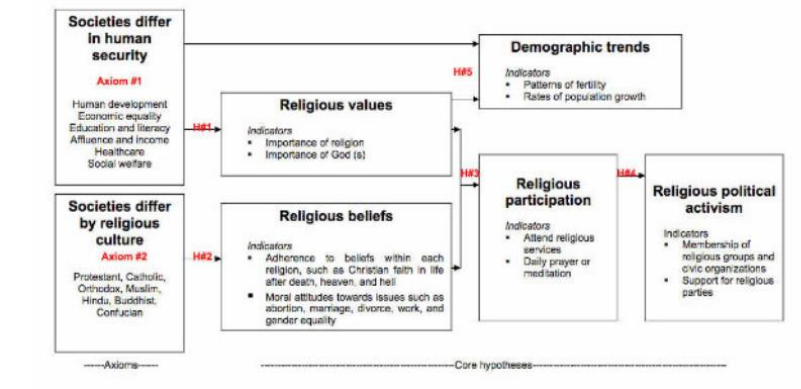
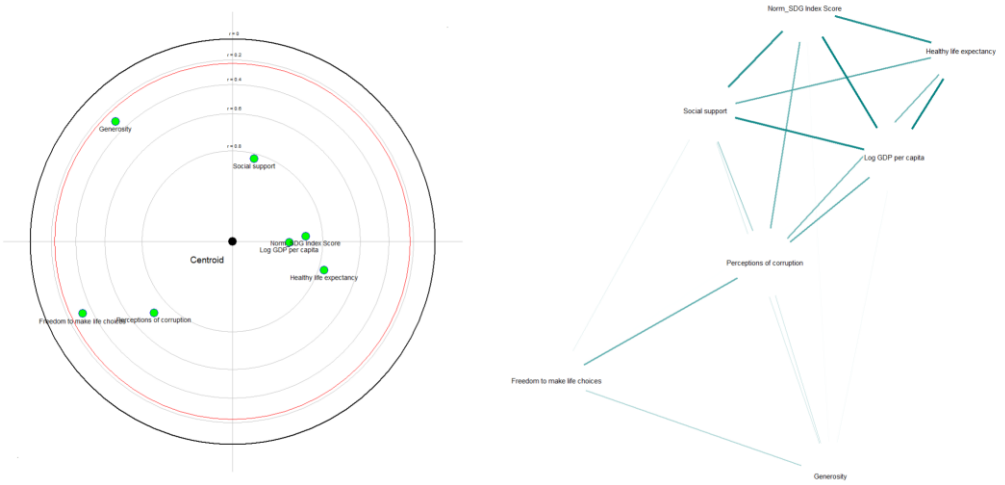
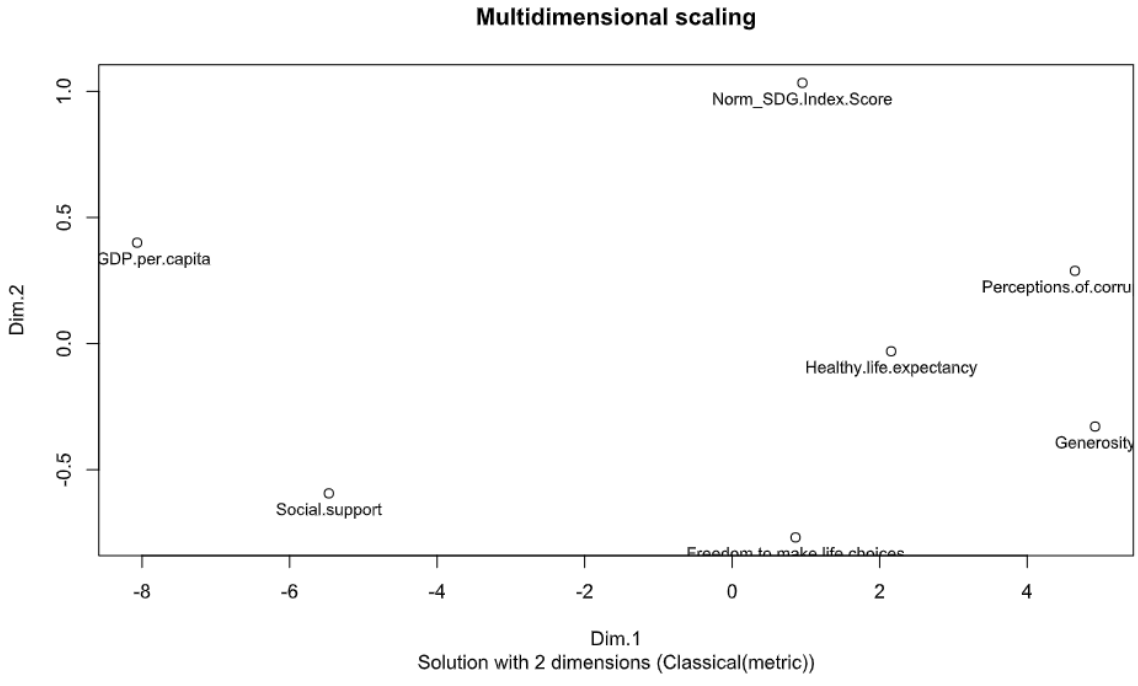


Figure A1. Source. Sacred and Secular, Ronald Inglehart & Pipa Norris.





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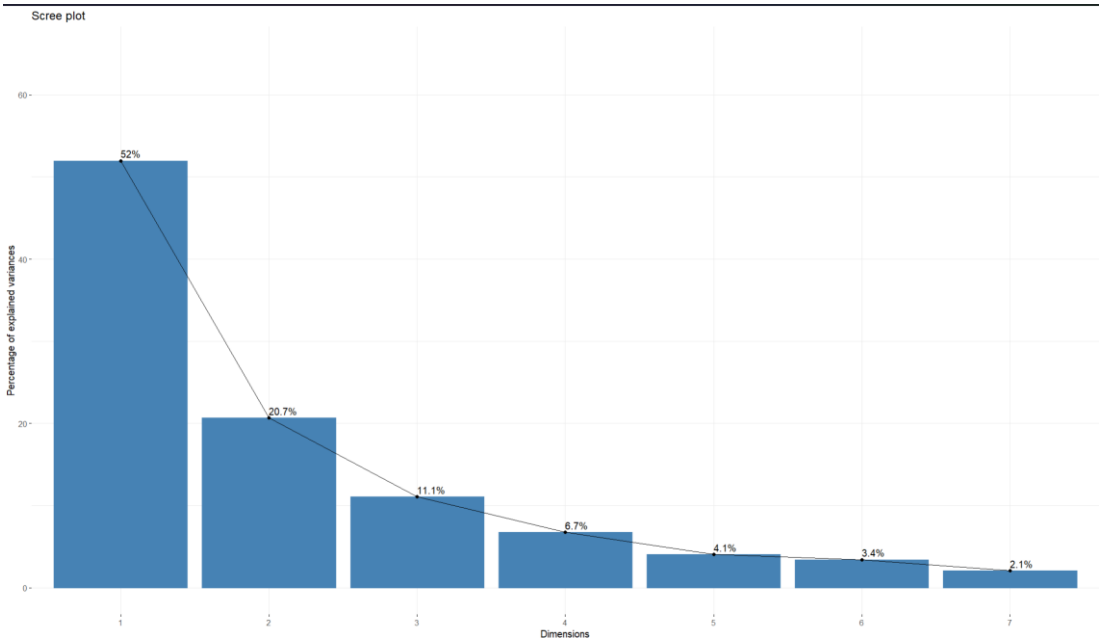

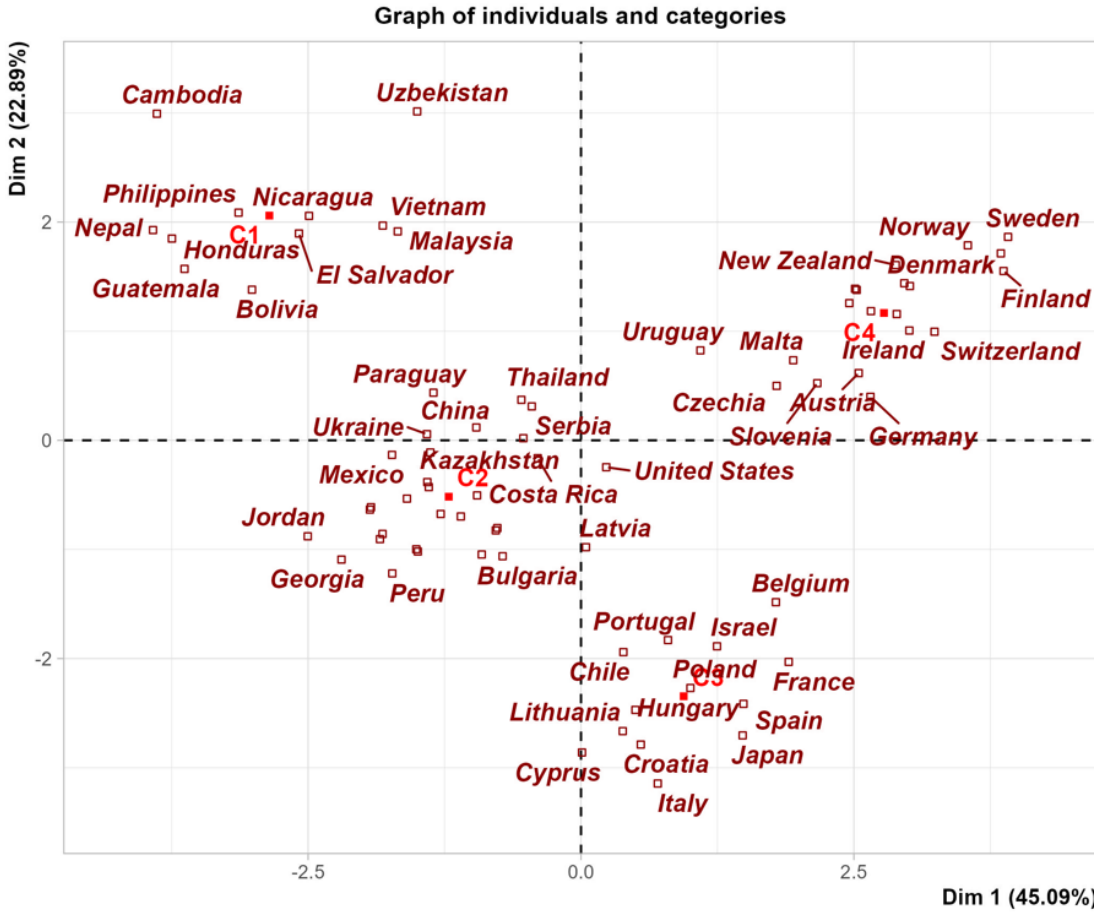

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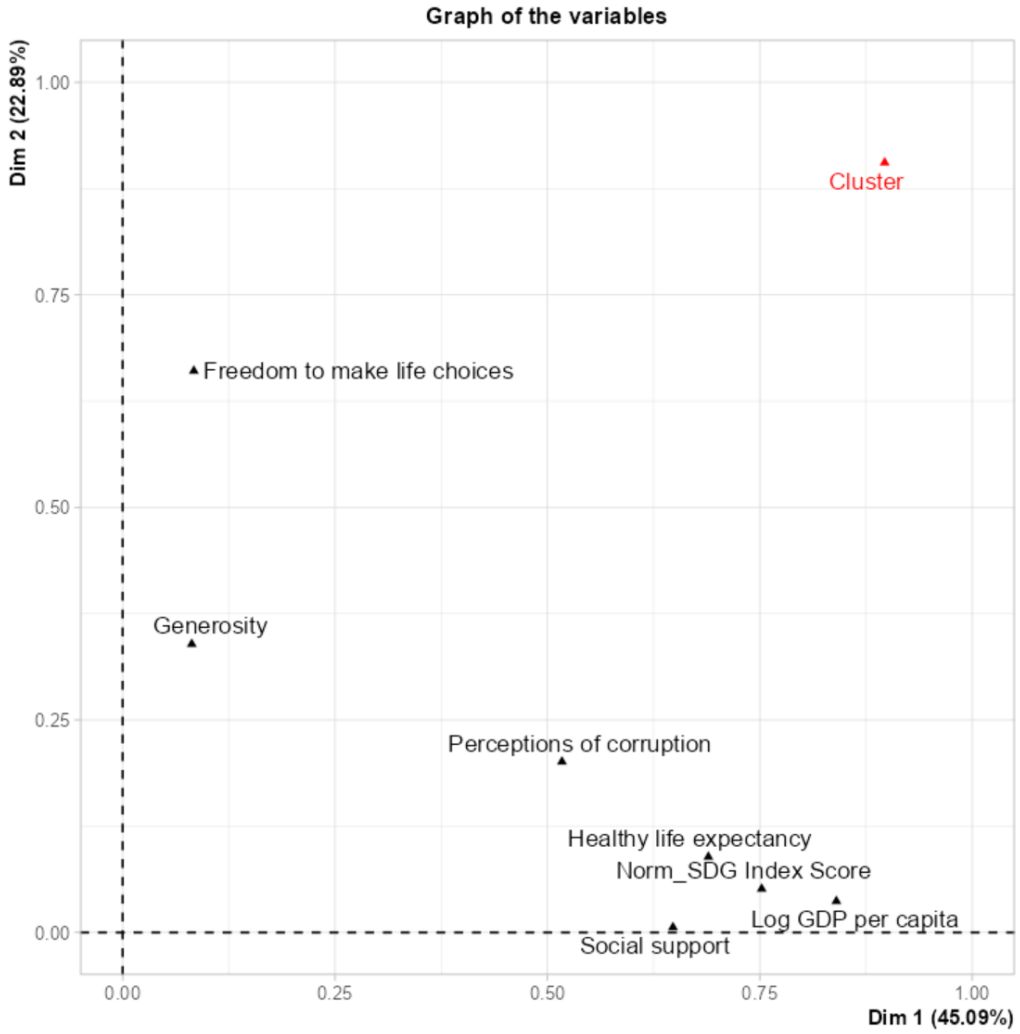

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