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The Impact of Cultural Codes on Circular Economy Efficiency in the Context of SDG 12

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Abstract

This study examines the influence of cultural codes and behavioral factors on countries' achievement of SDG 12 (responsible consumption and production) as an integral component of the transition to a circular economy. While existing research largely emphasizes techno-economic drivers, this study highlights the overlooked role of cultural codes and value orientations. Using data from 78 countries, we apply a two-stage methodology combining multiple regression analysis with cluster analysis and Zhuravlev's discrete modeling algorithm to evaluate both the direction of influence and the structural significance of cultural indicators. The results reveal a robust and statistically significant negative relationship between SDG 12 achievement and key development and cultural indicators (such as individualism, long-term

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orientation), Human Development Index, and Global Innovation Index, suggesting that socio-economic progress and innovation often correlate with higher material footprints. Initial hypotheses expecting positive effects from individualism and long-term orientation were rejected. Cluster analysis identified three country groups based on SDG 12 scores. Testor analysis indicates that power distance, individualism, uncertainty avoidance, and long-term orientation are the most structurally important cultural factors differentiating countries within clusters. These findings underscore that cultural codes shape not only organizational environments but also consumption behaviors and societal readiness to adopt circular practices. Finally, achieving SDG 12 requires the synergy of institutional efficiency, technological solutions, and culturally anchored environmental responsibility.

7.1 Introduction

The 17 global goals that underpin the 2030 Agenda, adopted by the UN in 2015, have become a guiding principle for global development, encompassing all the spheres of social, economic, and environmental development. However, the SDGs 2025 report (Sachs et al., 2025) shows that while real progress has been made in the last decade in areas such as education, health, digital access, and renewable energy, the implementation of the SDGs is not sufficient to fully achieve them by 2030. Poverty, hunger, inequality, climate crisis, and resource scarcity continue to hinder progress (Fonseca et al., 2020).

Although the SDGs aim to combine economic development and environmental sustainability, the often-occurring conflict between these two goals hinders sustainable progress, as it requires certain compromises. When economic growth is based on intensive use of resources and environmental constraints are tightened, countries face difficult choices, which slow down the pace of SDGs implementation. This incomplete progress particularly highlights the importance of SDG 12, since it is impossible to achieve sustainable and inclusive development without responsible consumption and production.

SDG 12 is closely interlinked with many other sustainable development goals, since sustainable consumption and production directly affect environmental health, economic development and social well-being. The essence of SDG 12 lies in balancing economic growth, environmental protection and social well-being by transforming current models of production and consumption. It requires both systemic changes (industry, government) and responsible behavior by consumers and society. In this context, consumer rights and protection play an important but often underestimated role.

Table 7.1 Key SDG 12 targets aligned with CE.

SDG 12 Target	CE Principle	Explanation
12.2 Sustainable management of natural resources	Resource efficiency	Reduce raw material extraction and close resource loops.
12.3 Halve global food waste	Reduce waste	Prevent waste at production and consumption stages.
12.4 Manage chemicals and waste	Safe cycles	Ensure safe circulation of materials without harmful substances.
12.5 Reduce waste generation	Keep materials in use	Increase reuse, recycling, repair, remanufacturing.
12.6 Sustainability reporting	Transparency	Companies disclose circularity practices and impacts.
12.7 Sustainable public procurement	Circular procurement	Governments purchase circular and low-waste products.
12.8 Awareness and education	Behavior change	Encourage circular lifestyles and consumption patterns.

Responsible consumption implies not only individual awareness, but also institutional safeguards that protect consumers from limited or incomplete information and unsustainable products. Without effective consumer protection frameworks, the transition to circular consumption patterns remains fragmented and largely voluntary, which weakens the social dimension of Sustainable Development Goal 12.

All this shows that ensuring sustainable consumption and production is not possible without a profound transformation of the economic model. From this perspective, the circular economy gains importance, offering a new logic of resource use, reducing waste, extending product life and ensuring a closed loop of material flows. At the policy level, the circular economy is explicitly framed as a key pathway to deliver SDG 12, since SDG 12 indicators (resource productivity, material footprint, circular material use) overlap with core CE metrics.

However, the link between the Circular Economy and SDG 12 can also be presented as mutually reinforcing, since SDG 12 is the political and strategic goal that promotes the development and implementation of a circular economy model. To clarify the conceptual link between SDG 12 and circular economy principles, Table 7.1 summarizes the key SDG 12 targets that are directly aligned with core CE dimensions.

Despite the SDG targets and the multi-faceted policies promoting the circular economy, the level of circularity has declined globally. According

to global data, only 6.9% of the materials used annually worldwide come from recycled sources by 2025, according to the Circularity Gap Report 2025 (Circularity Gap Report, 2025). This finding indicates that current efforts, despite certain achievements, remain insufficient. It is a concerning signal that calls for a deeper examination of underlying causes, identification of contributing factors, and reinforcement of measures that can genuinely increase circularity. It is important to note that awareness-raising and education (Target 12.8) cannot be effective without transparent information and protected consumer rights. Consumer protection mechanisms ensure that people can make informed choices by providing access to reliable product information, eco-labels, and protection from misleading environmental claims. Consumer rights thus serve as a prerequisite for behavioral change toward circular consumption.

Studies by Campoli, et al. (2024) and Wackernagel, et al. (2017) show that high-income countries score high on the SDG Index overall, but the same countries often score low on SDG 12 because their material footprint, waste generation, and consumption levels are very high.

We also conducted a correlation analysis between SDG 12 and various development indicators, and the results confirm that not only GDP (Gross Domestic Product), but also HDI (Human Development Index), GII (Global Innovation Index), and other SDG performance indicators exhibit a negative correlation with SDG 12 (Responsible Consumption and Production), This finding underscores that economic and social development is often accompanied by higher levels of consumption, larger material footprints, and less sustainable production–consumption patterns, which in turn lead to lower SDG 12 scores—even for countries with overall high levels of human development and innovation capacity.

This inconsistency is called the circularity paradox (Angelis, 2020), a situation where economically advanced countries create advanced circular solutions but also consume so much that they still score low on SDG 12. To eliminate this inconsistency, it is necessary not only to change policies and behaviors, but also to redistribute research priorities and deepen international cooperation to reduce the negative consequences of economic development, which can stimulate the transition from a linear to a circular economic model. In recent years, particularly in the context of transforming economic models, increasing attention has been paid to the influence and importance of behavior, cultural codes, and social norms, and many scholars have examined their effects on economic development (Small et al., 2010; Sargsyan & Martirosyan, 2024; Sargsyan et al., 2026). Auzan and co-authors emphasize



Figure 7.1 Correlation matrix of SDG 12 and various development indicators (GDP-Gross Domestic Product, HDI -Human Development Index, GII -Global Innovation Index, SDG-Sustainable Development Index).

in their work that socio-cultural factors have a multi-level and multifaceted impact on the sustainability of a country's development. For example, cultural norms, value orientations, and attitudes shape the level of social capital, which directly influences institutional quality, societal trust, and the willingness of individuals and groups to cooperate (Auzan et al., 2020).

Our claim is that the establishment of the CE model, which is manifested in particular by the effective implementation of SDG 12, depends not only on the institutional system, technological solutions, but also on the behavioral readiness of society and cultural codes. For example, one of the components of the Circular Economy -recycling and reuse- often involves mental and behavioral barriers.

The purpose of this study is to identify and assess the impact of selected cultural and behavioral indicators on the development of the circular economy within the context of SDG 12 implementation. To achieve this goal, we conducted a clustering analysis of countries and examined the extent to

which cultural codes influence the formation of country clusters based on SDG 12 performance.

7.2 Literature Review

A review of existing studies show that interest in the introduction and implementation of a circular economy has been steadily increasing year by year, both in business and academic circles. Many publications analyze that the transition to a circular economy as one of the key pathways for achieving SDG 12 and examine how the CE model contributes to the accomplishment of the SDGs in general and SDG 12 in particular (Schröder et al., 2024, Milošević et al., 2025, Filho et al., 2025).

Most of the existing studies focus on macroeconomic policies, technological innovations and industrial models, while relatively little attention is paid to identifying and assessing the impact of socio-cultural values, perceptions and behavioral norms of society. Yet Huntington's civilizational approach (Huntington, 1996) and the joint analysis by Harrison and Huntington (Harrison & Huntington, 2000) demonstrate that considering cultural codes plays an important role in explaining differences between global development models. They distinguish between "advanced" and "traditional" cultures, arguing that progressive ones are prone to innovation and democracy, which can contribute to the adoption of responsible consumption patterns. Schwartz's value theory (Schwartz, 2006) complements this analysis by emphasizing that cultures that demonstrate concern for the well-being of others and the environment are more willing to move to new development models. The work of Primc and co-authors builds on Schwartz's theory, highlighting how such values shape patterns of environmentally responsible behavior (Primc et al., 2021). Cultural values, as measured by Hofstede's indices (Hofstede Insights, 2024), have a significant impact on the economic and social development of countries, but a deeper analysis is needed to understand how the cultural codes of a society, in particular Hofstede's cultural dimensions, affect the level of responsible consumption and production in different countries. The present study aims to fill existing gaps by addressing two main research questions:

RQ1: What is the direction of the influence of cultural codes on responsible consumption and production?

RQ2: Which cultural and socio-economic indicators are structurally the most significant in shaping clusters of countries with similar levels of responsible consumption and production?

7.3 Methodology

The research was conducted in two stages. Firstly, to conduct a comprehensive analysis of the impact of socio-economic and cultural indicators on SDG12, a regression analysis was conducted on data from 78 countries. The number of countries was determined by the availability of Hovstede cultural indicators, and the latest available data for the year was selected. In the second stage of the research, the importance of indicators by country was assessed using cluster analysis and discrete modeling.

To identify the distinguishing features of countries within clusters, the testor method based on Zhuravlev's algorithm was applied (Zhuravlev, 1978; Zhuravlev et al., 2014). This algorithm is based on the concepts of test and typical testors, which serve as fundamental constructs for solving recognition and classification problems. A test is a subset of features that distinguishes objects from different classes - no two objects from different classes are identical when restricted to those features. A typical testor is a minimal or irreducible test: it is a test such that removing any single feature from it causes it to no longer be a test (i.e., some objects from different classes become indistinguishable).

The process consists of two steps:

1. We identify all combinations of features by which countries have completely different "profiles" (that is, each country can be uniquely recognized).
2. We calculate the information weights of the features by counting how often each feature occurs in the dead-end tests.

Information weight is the frequency of appearance of the feature/number of all dead-end tests.

Thus, features with high information weights are most often found in the minimum combinations that distinguish countries, and therefore, they are considered the most important cultural dimensions of differentiation of countries in a given cluster. In other words, they represent the most probable cultural "pillars" that effectively group these countries into their respective clusters.

This two-stage approach is driven by the need to:

- identification of factors that have a statistically significant influence on the level of achievement of SDG 12;
- assessment of the strength and direction of this influence;
- understand which groups of countries demonstrate similar profiles according to SDG 12 performance and the transition to progress toward

the Circular Economy, and identify typological differences between them,

- to understand which specific cultural indicators are key to differentiating countries, which will allow to determine the most critical combinations of features that shape the quality of behavior promoting responsible consumption and production;
- find the most typical country in each cluster (centroid approach), which best represents the entire group of countries, taking into account the informational importance of the features. (The country with the minimum distance to the centroid is selected. This country is considered the most typical for the cluster).

The study employs the following groups of variables:

1. As the dependent variable, SDG 12 indicators were used, obtained from the Sustainable Development Report 2025.
2. As socio-economic well-being indicators, the following variables were considered: the Human Development Index (HDI), the Global Innovation Index (GII), and the overall SDG Index Score. (Sustainable Development Report 2025, GDP per capita (constant LCU) | Data, HDR25_Statistical_Annex_HDI_Table.xlsx, Environmental Performance Index by Country 2025, World Development Indicators | DataBank)
3. As cultural indicators, Hofstede's cultural dimensions were used. (Hofstede Insights, 2024).

- **Power Distance (Power_Dist)-**Shows how easily a society accepts that people have unequal power—there are strict leaders and subordinates, and this hierarchy is considered normal.
- **Individualism vs. Collectivism (Individualism)-**Shows whether people are more driven by personal goals or by the interests of the group/society.

  Individualism - the "I" is emphasized,

  Collectivism - the "We" is emphasized.
- **Long-Term Orientation (Long_Term_Orient)-**Shows whether a society thinks about the future, development, and long-term plans, or focuses on traditions and quick results.

- **Masculinity vs. Femininity-**Shows whether a society values competition, success, and strong achievement (masculinity) or cooperation, care, and quality of life (femininity).
- **Uncertainty Avoidance (Uncertainty Avoidance)-**Shows how much anxiety arises from uncertain, new, or unpredictable situations.

  High index - people prefer strict rules and predictability.
- **Indulgence vs. Restraint (Indulgence)-**Shows how much a society allows enjoying life, pleasures, and freedom.

  High index - more open and free,

  Low index - more restrictive, "one must restrain oneself" approach.

The following hypotheses were tested:

H1: Countries with higher levels of individualism demonstrate better performance on SDG 12.

H2: Countries with higher levels of Long-Term orientation demonstrate better performance on SDG 12.

H3: Countries with lower levels of power-distance demonstrate better performance on SDG 12.

7.4 Results

1. ***Regression Analysis***
   To assess the relationship between cultural and socio-economic factors and the achievement of SDG 12, three multiple regression models were estimated using different combinations of explanatory variables. The models include key cultural dimensions (individualism, power distance, long-term orientation) and development indicators (HDI and GII). Table 7.2 summarizes the regression results. Across all specifications, the dimensions Masculinity vs. Femininity, Uncertainty Avoidance, and Indulgence were found to be statistically insignificant and were therefore excluded from the final models.

To ensure the statistical adequacy and reliability of all three models, the Breusch–Pagan–Godfrey heteroskedasticity test, the Ramsey RESET test, and the VIF test were performed. These diagnostics confirmed that the

Table 7.2 Regression results for designed models.

Variables	Model 1 SDG12	Model 2 SDG12	Model 3 SDG12
INDIVIDUALISM	**–0.182**		**–0.48**
HDI	**–104.75**		
POWER_DISTANCE		**+ 0.166**	
GII		**–0.697**	
LONG_TERM_ORIENTATION			**–0.116**
Constant	165.83	84.7	96.38
Included observations	67	68	78
R-squared	0.698	0.573	0.645
Adjusted R-squared	0.688	0.560	0.6363
Prob(F-statistic	< 0.0001	< 0.0001	< 0.0001
Durbin-Watson stat	1.83	1.86	2.01

models are statistically adequate and reliable. Therefore, the results can be considered robust and suitable for drawing substantive conclusions.

Model 1. GOAL12 = 165.83 - 0.182*INDIVIDUALISM - 104.75*HDI + ε

This model examines the joint effect of individualism and human development. The results show that both variables are negatively and statistically significantly associated with SDG 12 performance. A higher level of individualism is linked to lower responsible consumption and production outcomes, while higher HDI scores are associated with a substantial reduction in SDG 12 values. Given that HDI ranges between 0 and 1, this effect should be interpreted proportionally: a 0.1 increase in HDI corresponds to an approximate 10.5-point decline in the SDG 12 score.

Model 2. GOAL12 = 84.7 + 0.166*POWER_DISTANCE - 0.697*GII + ε

Model 2 focuses on power distance and innovation capacity. The Global Innovation Index exhibits a strong and statistically significant negative association with SDG 12, indicating that higher innovation levels tend to coincide with lower responsible consumption and production performance. In contrast, power distance shows a positive and statistically significant effect, suggesting that more hierarchical societies may find it easier to implement

centralized measures related to SDG 12. This combination highlights a paradoxical relationship between innovation, governance structures, and sustainable consumption outcomes.

Model 3. GOAL12 = 96.38 - 0.48*INDIVIDUALISM -0.116*LONG_ TERM_ORIENTATION + ε

Model 3 evaluates the combined influence of individualism and long-term orientation. Both variables display negative coefficients, with individualism exerting a strong and highly significant effect. Long-term orientation also shows a negative association with SDG 12, although at a lower level of statistical significance. Contrary to initial expectations, societies characterized by long-term planning and accumulation appear to prioritize economic growth over reductions in material consumption. Across all models, a consistent negative relationship between individualism and GOAL12 is confirmed. This indicates that a high level of individualism does not yet translate into sustainable consumption and production behavior, and that more collectivist societies tend to demonstrate better SDG 12 performance.

Taken together, the regression results reveal a consistent pattern: higher individualism, stronger innovation performance, and higher levels of socio-economic development are not automatically translated into responsible consumption and production outcomes. As a result, the hypotheses predicting positive effects of individualism, long-term orientation, and lower power distance on SDG 12 performance are not supported.

2. ***The importance of the influence of cultural codes according to the distribution of countries by clusters relative to goal12***

Since the variation in SDG 12 performance among the observed countries is very large, we conducted a cluster analysis. To determine the optimal number of clusters, the elbow method was used, and three clusters were identified.

Next, the average values of the Goal 12 indicator were calculated for each cluster.

Next, we identified which features were the most important for the countries within each cluster by applying the mathematical framework of testor theory (the Zhuravlev algorithm). The following results were obtained.

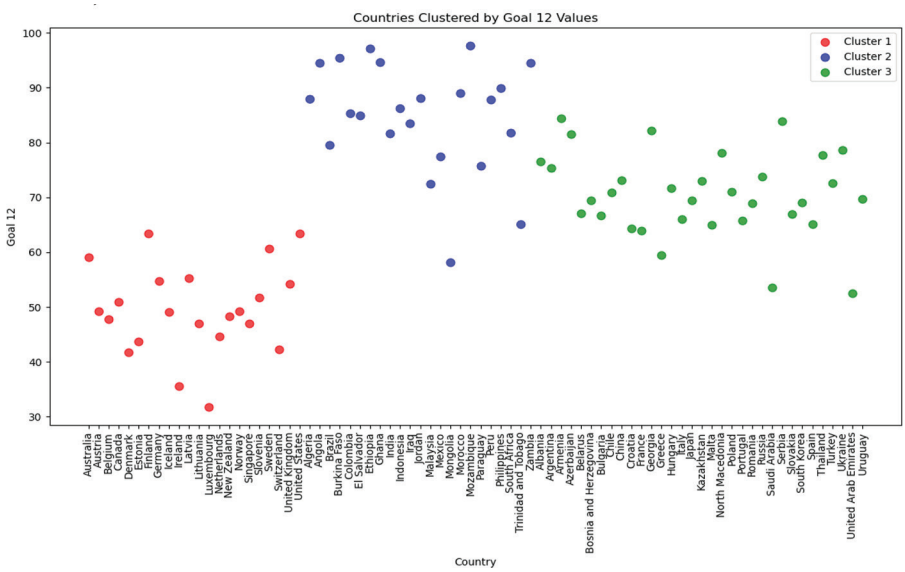

Figure 7.2 Visualization of country clusters by SDG12 values.

Table 7.3 The list of countries by clusters.

Cluster 1 (mean goal12= 49.56), 22 countries	Australia, Austria, Belgium, Canada, Denmark, Estonia, Finland, Germany, Iceland, Ireland, Latvia, Lithuania, Luxembourg, Netherlands, New Zealand, Norway, Singapore, Slovenia, Sweden, Switzerland, United Kingdom, United States
Cluster 2 (mean goal12= 84.72), 23 countries	Algeria, Angola, Brazil, Burkina Faso, Colombia, El Salvador, Ethiopia, Ghana, India, Indonesia, Iraq, Jordan, Malaysia, Mexico, Mongolia, Morocco, Mozambique, Paraguay, Peru, Philippines, South Africa, Trinidad and Tobago, Zambia
Cluster 3 (mean goal12= 70.53), 33 countries	Albania, Argentina, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Chile, China, Croatia, France, Georgia, Greece, Hungary, Italy, Japan, Kazakhstan, Malta, North Macedonia, Poland, Portugal, Romania, Russia, Saudi Arabia, Serbia, Slovakia, South Korea, Spain, Thailand, Turkey, Ukraine, United Arab Emirates, Uruguay

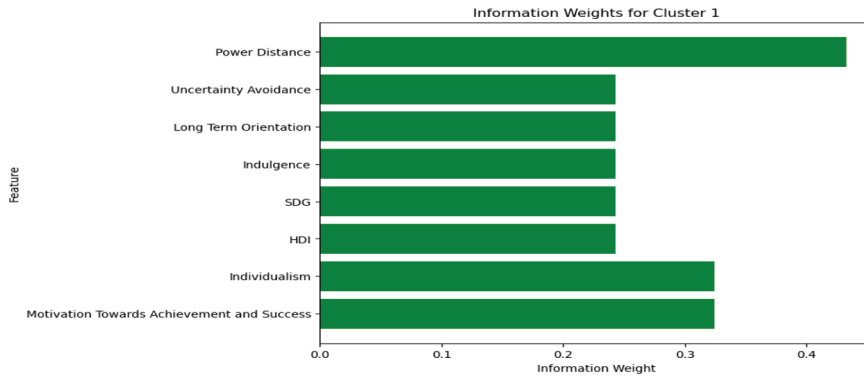

Figure 7.3 Distribution of information weights of the features in cluster 1.

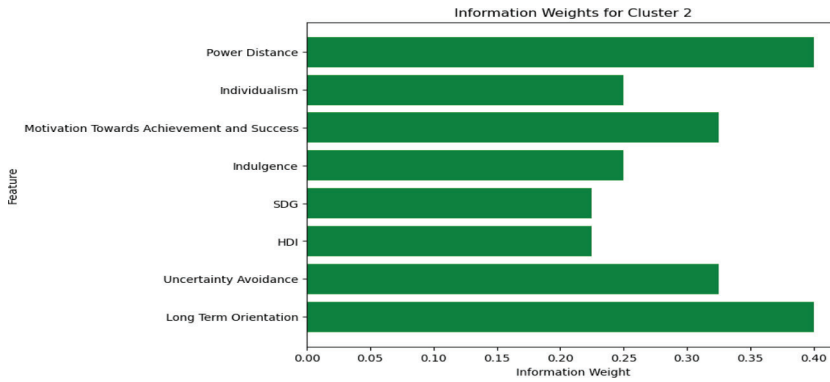

Figure 7.4 Distribution of information weights of the features in cluster 2.

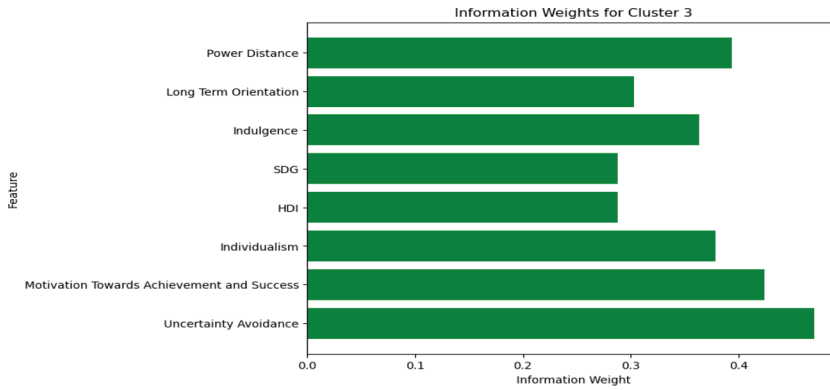

Figure 7.5 Distribution of information weights of the features in cluster 3.

The importance of the indicators for cluster formation (informational weights of the features) is presented in Table 7.4.

Table 7.4 Informational weights of the features.

Feature	Information weight in Cluster 1	Information weight in Cluster 2	Information weight in Cluster 3
Power Distance	0.4324	0.4000	0.3939
Uncertainty Avoidance	0.2432	0.2500	0.4697
Long Term Orientation	0.2432	0.4000	0.3030
Indulgence	0.2432	0.2500	0.3636
SDG Index Score	0.2432	0.2500	0.2879
(HDI)	0.2432	0.2500	0.2879
Individualism	0.3243	0.2500	0.3788
Motivation Towards Achievement and Success	0.3243	0.3250	0.4242

We also identified the most typical country in each cluster—the country that best represents the entire group, taking into account the informational importance of the features. (The country with the minimum distance to the centroid is considered the most representative of the cluster.)

The representative country for Cluster 1 is Canada - distance from centroid= 0.2722.

The representative country for Cluster 2 is Jordan - distance from centroid= 0.3316.

The representative country for Cluster 3 is Bulgaria - distance from centroid= 0.5189.

7.5 Discussion and Conclusion

The results obtained demonstrate a stable and statistically significant relationship between a society's cultural codes and its level of achievement of SDG 12. This confirms the need to go beyond traditional techno-economic analysis when assessing the transition to sustainable models of production and consumption. The findings confirm the existence of the circularity paradox: higher levels of socio-economic development and innovation do not automatically translate into responsible consumption and production. Instead, cultural codes such as individualism and long-term orientation appear to reinforce consumption-intensive lifestyles, limiting progress toward SDG 12.

This suggests that cultural readiness and behavioral norms play a decisive role alongside technological and institutional capacity.

The observed dynamics also align with the environmental Kuznets curve: increases in income and development at early stages lead to greater environmental pressure, and only after reaching a certain threshold do countries begin a gradual transition toward more effective environmental policies (Grossman & Krueger, 1995). The negative coefficients of HDI, GII, and the SDG Index indicate that many countries in the sample are still located on the upward segment of the curve—where economic progress is accompanied by an expanding material footprint.

Cluster analysis deepened this understanding. Countries in Cluster 1 (average SDG 12 score: 49.56) are characterized by low power distance, higher levels of individualism and achievement orientation, which in combination with institutional maturity facilitates the implementation of circular solutions. It is also important to note that countries often considered global leaders in environmental policy—Sweden, Finland, Denmark, Norway, Germany, Austria, the Netherlands, Estonia, demonstrate high performance in renewable energy, recycling, and waste management. In these areas, they are indeed closer to achieving SDG 12. Yet their SDG 12 scores remain relatively low, reflecting the circularity paradox: high levels of development, innovation, and consumption produce a substantial material footprint that even advanced environmental policies cannot fully offset. This illustrates that achieving SDG 12 depends not only on technologies and institutions but also on the transformation of behavioral and cultural models that shape consumption patterns. Cluster 2 (average score: 84.72) includes countries where traditional cultural norms and limited institutional capacity hinder environmental transformation. Cluster 3 (average score: 70.53) represents an intermediate group with high cultural heterogeneity; the most typical country, Bulgaria illustrates a mixed profile in which the positive influence of certain cultural factors is offset by constraints in sustainable consumption. Worth noting, that cultural readiness alone is insufficient without institutional empowerment of consumers. Consumer rights and protection frameworks translate cultural values into fair and practical circular consumption by ensuring product safety, durability, reparability, and truthful sustainability claims. They directly shape consumer-relevant outcomes such as repair and reuse behavior, waste prevention, sustainable purchasing, and access to circular services. Thus, consumer protection serves as a key interface between cultural codes and the effective implementation of circular economy principles.

Testor analysis showed that the key features determining similarity within clusters are power distance, individualism, long-term orientation, and

uncertainty avoidance. These findings underscore that cultural codes shape not only institutional environments but also consumption behaviors, influencing a society's readiness to adopt circular practices. Thus, a sustainable transition is impossible without taking into account the cultural foundations—systems of values, norms of economic behavior, and collective conceptions of rationality.

Overall, the study demonstrates that achieving SDG 12 requires the synergy of three components: institutional efficiency technological solutions and culturally anchored environmental responsibility.

Thus, the promotion of SDG 12 should include measures aimed at forming the cultural and behavioral readiness of society: educational programs based on local values; public campaigns strengthening the norms "don't throw away — but recycle"; and the development of collective practices of ecological behavior.

Several limitations of this study should be acknowledged. First, the analysis is conducted at the country level and relies on aggregated indicators, which does not allow for capturing heterogeneity in individual consumer behavior or intra-country cultural variation. Second, Hofstede's cultural dimensions, while widely used, represent relatively stable and generalized cultural traits and may not fully reflect dynamic changes in values related to sustainability and consumption. Future research could address these limitations by incorporating micro-level consumer data, experimental or survey-based approaches, and longitudinal designs to better capture behavioral change over time. Further work could also explicitly integrate consumer protection indicators and regulatory quality measures to deepen the understanding of how institutional frameworks mediate the relationship between cultural codes and circular consumption outcomes.

The findings of this study suggest that public policies aimed at achieving SDG 12 and developing a circular economy must go beyond purely technological and economic instruments. Given the significant role of cultural codes in shaping consumption patterns, regulators and government agencies must develop differentiated policy frameworks that take into account the cultural and behavioral context. Strengthening consumer rights and protections is becoming a crucial policy lever for ensuring fair and informed consumption through standards for product durability, repairability, transparent eco-labels, and the prevention of misleading sustainability claims. Governments also play a key role in ensuring equal access to circular services by aligning regulatory frameworks with cultural and behavioral realities. Policymakers can more effectively translate sustainable development goals into everyday consumer practices and support a socially inclusive transition to circular consumption.

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