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The role of environmental, economic, and social dimensions of sustainability in the quality of life in Spain

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Abstract:	<p>Environmental sustainability can positively affect quality of life by reducing environmental degradation and increasing access to natural resources, while economic sustainability initiatives can have both positive and negative impacts on quality of life, depending on the context. Social sustainability initiatives can also have both positive and negative impacts on quality of life, particularly for marginalized communities and low-income populations. The investigation draws on a comprehensive national survey in Spain encompassing 2,270 responses, ensuring representative profiles in terms of gender, residence, income, age, and economic sector. Considering the aforementioned factors, this research aims to underscore the necessity of recognizing the interconnections between sustainability and quality of life in policy and decision-making processes towards social happiness. To achieve this, an analysis of variance is presented, enabling the examination of significant differences in the sociodemographic characteristics of Spanish citizens across the three dimensions defining sustainability. Specifically, income, age and population size are key in determining the relationship between sustainability and social happiness. Furthermore, an econometric analysis has demonstrated a positive relationship between sustainability and quality of life in Spain. The key factors are safety, trust, income, and accessibility. The findings of this study can provide valuable insights to inform policy decisions aimed at promoting sustainability and enhancing the overall quality of life. The interlinked integration of smart cities and smart rural areas constitutes the quality of life zone that influences sustainability.</p>	
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We would like to thank the reviewer for his comments on our article. Thank you for all the suggestions, this has allowed us to present our manuscript again in a better version. We hope we have responded to all your instructions.

We have incorporated changes into the document highlighted in yellow.

We have incorporated changes in the document highlighted in yellow: the suggested phrases have been removed, we have redrafted what was not clearly expressed (such as the justification for why we have not included the variables, page 11 before table 3) and we have corrected the errors made (errors in the tables, some words, number of surveys, etc.)

The role of environmental, economic, and social dimensions of sustainability in the quality of life in Spain

Abstract

Environmental sustainability can positively affect quality of life by reducing environmental degradation and increasing access to natural resources, while economic sustainability initiatives can have both positive and negative impacts on quality of life, depending on the context. Social sustainability initiatives can also have both positive and negative impacts on quality of life, particularly for marginalized communities and low-income populations. The investigation draws on a comprehensive national survey in Spain encompassing 2,270 responses, ensuring representative profiles in terms of gender, residence, income, age, and economic sector. Considering the aforementioned factors, this research aims to underscore the necessity of recognizing the interconnections between sustainability and quality of life in policy and decision-making processes towards social happiness. To achieve this, an analysis of variance is presented, enabling the examination of significant differences in the sociodemographic characteristics of Spanish citizens across the three dimensions defining sustainability. Specifically, income, age and population size are key in determining the relationship between sustainability and social happiness. Furthermore, an econometric analysis has demonstrated a positive relationship between sustainability and quality of life in Spain. The key factors are safety, trust, income, and accessibility. The findings of this study can provide valuable insights to inform policy decisions aimed at promoting sustainability and enhancing the overall quality of life. The interlinked integration of smart cities and smart rural areas constitutes the quality of life zone that influences sustainability.

Keywords: sustainable, environmental, economic, social, quality of life

1. Introduction

Sustainability and quality of life are two concepts that are increasingly interrelated and relevant in today's society. The relationship between these two concepts is complex and multifaceted, and its understanding is essential to address the challenges facing humanity, such as climate change, resource depletion, and social inequality (Moser, 2009; Pitarch-Garrido, 2018). Sustainability refers to the ability of systems to persist and maintain their viability over time. In contrast, quality of life refers to the well-being of individuals and the satisfaction they experience in different domains, such as health, work, education, and leisure (Moser, 2009), including life satisfaction and overall happiness (Hartley, 2023; Kundu et al., 2024). Thus, citizen happiness is regarded as part of the lived experience, of everyday life, and justifies the choice of place of residence, which is connected to the social and economic perspectives of each individual (Baum et al. 2020; Khan y Hussain, 2020).

In this scenario, Chen (2022) establishes that for smart cities to approach sustainability and long-term habitability that involves multiple concepts such as equity and social and environmental justice, they require quality of life as a key variable. It also reflects the living conditions of cities, such as the well-being and quality of the built environment and urban spaces (Mirzaei and Zangiabadi, 2021). In addition, habitability and quality of life associated with socio-structural relationships, environmental and material well-being,

and community integration are crucial for smart cities to become sustainable (Macke et al., 2018). In this sense, there is a significant interest in cities being happy and healthy as they progress towards the concept of efficiency or smart. Thus, negative aspects in cities are increasingly becoming a cause for concern among residents, such as transportation (Kourtit et al., 2023). Lopez-Ruiz et al. (2019) explore the direct relationship between three dimensions used to measure the sustainability of a city - economic, social, or environmental - and the quality of life for 52 European cities.

In Spain, with the aim of promoting sustainability and quality of life for citizens, the government has implemented a series of policies and initiatives. As a result, Spain has become a leading country in the development of renewable energy sources, due to the investment made in wind and solar energy. The country has also implemented programs to promote sustainable transportation, such as bike-sharing schemes and pedestrian zones in cities. Additionally, Spain has established protected natural areas and wildlife reserves to preserve its biodiversity. In this sense, access to these types of sustainable and affordable energy services are crucial factors in reducing poverty in developing countries (Terrapon et al., 2014).

Several studies have examined the relationship between sustainability and quality of life. However, the existing literature does not address it in terms of social happiness, making this research a valuable contribution in that regard. For example, Pitarch-Garrido (2018) analyzes the metropolitan area of Valencia, this relationship taking into account social sustainability where they include very diverse aspects such as access to public services, health, local culture, the degree of aging of the population, the level of involvement in public life, social capital, etc., since everything implies effects on the quality of life of people and, clearly, in environmental quality and in obtaining the essential financial resources. Overall, the evidence suggests that there is a positive relationship between sustainability and quality of life in Spain. The country's commitment to promoting sustainability has the potential to elevate the well-being of its citizens. This improvement is defined by the interplay of social factors, economic considerations, and environmental stability. By maximizing opportunities for sustainable development, these collective efforts not only aim to enhance economic prosperity but also aspire to elevate the overall quality of life for the populace (Vaz, 2023).

In order to achieve sustainable development, it is essential that we adopt a holistic approach that takes into account the interconnectedness of different aspects of our lives, including our economic, social, and environmental well-being. This means developing policies and practices that promote sustainability in areas such as energy, transportation, housing, and waste management, among others. Moser (2009) views the living environment as a vital factor in achieving a balance between people and their surroundings. He suggests a framework for examining the alignment between objective and subjective evaluations of environmental stressors, in relation to both individual and social indicators of well-being.

In this paper, **the objective was to** explore the relationship between the three dimensions of sustainability: economic; social; and environmental and the quality of life, examining these dynamics through a scientific perspective, considering both theoretical and empirical studies. **To achieve this objective, an analysis of the concepts,** the interconnections between them, and the impact of sustainability on quality of life with three hypotheses that we show later. Specifically, **our approach to evaluating quality of life focused on** citizens' happiness. Thus, using the information of a survey of the Spanish population (2,270 people interviewed), an econometric study is presented that analyzes the relationship of the three

dimensions that define sustainability with the quality of life of citizens. With this study, we hope to see if there is a relationship between the dimensions of economic, social and environmental sustainability, and citizen's quality of life, with variations according to gender, age, place of residence, and income. To ascertain the existence of disparities based on socio-economic conditions, we employed an analysis of variance (ANOVA).

The study innovates because it introduces a holistic perspective on sustainability, delineating its fundamental impact on achieving the quality of life in contemporary society. This extends beyond mere wealth or well-being, as it incorporates the paradigm of efficiency and sustainable development.

2. Exploring quality of life as citizen happiness, and hypothesis development

While studies on quality of life concentrate on the well-being of individuals in the present, there exists a substantial body of research addressing sustainable development, aiming to ensure a 'good' life for all individuals in the current moment and for future generations (Schäfer et al., 2004).

Sustainability is a broad and complex concept that involves environmental (McCracken and Meyer, 2018), economic (Okafor-Yarwood, 2019; Schröder et al., 2019; Xie et al., 2021), and social (Gill and Germann, 2022) dimensions. On one hand, in environmental terms, it refers to the ability of natural systems to maintain their viability over time, preserving biodiversity and ecosystem services. On the other hand, economic sustainability refers to the ability of systems to generate economic benefits while maintaining their viability and preserving natural resources. Finally, the term 'social sustainability' refers to the ability of systems to generate well-being and equitable outcomes for all stakeholders (Moldan, Janoušková and Hák, 2012). In this regard, the concept of sustainability has evolved over time and is widely debated among scholars and policymakers. Some authors argue that sustainability is primarily concerned with environmental protection and the preservation of natural resources. Others argue that sustainability is a more holistic concept that involves the integration of environmental, economic, and social dimensions (Smith, 2013).

The term 'sustainability' is inherently complex, and consensus on its meaning becomes even more elusive when applied to the sustainability of cities (Pollesch and Dale, 2016). Some studies, such as that of Rotmans et. al. (2000), include the same economic, sociocultural, and environmental aspects, where a great effort is made to define the meaning of the term and to be able to work with it. In this sense, one of the most widely used approaches to determine the degree of sustainability is the level of quality of life in the city (Prado-Lorenzo et al., 2012).

Given these critical dimensions, both researchers and policymakers grapple with addressing challenges associated with enhancing quality of life. Sustainability, in this context, implies ensuring satisfactory conditions for both individuals and their environment. Consequently, formulating policies, particularly in the environmental scope, becomes a top priority (Moser, 2009).

The Brundtland Report, focused on advancing the quality of life through the lens of sustainability, defines it as a development with the aim of meeting the needs of the present generation without compromising the capacity of future generations (WCED, 1987). This satisfaction of individual and collective human well-being refers to the factors that contribute to the quality of life. Thus, the definition

of Quality of life refers to the well-being of individuals and the satisfaction they experience in different domains, such as health, work, education, and leisure. The concept of quality of life has also evolved over time, and its definition has become more complex and nuanced (Diener and Seligman, 2004). Some authors define quality of life as the satisfaction individuals experience with their lives (Diener, 2000), while others define it as a multidimensional concept that includes objective and subjective indicators (Cummins, 2000).

Therefore, quality of life has two interrelated dimensions: objective (physical, social, economic aspects etc.) and subjective (psychological state of satisfaction). Thus, quality of life can be set as a general sustainable development aim, through objective and subjective economic, social and environmental profiles (Nevado-Peña, et al., 2019).

Uzzell and Moser (2006) grouped the term quality of life in four areas of public policy and applied psychological research: health, individual satisfaction with life, target living standards and sustainable development. This suppose that there is a link between environmental sustainability and quality of life, in such a way that without the achievement of an environmental quality objectively and subjectively, a sustainable development of society cannot be achieved (Moser, 2009).

The relationship between sustainability and quality of life is further underscored by its multifaceted nature. Sustainability can positively impact quality of life by providing access to essential resources, such as clean water and air, and by reducing environmental degradation, such as pollution and climate change. Conversely, sustainability initiatives may negatively impact quality of life by limiting resource access, reducing economic growth, and increasing social inequality.

This analysis aims to explore the relationship between sustainability and quality of life, adopting a subjective approach that considers both the internal characteristics of individuals and external factors influencing happiness. The investigation encompasses various perspectives and methodologies to provide a comprehensive understanding of this complex interaction. In the following points, we will review some of the most relevant studies and their findings, trying to respond to the different hypotheses raised.

2.1 Environmental Sustainability and Quality of Life

Poor environmental quality is perceived as a relevant threat to people's well-being (Moser, 2009). This leads to one of the most frequently studied aspects of the relationship between sustainability and quality of life is the impact of environmental sustainability on quality of life. Several studies have found that environmental sustainability can positively impact quality of life by reducing environmental degradation, such as air and water pollution, and by increasing access to natural resources, such as parks and green spaces (Wells and Evans, 2003). For instance, Jeswani and Azapagic (2020), using econometric models, examine the relationship between environmental quality and health outcomes, revealing that subpar environmental conditions are linked to adverse health effects such as respiratory problems and cardiovascular diseases. Prado-Lorenzo et al. (2012) delved into the relationship between quality of life and sustainability using regression models.

The economic, social, and environmental sustainability of cities presents distinct challenges amidst the ongoing global urban development (Durán-Sánchez et al., 2017). Consequently, research on urban

sustainability has garnered significant attention in recent years due to the deterioration suffered in urban environments, which has led to the decrease in the quality of urban life of citizens. Douglas et al. (2019) found that access to green spaces is positively associated with quality of life in urban areas, with higher levels of physical and mental well-being observed among individuals with greater access to green spaces. Similarly, a study by Stigsdotter et al. (2010) found that exposure to air pollution is negatively associated with quality of life, with higher levels of respiratory problems, headaches, and sleep disturbances observed among individuals with higher exposure to air pollution. These findings suggest that environmental sustainability initiatives that reduce environmental degradation and increase access to green spaces can have a positive impact on quality of life.

The use of survey data to measure the relationship between sustainability and quality of life, as in the present study, is a relatively novel approach. However, previous research has shown that survey data can be a useful tool for investigating this relationship. For example, a study by Kaida and Kaida (2019) used survey data to examine the relationship between environmental quality and quality of life in a rural Australian community. The study found that environmental quality was an important predictor of quality of life and suggested that policies aimed at improving environmental quality could have positive impacts on the well-being of residents.

In this same sense, Chen (2023), from the study carried out for smart cities, concludes that the improvement of green spaces, air pollution and recycling services are essential for better habitability and improvement of subjective well-being, but these variables they should not be completely isolated from indicators in other dimensions of smart cities.

Therefore, following the previous review and considering that environmental sustainability is gauged by factors such as air quality, pollution levels, cleanliness, and the preservation of green areas, we propose the first hypothesis:

- *H1: Environmental sustainability has a positive and significant impact on the quality of life.*

2.2. *Economic Sustainability and Quality of Life*

Economic sustainability is another aspect of the relationship between sustainability and quality of life that has been widely studied. Some studies such as Prado-Lorenzo et al. (2012) demonstrated the impact of political factors on the sustainability of cities and their effect on the economic development. Other authors have found that economic sustainability can positively affect the quality of life by generating economic growth, creating jobs, and reducing poverty (Stern, 2000).

However, other studies have found that economic sustainability initiatives can also negatively affect the quality of life, particularly for marginalized communities and low-income populations. In this context, Karlsson and Luttrupp (2006) found that economic sustainability initiatives prioritizing efficiency and resource conservation may result in increased costs for essential goods and services, such as energy and food, thereby affecting the quality of life of low-income populations. On the contrary, Steg and Gifford (2005) consider that economic indicators should measure possible effects on economic well-being, such as macroeconomic changes, GDP, economic efficiency, income distribution, and unemployment rates.

Therefore, it is important to take a comprehensive approach when evaluating the impact of economic sustainability initiatives, and to consider not only their effects on the environment and the economy, but also on social equity and quality of life. This requires a nuanced understanding of the complex interrelationships between different aspects of sustainability, and a recognition that what may be beneficial for one group of people or for the environment may not necessarily be beneficial for others.

In essence, the objective of economic sustainability initiatives should be to promote a high quality of life for all individuals and communities, in terms of social happiness, while also protecting the environment and promoting long-term economic prosperity. Attaining this goal demands a well-balanced approach that considers the needs and viewpoints of all stakeholders, placing emphasis on social equity and sustainability alongside economic growth.

Hence, we propose a second hypothesis (H2) that considers economic sustainability in terms of the accessibility of public and commercial transport, as well as the overall economic situation:

- *H2: Economic sustainability has a positive and significant impact on the quality of life.*

2.3. Social Sustainability and Quality of Life

Social sustainability has been extensively explored, although not always with a conscious geographical perspective emphasizing spatial equity (Pitarch-Garrido, 2018). It plays a pivotal role in the nexus between sustainability and quality of life, considering the social dimensions of sustainability and the impact of sustainability initiatives on individuals and communities.

Some studies have found that social sustainability initiatives, such as community-based renewable energy projects, can positively affect quality of life by increasing community engagement and empowerment, and by providing access to essential resources, such as energy and water. In Spain, Castro-Santos et al. (2019) investigated the effects of renewable energy projects on residents' quality of life, finding a positive impact through economic opportunities and improved local environments.

Other studies have used qualitative methods to investigate the impact of sustainable development policies on local communities. Grum and Kobal (2020), consider crucial aspects of daily life, including home characteristics, neighborhood safety, proximity to schools and public services, parking facilities, and green areas. Residents' satisfaction in their place of residence is dependent on these factors, significantly influencing their quality of life. Therefore, social development aims to fulfill all people's needs, leading to satisfaction, security, health, and ultimately, happiness. Elements of social infrastructure, encompassing economic, environmental, physical, political, and psychological aspects, along with satisfaction with one's place of residence, are deemed essential for achieving a high quality of life (Grum and Kobal, 2020).

Finally, we propose the third hypothesis (H3), suggesting that trust in the neighborhood, integration, and multiculturalism collectively contribute to measuring social sustainability. Therefore, we propose:

- *H3: The social sustainability of cities has a positive and significant impact on the quality of life and happiness of an individual.*

In summary, the hypothesis established that there are a positive relationship between sustainability in its three dimensions - environmental, economic, and social - and the quality of life of citizens (see Figure 1). Specifically, communities that prioritize sustainability and adopt policies and practices that promote

sustainability are likely to have a higher quality of life, as reflected in measures such as access to essential goods and services, social equity, and overall well-being. This relationship is expected to be mediated by factors such as income, education, and community engagement, which can influence both sustainability and quality of life outcomes. Additionally, the relationship between sustainability and quality of life must be stronger in communities that are more socially and economically marginalized, as sustainability initiatives may have a greater impact on improving the well-being of these populations. Further research is needed to test these hypotheses and explore the complex relationship between sustainability and quality of life in different contexts and populations. The multidimensional model of quality of life incorporates the remaining occupational, residential, and familial factors not present ('other factors' in Figure 1) in the sustainability approach, in order to estimate the significance of the considered hypotheses.

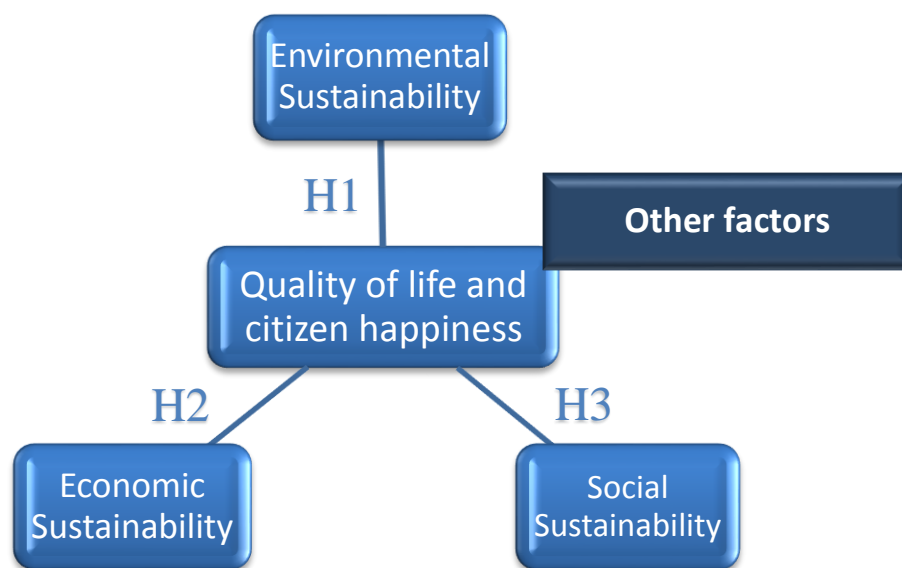


Figure 1. Hypothesis between sustainability and quality of life model

3. Materials and Methods

In general, the literature employs a variety of methods, including econometric models (Prado-Lorenzo et al., 2012; Jeswani and Azapagic, 2020, among others), quantitative and qualitative statistical approaches utilizing survey data (Welsch, 2006; Kaida and Kaida, 2019, among others), which offer valuable insights into the relationship between sustainability and quality of life. This underscores the significance of promoting sustainable development policies to enhance the well-being of citizens and create more resilient and equitable communities.

Drawing upon insights from the literature, the methodology employed in this study embraced a cross-sectional survey design involving 2,270 interviews with the Spanish population conducted during the months of April to May 2022. This sample size supposes a sample error of 2.06% with a confidence level of 95%. The survey was designed to capture a multidimensional view of quality of life, with variables in

Likert scale covering factors such as residential, family, and work-related issues, as well as environmental concerns and the impact of the COVID-19 pandemic.

The information has been collected by a specialized company using a telephonic interview and social networks, ensuring representation by place of residence and regional territory, as well as gender distribution. Specifically, the questionnaire is composed of three blocks. The first captures socio-demographic variables, including the classification of place of residence, enabling differentiation between rural and urban areas. The second block encompasses variables related to citizens' assessment of happiness and quality of life, involving both direct evaluations and responses to 20 variables associated with key aspects of quality of life. These aspects are framed as questions pertaining to the living environment (family situation, trust, environment, commercial accessibility and public transport, green areas, culture and sport, foreign population, health, education, housing prices, and safety), as well as the working and educational environments (economic situation, employment status, working environment, training, and access to the communication technologies). These key aspects of citizens' quality of life were developed based on a literature review, drawing on works by scholars such as Diener (2000), Florida et al. (2013), Diener et al. (2013), Moghnie and Kazarian (2011), and Lopez-Ruiz et al. (2022). The third block comprises two questions related to quality of life: a direct assessment of the impact of the pandemic and an evaluation of social happiness from a multidimensional perspective. The questions in blocks 2 and 3 are presented on a 10-point Likert-type scale (from 1 "not at all satisfied" to 10 "very satisfied").

Respondents, who were adults, voluntarily provided information on 20 variables related with the quality of life listed in Table 1. These questions pertain to the social spheres most relevant to citizens: residential, social, and occupational. We highlight in bold (Table 1) the variables directly related to the three-dimensional sustainability approach considered in this paper. Specifically, for the economic dimension, we considered P13 and P05; for the social dimension: P03, P08, and P12; and for the environmental dimension P04 and P06.

In terms of methodology, econometric modeling with a linear functional form, specifically ordinary least squares regression (OLS), was chosen to analyze the survey data. The dependent variable was a composite measure of life satisfaction (P01) and happiness (P20) (see Table 1), with the independent variable of interest being environmental policy (P04, P06). The study controlled for a range of potential confounding factors, including economic and labor related factors, as well as the effects of the COVID-19 pandemic.

Table 1. Variables

Code:	Variable	Sustainability dimensions and other factors
P01:	Satisfaction with life	Quality of Life formation
P02:	Family situation	Other
P03:	Trust in the neighborhood	Social
P04:	Air quality, pollution, and cleanliness	Environmental

P05:	Public transport and commercial accessibility	Economic
P06:	Sustainability of the environment and green areas	Environmental
P07:	Culture and Sport	Other
P08:	Integration, multiculturalism	Social
P09:	Health services	Other
P10:	Education services, also university	Other
P11:	Access to housing	Other
P12:	Safety	Social
P13:	Economic situation	Economic
P14:	Job qualification	Other
P15:	Happiness at work	Other
P16:	Working environment and labor relations	Other
P17:	Job training	Other
P18:	Use of information and communication technologies	Other
P19:	Covid19 affectation	Other
P20:	Happiness (multidimensional approach)	Quality of Life formation

Overall, this approach appears suitable for addressing the research at hand, enabling the investigation of the relationship between sustainability and quality of life, while accounting for potential confounding factors. However, like any research methodology, there are limitations, particularly in terms of assumptions made in the econometric model and potential biases in the survey data. It is important to interpret the results considering these limitations and explore alternative explanations for any observed relationships.

The methodology for studying the relationship between citizen quality of life and sustainability (economic, social, and environmental) uses two models. The first model encompasses all factors related to quality of life, while the second model only includes those factors directly related to sustainability.

The first model provides a comprehensive analysis of citizen quality of life, considering various aspects such as health, education, safety, and cultural opportunities. However, it may not specifically focus on sustainability-related factors.

In contrast, the second model offers a more focused analysis of the relationship between the quality of life of citizens, specifically in terms of social happiness, and sustainability. The model includes only factors with a direct impact on sustainability, such as the green spaces in residential place, waste management, social safety and trust, or public transportation. This approach facilitates a more focused analysis of the impact of sustainability on citizen quality of life.

While the first model provides a broader understanding of citizen quality of life, the second model provides a more focused analysis of sustainability related factors. Ultimately, both models can provide

valuable insights into the relationship between citizen quality of life and sustainability, informing policies and practices aimed at improvement.

4. Results and discussion

Initially, an ANOVA analysis was conducted using the variables highlighted in bold in Table 1—those directly associated with sustainability dimensions. The objective was to determine whether the means of one variable differ across levels or groups of another categorical variable, considering the sociodemographic characteristics of Spaniards, such as gender, age, place of residence, and income level. This test serves as a generalization of the hypothesis test for equal means in two independent samples, wherein we begin with the null hypothesis (H0) positing that the population means are equal.

Assuming the null hypothesis is true, the statistic used in the ANOVA follows a Fisher-Snedecor F distribution. If its within class significance level is less than or equal to 0.05, we reject the hypothesis of equal means; otherwise, if it is greater, we accept the equality, and there would be no significant differences among the groups.

The results obtained (Table 2) have shown how only the economic situation (P05 and P13) presents significant differences in each of the studied categories of gender, age, inhabitants by residence place, and annual income. This highlights the importance of economic sustainability among Spaniards.

Regarding social sustainability, we see that all variables are significantly different in terms of income. In other words, citizens in better economic situations have residential biases that condition their quality of life. Their residences are safer, and they tend to cluster, forming neighbourhoods with similar incomes. Integration and multiculturalism, however, are linear and seem to be more appreciated by the middle classes. Regarding the rest of the differentiations in terms of social sustainability, age shows that young people have lower residential quality of life and are more likely to prefer integration. Moreover, small towns are shown to be safer and more integrative places. Gender, finally, is not a differentiating group in social terms.

Finally, environmental sustainability has taken root in our society. Gender does not make a difference in its assessment in terms of quality of life. However, the idealization of rural areas versus urban areas remains a reality. In cities, ratings for green policies and environmental care are notably lower than in small towns, thus the quality of life is significantly higher. In this sense, young people are also clearly more critical of these variables. Lastly, the lowest incomes, perhaps due to their residential conditions, score lower on this environmental sustainability.

Table 2. Sample characteristics, means and F significance (bold)

Variables	Categories	P03	P04	P05	P06	P08	P012	P013
Gender	Male	6.96	7	6.49	7.05	6.5	7.40	6.46
	Female	6.84	6.9	6.11	6.95	6.6	7.52	6.19
Age	18-19 years old	6.34	6.75	7.08	7.11	7.20	7.26	5.66
	20-29 years old	6.31	6.37	6.36	6.53	6.37	7.23	5.59
	30-39 years old	6.63	6.97	5.96	6.82	6.40	7.51	5.88
	40-49 years old	6.86	6.99	5.82	6.87	6.53	7.55	6.28

	50-59 years old	6.99	7.29	5.83	7.16	6.71	7.60	6.27
	60-69 years old	7.15	6.88	6.70	7.12	6.40	7.41	6.67
	Over 70 years	7.45	7.01	7.08	7.32	6.65	7.46	7.19
inhabitants by residence place	< 1001	7.12	8.42	4.02	8.2	6.82	8.22	6.18
	1001-5000	6.94	8.04	5.17	7.51	6.71	7.87	6.01
	5001-100000	6.98	7.16	6.39	6.93	6.52	4.52	6.31
	>100000	6.77	5.9	7.31	6.52	6.44	7.05	6.51
Annual Income	<12.000€	6.46	6.84	5.97	6.78	6.33	7.29	5.14
	12.000€/24.000€	7.01	7.02	6.31	7.09	6.70	7.54	6.38
	24.000€/42.000€	7.24	6.96	6.56	7.14	6.64	7.55	7.33
	>42.000€	7.2	7	6.83	6.96	6.55	7.58	7.79

The results obtained from the linear relationship between quality of life in terms of happiness and satisfaction with different factors can be defined according to a random effects model that follows the form of equation 1. The equation has as its endogenous variable the average between the life satisfaction index of the surveyed citizens and the level of happiness, from a multidimensional social perspective, in which the individual's different social environments are used.

Equation 1

$$P01_i + P20_i/2 = \sum_{k=2}^{19} \beta_k \cdot P_{ki} + u_i$$

Where β is the coefficient that quantifies the relationship, elasticity in percentage terms; P is the variable that determines citizen happiness; and u is the random variable with white noise behaviour, that is, with zero mean, homoscedasticity, and no correlation. Among the exogenous variables, all possible factors are verified (Table 1), collecting **only** the **significant variables** in model 1 (Table 3). Following the same specification, we estimate model 2, in which **we only include the significant variables** related to the triple dimension of sustainability (Table 3).

Table 3. Quality of Life' Models

	Model 1 (all factors)		Model 2 (only sustainability dimensions)	
Variables	Coefficient (T-statistic)	<i>Elasticity</i>	Coefficient (T-statistic)	<i>Elasticity</i>
P02	0.362826 (29.03126)**	0.384792		
P03	0.119682	0.112179	0.246386	0.230939

	(9.495649)**		(16.02112)**	
P04			0.068716	0.064794
			(4.324629)**	
P05	0.032816	0.028057	0.102831	0.087920
	(3.157678)**		(9.064137)**	
P06	0.061470	0.058395	0.063301	0.060135
	(5.246673)**		(4.123703)**	
P07	0.031986	0.028660		
	(2.419847)*			
P08	0.037213	0.033126	0.106053	0.094404
	(2.965102)**		(6.942266)**	
P12	0.094669	0.095966	0.187574	0.190144
	(6.723398)**		(10.38997)**	
P13	0.111145	0.095367	0.302700	0.259729
	(9.613158)**		(25.40103)**	
P15	0.096740	0.087689		
	(8.726986)**			
P16	0.049616	0.051759		
	(4.615558)**			
P19	0.023251	0.021453		
	(2.971223)**			
R²	0.642597		0.440090	

Note: (**) significant at the 0.01 level, and (*) significant at the 0.05 level.

From the findings presented in Table 3, it can be inferred that the quality of life of Spaniards is significantly influenced by sustainability across its three dimensions: social, economic, and environmental. Moreover, these relationships are positive, supporting the acceptance of the three hypotheses established. Therefore, Hypothesis 1 is accepted, in line with the findings of Prado-Lorenzo et al. (2012), Wells and Evans (2003), Jeswani and Azapagic (2020) or Chen (2023), the results show a positive and significant relationships between environmental sustainability and quality of life. Improved environmental sustainability is associated with a better quality of life. Hypothesis 2 is also accepted, aligning with Stern (2000) and Steg and Gifford (2005), as the results show a positive and significant relationships between economic sustainability and quality of life. Finally, a positive relationship is observed between social sustainability and quality of life (Hypothesis 3), in accordance with the assertions of Castro-Santos et al. (2019) and Grum and Kobal (2020).

Only aspects related to the individual's work (P15, P16) and family environment (P02) complement this perspective of sustainable quality of life. We can arrive at the aforementioned conclusion by examining the

differences between the general model (1) and the model that solely estimates the complex sustainability relationship (2).

If we fix the importance of the factor in the comparison of elasticities (impact in terms of percentage variation), in equation 2, we observe that economic situation (P13 and P05) corresponds to approximately 35% of the effect; meanwhile, the community or neighborhood environment (P03, P08 and P12), which partly covers the family environment, are the fundamental factors that condition citizen happiness, accounting for nearly 52% of the specified effect. However, the environmental issue, although significant, accounts for only 12.5% as the sum of elasticities (P04 and P06).

5. Conclusions

The relationship between sustainability and the quality of life, crucial for citizens to attain happiness, remains a complex and multifaceted issue. Understanding this relationship is essential to address the challenges facing humanity. Sustainability, in this sense, can be observed from a triple perspective encompassing social, economic, and environmental dimensions. Environmental sustainability can positively influence quality of life by reducing environmental degradation and increasing access to natural resources, while economic sustainability initiatives can have both positive and negative impacts on quality of life, depending on the context. Social sustainability initiatives can also have both positive and negative impacts on quality of life, particularly for marginalized communities and low-income populations.

It is important to consider the interconnections between sustainability and quality of life in policy and decision-making processes, ensuring that sustainability initiatives result in positive outcomes for all individuals and communities. Further research is needed to understand the complex relationship between sustainability and quality of life, particularly in terms of social happiness, and to develop effective strategies to address the challenges facing humanity.

This study contributes to the literature showing how the environment, social and economic development are important for Spanish citizens. However, there are indicators that the literature had not previously taken into account for measuring these dimensions. Thus, in the economic dimension, not only indicators such as the citizen's economic situation were used for this dimension, but also information on the accessibility of public and commercial transportation are considered. In the case of the social dimension, variables already reviewed in the literature such as trust in the neighborhood, integration, multiculturalism and safety, were considered. Finally, in the environmental dimension we use factors such as air quality, pollution, cleanliness and sustainability of the environment and green areas. The quality of life for Spanish citizens, particularly in terms of happiness, is found to depend on a triple pathway. To feel satisfied with their life in society, individuals must strike a balance between these dimensions. It is not only a matter of income, nor solely of social well-being, but rather is integrated with an efficiency in development within the environment and in global relationships.

The results verify the three hypotheses established and show a positive relationship among the citizen's quality of life and the sustainability considering the three dimensions: social, economic, and environmental being this the order considering the intensity of the relationship. In this sense, adopting policies that contribute to sustainability and that are reflected in access to essential goods and services such as housing, improvement of education, social equity and general well-being will influence the quality of life of citizens or social happiness.

On the other hand, the hypotheses raised about whether the relationship between sustainability and quality of life is stronger in communities that are more socially and economically marginalized, respond that yes motivated by the fact that sustainability initiatives tend to have a greater impact on improving the well-being of these populations, although these hypotheses can be analyzed, opening new lines of research in the future, **such as making a differentiation between cities and rural areas**. Moreover, other research lines open with this paper could analyze if these relationships are similar in different countries or the effect of external factors over these relationships. Concerning limitations in this study, it is important to acknowledge that social, economic, and environmental dynamics are constantly evolving, representing an ongoing concern for citizens.

Finally, this analysis provides lines of action to improve public policies that have been implemented in some cases with the aim of generating benefits in the environmental, social, and urban spheres. The differences found in the improvements in the quality of life for residents in areas designated as 'smart cities' and in 'smart rural areas with high connectivity' in Spain raise new questions about how digital capabilities impact both communities in terms of efficiency and individuals in terms of quality of life.

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The role of environmental, economic, and social dimensions of sustainability in the quality of life in Spain

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Abstract

Environmental sustainability can positively affect quality of life by reducing environmental degradation and increasing access to natural resources, while economic sustainability initiatives can have both positive and negative impacts on quality of life, depending on the context. Social sustainability initiatives can also have both positive and negative impacts on quality of life, particularly for marginalized communities and low-income populations. The investigation draws on a comprehensive national survey in **Spain encompassing 2,270 responses**, ensuring representative profiles in terms of gender, residence, income, age, and economic sector. Considering the aforementioned factors, this research aims to underscore the necessity of recognizing the interconnections between sustainability and quality of life in policy and decision-making processes towards social happiness. To achieve this, an analysis of variance is presented, enabling the examination of significant differences in the sociodemographic characteristics of Spanish citizens across the three dimensions defining sustainability. Specifically, income, age and population size are key in determining the relationship between sustainability and social happiness. Furthermore, an econometric analysis has demonstrated a positive relationship between sustainability and quality of life in Spain. The key factors are safety, trust, income, and accessibility. The findings of this study can provide valuable insights to inform policy decisions aimed at promoting sustainability and enhancing the overall quality of life. The interlinked integration of smart cities and smart rural areas constitutes the quality of life zone that influences sustainability.

Keywords: sustainable, environmental, economic, social, quality of life

Compliance with Ethical Standards

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