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AI-Enhanced Strategies to Ensure New Sustainable Destination Tourism Trends Among the 27 European Union Member States

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Abstract: The United Nations 2030 Agenda defines the priorities and aspirations for global development based on seventeen ambitious sustainable development goals encompassing economic, environmental, and social dimensions. Tourism plays a vital role in the list of actions for the people and the planet. While the tourism industry drives economic growth, its environmental and social impact is equally high. Sustainable tourism aims to reduce the damage caused by the tourism industry, protect communities, and guarantee the industry's long-term future. These changes require tourists' collective and concerted effort. The question arises whether tourists are willing to be more demanding about sustainability when looking for a destination. This study uses artificial intelligence to classify a new trend in European citizens' search for sustainable destinations and to generate intelligent recommendations. Using data from the Flash Eurobarometer 499, we use a tree-based algorithm, random forest, to obtain intelligent citizens classification systems supported by machine learning. The classification system explores the predisposition of citizens to contribute to the three pillars of sustainability when choosing a destination to visit based on gender, age, and the region of living. We found that European citizens place little emphasis on the social sustainability pillar. While they care about preserving the environment, this competes with the cultural offerings and availability of activities at the destination. Additionally, we found that the willingness to contribute to the three pillars of sustainability varies by gender, age, and European region.

Keywords: sustainable development; tourism sustainability; sustainable destinations; social sustainability; environmental sustainability; economic sustainability; generative artificial intelligence; machine learning

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1. Introduction

In contemporary development discourse, sustainability has become a popular buzzword among civil society, industries, and governments. This issue gained momentum with the signing by 193 countries of the 2030 Agenda for Sustainable Development. This commitment challenged government leaders to meet seventeen Sustainable Development Goals (SDGs) over 15 years. Although defined in countless ways (e.g., [1]), the most often cited definition of sustainable development proposed by the Brundtland Commission Report states it as the development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs [2]. Therefore, inter- and intra-generational equity is at the center of sustainable development, which is essentially based on three different but interlinked dimensions: environment, economy, and society. Thus, the main goal of sustainable development is not to create more economic benefits but to provide better living conditions for community members. Despite the enthusiasm generated around Agenda 2030 and the considerable amount of literature that has emerged around this topic (e.g., [3,4]), progress towards the SDGs has stagnated. According to the United Nations, almost half of the SDGs have made minimal or moderate progress, while more than a third have stagnated or regressed, with only 17% on track [5].

There is a delay in resolving these problem when dramatic events, such as the recent floods in central Europe or this summer's fires in Greece and Portugal, occur, which, by revealing the vulnerability of society, put everything into perspective. In this scenario, tourism plays a crucial role. The tourism sector is the world's largest and fastest-growing industry. It catalyzes economic growth, a crucial source of income and sustenance for many developed [6] and developing [7] countries. In 2023, tourism made up 9.1% of the global gross domestic product (GDP) and was responsible for 27 million new jobs, offering 329 million jobs corresponding to 9.1% of total employment [8]. However, the exponential growth of tourism has brought about new social, economic, and environmental challenges, and due to its holistic nature, the tourism sector could become a victim of its success. Improperly planned and executed tourism activities can increase inequality and generate environmental pollution while contributing to the de-characterization of local areas with the loss of cultural identity.

In the 2100 timeframe, climate changes are expected to trigger regional changes in travel patterns as we know them today. With global warming, a north–south pattern in tourism demand changes is predicted to occur in Europe, with Northern regions benefiting from climate change and southern regions facing significant reductions in tourism demand [9]. Concerning socio-cultural aspects, mass tourism is associated with the displacement of former residents and property speculation. The recent phenomenon of gentrification presents issues regarding the privatization of public spaces, the transformation of public services to cater to tourists, the erosion of community social bonds, and the commodification of regional consumption, which has far-reaching impacts on residents' stress and their desire to relocate [10]. The recent anti-tourism protests that have swept Europe, with demonstrations in the Netherlands, Greece, Spain, and Portugal, denote the discontent of local communities. Europeans are rebelling against mass tourism, demanding 'less tourism and more life!'. The dissatisfaction of host communities with tourism can make tourists feel unwelcome and divert them to other regions. Thus, as tourism expands, the need for responsible development becomes crucial. Sustainable development combines harmoniously with tourism development due to the relationship of correspondence and reciprocity that exists between the two. As with sustainable development, sustainable tourism is founded on economic, ecological, and social pillars. Indeed, tourism is expected to contribute significantly to the global sustainable development scenario, making it one of the centerpieces of the key agenda points for Global Sustainable Development 2030.

While promoting sustainable tourism remains a laudable goal, research has shown that sustainability problems are often rooted in human behavior and that changing (unsustainable) behavior remains critical to implementing long-term solutions [11]. In this sense, achieving sustainable tourism requires the involvement of all stakeholders, i.e., current visitors, future visitors, and the current host community, the future host community, including residents, business owners, and government officials [12], with a special focus on tourists. As a result, understanding tourists' sustainable attitudes and behavior has become a widely studied subject in the literature [13,14], even though its understanding remains chaotic [14]. Most studies on tourism rely on environmental and economic concerns [15], neglecting the social dimensions [16]. Moreover, there is a lack of clarity on whether demographic factors, such as age and gender, influence tourists' sustainable predisposition to become sustainable. Finally, the lack of geographical variance and real-world application has been signaled as a critical area needing further research [17].

Our study seeks to fill these gaps through an integrated approach. The study reported in this article has a twofold aim. Using secondary data retrieved from Flash Eurobarometer 499 [18], we developed, through a machine learning (ML) algorithm, an intelligent system of classification of European citizens in terms of their potential contribution, as tourists, to environmental, social, and economic sustainability when choosing a destination to visit, taking into account their age (Generations Z, Y, and X and Baby Boomers (BBs)), gender, and region where they live (North, Central, East, and West). Then, according to this classification, intelligent corrective measures were generated to direct citizens to fulfil all

the dimensions of sustainability. Using the OpenAI Application Programming Interface (API), intelligent recommendations were generated by considering the classification into one of the three sustainability pillars (economic, environmental, or social). Based on this classification, personalized suggestions were created to encourage engagement with the other pillars, offering corrective measures that align with the tourist's initial preferences while promoting a more sustainable travel experience.

The main results suggest that Europeans generally show a moderate commitment to sustainable tourism, with a predisposition to contribute to the social pillar standing out as unfavorable. Furthermore, age and gender differentiate this commitment, and some differences exist between European regions.

This research is particularly relevant for Europe because it is the world's leading tourist destination, mainly because of its combined natural and cultural attractiveness (with 453 inscribed sites, it accounts, for instance, for nearly half of the UNESCO World Heritage List). In 2019, Europe was the most visited region in the world, accounting for 51% of all international arrivals and 41% of tourism receipts [19]. However, in 2023, Europe takes the top 17 places on the Sustainable Travel Index 2023 [20]. In a countdown to honor the commitment to achieve sustainable development by 2030, the present study seeks to contribute to the formulation of tourism policies that allow the European Union (EU) as a block to respond in a united way to the challenges of achieving more sustainable tourism and, thus, be closer to align with Agenda 2030.

2. Theoretical Framework

2.1. Tourism and Sustainable Development

Recent years have been fruitful in discussing general sustainable development and tourism sustainability. The combination of sustainability and tourism concepts was first used at a seminar held in 1990 in Bali, Indonesia [21]. Later, in 2012, the global leaders taking part in the United Nations Conference on Sustainable Development (Rio+20), whose aim was to discuss the renewal of political commitment to sustainable development, recognized that 'well-designed and well-managed tourism' could contribute to sustainable development. This idea was emphasized by the former Secretary General of the United Nations, Ban Kin-Moon, in his message for World Tourism Day 2015, recognizing tourism as a world-leading sector in job creation and as such a powerful and transformative force, genuinely capable of making a difference to the lives of millions of people and with considerable potential for sustainable development [22]. Since then, research on sustainable tourism has witnessed exponential growth and has covered many topics [14,17,23,24]. The interest and importance attached to sustainable tourism was of such magnitude that it has even led to a specialist journal dedicated exclusively to research into sustainable tourism: the *Journal of Sustainable Tourism*. Alongside this journal, *Sustainability*, although not exclusively focused on tourism, is nowadays mentioned as one of the key journals contributing to sustainable tourism research [25]. Thus, sustainable tourism research remains a crucial and dynamic field, drawing together scholars from diverse academic disciplines united by a common aspiration goal—transforming the tourism industry into more environmentally responsible, socially equitable, and economically fair. As a result of this interest, many definitions of sustainable tourism have emerged in the literature [14,26–28]. However, the one proposed by the United Nations Organization is, due to its official nature, the most accepted and widespread. It states that sustainable tourism fully considers its current and future economic, social, and environmental impacts, addressing the needs of visitors, the industry, the environment, and host communities [29]. Consequently, sustainable tourism involves managing the tourism industry's negative impacts and potential harm, ultimately aiming to achieve sustainable development goals. Indeed, tourism can potentially contribute directly or indirectly to promoting all 17 SDGs. From its ability to reduce poverty (SDG1) through job creation to promoting health for all (SDG3) through the tax revenue it generates to being a promoter of peace and justice (SDG16) through the billions of encounters it facilitates between different cultures, tourism is paramount to reach sustainable development.

Sustainable tourism is a continuous journey, not a fixed destination. This journey requires the collaboration of all stakeholders, especially tourists, who are the instigators of change.

Although significant progress has been made in recent years toward sustainable tourism, it seems to be insufficient (again, as demonstrated by the public discontent of local communities). In order to achieve sustainable tourism, tourists must be convinced to implement sustainable practices and to choose sustainable destinations. Therefore, any comprehensive assessment of a destination's sustainability must include the demand side, i.e., the likelihood of tourists opting for sustainable tourist destinations and pursuing sustainable behavior there. When tourists choose a destination, they do so with the destination's attributes in mind. Through this choice, they contribute to the three interconnected pillars of tourism sustainability: social, environmental, and economic.

The environmental aspect has been the most explored subject, with most studies focusing on conservation and preserving environmental conditions [30]. The human side, including health and safety, is emphasized in the social aspect [31].From an economic perspective, tourism activity in a destination is often a driver of development, triggering desired investments, employment and income earning opportunities, poverty alleviation, and economic prosperity at different levels of society [32]. In this regard, a country's cultural offering, for example, is a great contribution to economic sustainability in the sense that, in the form of museums or local events, it is a powerful resource for the local community by its ability to regenerate local economies, attract visitors, and generate revenue [33]. The concept of cultural capital in economic theory suggests that investing in cultural institutions, such as museums, generates significant societal and economic benefits. These institutions enhance overall well-being and serve as powerful drivers of urban revitalization. By attracting businesses, residents, and investments to their vicinity, museums can transform surrounding areas and elevate a city's reputation, ultimately contributing to broader economic prosperity and community development [34]. Beyond cultural offerings, the variety of activities available at a destination is also an economic factor. This variety of activities available in destinations was first dubbed a 'tourism product' by Medlik and Middleton [35] to refer to the bundle of activities, services, and benefits related to tourism.

Tourist destinations are inseparable from attractiveness and the ability to attract customers. Previous research shows that travelers' decision-making processes are influenced by a destination's appeal, i.e., by the diversity of available tourist services within the destination [36]. According to Herington et al. [37], service offering, the quality of infrastructure, natural and anthropogenic attractions, destination reputation, social elements such as safety and hygiene standards, and economic conditions influence a destination choice. Other research indicates that among the attractions of a destination are gastronomy offerings [38], cultural experience [39], eco-friendly tourism in rural settings [40,41], and service quality, natural aesthetics, security measures, and retail facilities [42].

According to some studies, there is reason to be optimistic as their results indicate that contemporary societies seem increasingly committed to sustainable tourism. They conclude that 81% of travelers worldwide believe sustainable practice is important [43], that tourists are willing to adopt respectful behaviors toward the local cultural heritage, and that there is a growing movement among tourists towards responsible travel practices [44]. However, it is important to ask whether this is the case since there is a difference between what people say they want to do and what they do. Changing behavioral patterns takes time and is challenging. One of the difficulties is that tourists act according to their economic interests when making decisions, which can increase resistance to sustainable behaviors that do not bring them any immediate added value [45]. Future generations will feel the gains from adopting sustainable behavior on the basis of intergenerational equity. Furthermore, switching to sustainable practices often means incurring more expenses. Evidence shows that price continues to be a blocking force in changing behaviors in favor of sustainability [46]. Additionally, people feel entitled to relax on holiday; so, straightforward

attitudes can become inconvenient. Thus, sustainability may not always coincide with the leisure mentality, which may explain why people behave more sustainably at home than when on holiday [47]. Therefore, achieving sustainable tourism depends on individuals' feelings and moral obligation regarding the economic, social, and environmental impacts of their attitudes and behaviors as tourists. These feelings and predisposition are conditioned by individual characteristics, such as age and gender.

2.2. Individual-Level Determinants of Tourists' Sustainable Attitudes

Age and gender, as individual-level determinants, play a significant role in the tourism sector. They influence expectations and preferences for sustainable practices [48], influencing destination selection.

The relevance of age as a driving factor for sustainable tourism has received the attention of several researchers. Tourism demand and future travel patterns are determined by age and take on a unique character for each generation. Individuals of different ages have different attitudes and perceptions towards tourism and, therefore, different tourism consumption patterns. A generation comprises individuals born in a specific period who share daily experiences and values that mold lifestyles and attitudes [49], differentiating them from previous and subsequent generations. Although few studies have explored the generational gap in sustainable tourism, there is much evidence about the younger generation, although the conclusions are not consensual. The greater interest in the younger generation stems from the fact that young people constitute the most significant part of all travelers, thus being an appealing market with a high potential to influence future tourism development [50]. There is evidence that youth tourists significantly contribute to local economies [51]. They have a profile that is more in line with the backpacker tourist typology since they prioritize locally operated services, engage with host communities, care about the local culture and traditions, and prefer food of local origins [52,53]. Young tourists are more concerned with ecology and protecting natural resources [54], more aligned with the idea of eco-tourism related to sustainable tourism practices [55], their average length of journeys is longer, and they are more loyal to their destination [56]. It was also found that Generation Z presents pro-sustainable tourism behaviors translated into economic, social, and environmental aspects [57,58]. However, there is also contradicting evidence. A recent study on younger tourists from Latvia, Lithuania, and Russia concluded that, although youths are mostly sustainable in their daily routines, they reveal weak sustainable behaviors while travelling, and their attitudes toward sustainable tourism are mainly related to the economic dimension [59]. A study in Turkey shows that aging raises both sustainable consciousness and sustainable tourism awareness [60]. Younger tourists also lack awareness and knowledge about the benefits of eco-tourism for local communities and the environment [61]. Pinho and Gomes [62] concluded that, although members of Generation Z reveal some interest in the SDGs and are concerned with choosing a sustainable destination, they do not care about keeping the destination sustainable or following pro-environment behaviors.

Women's role in promoting sustainability was recognized as early as 1999 in Agenda 21 for environmental sustainability, which acknowledged their specific environmental concerns and perspectives based on their social and biological roles [63]. Gender studies indicate that, compared to males, females are more socially responsible, are more empathetic, have higher levels of socialization, and have a stronger ethic of care and responsibility for environmental problems [64]. The psychology literature recognizes responsibility as a key determinant of sustainable tourism. Furthermore, a study demonstrated that men have a more selfish value orientation than women [65], a personal characteristic considered antagonistic to sustainable attitudes and behaviors [66]. Although few studies [67] have examined the impact of gender on sustainable tourism, the existing studies show that women play a greater role in promoting good practices [68], tend to be more confident about the reality and anthropogenic origin of climate change and as such are more concerned about

the impacts of climate change [69,70], have more vital sustainability values compared with men, and seek self-development through engagement with local communities [65].

3. Materials and Methods

3.1. Dataset

The data for our research came from the Flash Eurobarometer 499 conducted by the IPSOS European Public Affairs administered to a sample of individuals aged 15 years and above from the 27 EU member states [18] (GESIS, 2022). We intended to develop an intelligent classification system for European citizens according to their predisposition to contribute to sustainable tourism's environmental, social, and economic pillars. To this end, we used the fourth question (a) of the questionnaire, in which respondents are asked to indicate which of the ten proposed attributes they consider most important when choosing a destination to visit. These items were categorized into the three pillars of sustainability—environmental (four attributes), social (three attributes), and economic (two attributes). We excluded the fourth option concerning the price of the overall trip since it does not fit within the traditional framework of the three sustainability pillars. Thus, by using the nine items, we reached 19,785 valid answers. A description of the items used and how they were used in each sustainable dimension can be found in Table 1.

Table 1. Description of the variables of the dataset.

Variables Description			
'When Choosing a Destination to Visit, Which of the Following Aspects Are Most Important to You? Which One Is Your Top Priority?'	**Environmental Pillar**	**Social Pillar**	**Economic Pillar**
#1. The cultural offerings at the destination (museums, local events, gastronomy)			✓
#2. The natural environment at the destination	✓		
#3. The activities available at the destination			✓
#4. The total price of the trip		excluded	
#5. The accessibility of services and activities for everyone: children, elderly people, and people with disabilities		✓	
#6. The fact that the destination (city, region) promotes environmentally respectful practices	✓		
#7. The fact that the destination can be reached by environmentally low-impact transport	✓		
#8. The sustainability certification of accommodation and attractions	✓		
#9. The involvement of the local population in tourism activities		✓	
#10. The availability of clear health information and safety guidelines		✓	

3.2. Proposed Method

We propose a method that explores and classifies the respondents regarding the three pillars of sustainability. This methodology involved a three-step approach, as illustrated in Figure 1. Initially, we performed a descriptive analysis based on statistical techniques to examine the importance of each pillar considering both demographic factors, namely gender and age, and regional divisions within Europe. Subsequently, we employed advanced ML techniques, specifically a decision tree-based random forest algorithm, to classify these EU citizens into three classes: environmental, social, and economic. Finally, we employed generative artificial intelligence (AI) to generate automatic corrective measures to classify

citizens into the remaining sustainability pillars. These corrective measures encompass recommendations through which the tourist can engaged with the other sustainability pillars.

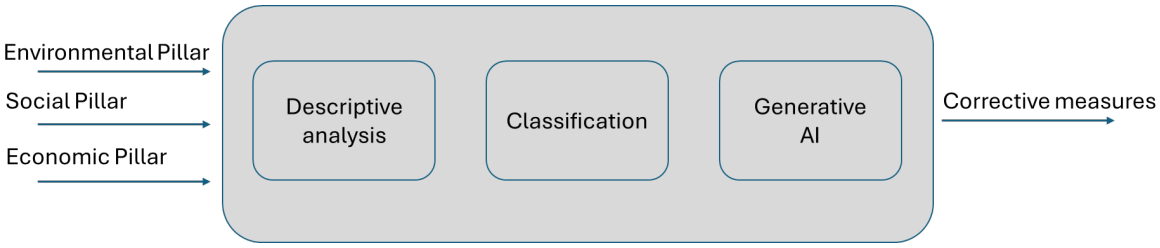

Figure 1. Proposed method.

Below is a brief description of each phase of the method employed.

1. Descriptive analysis. This step of the method examined the sustainability behaviors of the participants by calculating the percentages of sustainable practices across different demographics. The analysis started by analyzing the data by gender, revealing distinct trends in sustainability between males and females. Next, we separated the participants by age into generational cohorts. Following Koksal [71], we divided the participants' age into four generations to uncover generational differences in tourism sustainable behaviors: Generation Z (individuals born between 1995 and 2010); Generation Y (individuals born between 1980 and 1994); Generation X (respondents born between 1965 and 1979); and Generation BB (respondents born before 1965). Finally, we categorized the participants by European regions divided according to the four points of the compass: Northern (Denmark, Estonia, Finland, Ireland, Latvia, Lithuania, and Sweden), Southern (Cyprus, Greece, Italy, Malta, Portugal, and Spain), Eastern (Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovenia, and Slovakia), and Western Europe (Austria, Belgium, France, Germany, Luxembourg, and Netherlands). This allowed the identification of regional variations in citizens' future sustainability practices when acting as tourists. This descriptive analysis provided an overview of the contribution of respondents to the three pillars of sustainability when choosing a destination.

2. Classification. The second step relied on the random forest algorithm, a robust ML technique, to classify the respondents according to the sustainability pillars. The random forest algorithm constructs multiple decision trees during training and outputs the mode of the classes for classification tasks. It is an ensemble learning model combining multiple decision trees [72] to solve complex problems. By incorporating the various demographic factors (gender and age) and region of residence, the algorithm effectively classified the participants into the different pillars of sustainability. Classifying tourists into the three pillars of sustainability is crucial for understanding their ability to contribute to sustainable tourism. Our method involved offline processing where the data were divided into two sets: a training set and a test set. While the training set was used to develop the initial model, the test set was used to evaluate the quality of the classifications. The performance of these classifications was measured using standard evaluation metrics: classification accuracy and *F*-measure. Classification accuracy measures the overall performance of the ML model considering the number of true positives and negatives. In turn, the *F*-measure computed in both macro- and micro-averaging scenarios, assesses the model's effectiveness by combining precision and recall. Precision measures the percentage of correct classifications, while recall assesses the model's ability to correctly identify positive cases in the dataset. The combination of macro- and micro-averages provides a comprehensive evaluation of the model's performance across all target classes, either by assigning an equal weight to each class or considering them individually.

3. Generative AI. The last step relied on Open AI, which can potentially play a transformative role in generating intelligent corrective measures that actively direct tourists toward the remaining pillars of sustainability. When a respondent, for example, was classified under the economically sustainability pillar, generative AI could create intelligent

corrective measures to encourage their involvement in the social and environmental pillars. For the environmental pillar, AI could suggest eco-friendly accommodations or activities with a minimal environmental impact, such as hiking in nature or visiting eco-certified attractions, presenting these options in a way that appeals to the tourists' interest. For the social pillar, AI could promote activities that support the local community, like dining at locally owned restaurants or participating in local cultural events. By focusing on aligning sustainable AI-generated corrective measures that can gradually shift the tourists' focus to more holistic and responsible attitudes, this method integrates the economic, social, and environmental dimensions of sustainability.

4. Results and Experiments

We conducted offline experiments using a system equipped with the following hardware specifications:

- Operating System: Windows 64-bit.
- Processor: Intel(R) Core(TM) i7-8565U CPU @ 1.99 GHz.
- RAM: 16 GB.
- Disk: 500 GB SSD.

The experiments comprised (i) descriptive analysis, (ii) classification, and (iii) generative AI. While the classification models relied on scikit-learn from Python, generative AI employed OpenAI models.

4.1. Descriptive Analysis

The analysis focused on categorizing respondents into the three pillars of sustainability according to their gender, age (generation), and regions of residence within Europe.

Table 2 summarizes the main results. The results show that the least concern was shown for the social pillar, which was unanimous among the respondents. Furthermore, it is evident that the male respondents exhibited a stronger preference for attributes contributing to the economic pillar (38.54%), followed closely by the environmental pillar (37.95%). In contrast, females showed a more balanced distribution across the pillars, with a slightly higher emphasis on the social pillar (29.09%) than males (23.51%). Interestingly, the "Other" gender category placed the most significant importance on the environmental pillar (43.30%) and the social pillar (32.99%) and showed the least concern for economic aspects (23.71%). As for generation, older generations valued most of the attributes related to environmental preservation (38% and 40% for Gen X and BBs, respectively) and valued less those that contribute to the economic dimension (35% and 34% for Gen X and BBs, respectively). In contrast, when choosing a destination to visit, younger generations prioritized cultural offerings and available activities, in particular Gen Z (with a 5 percentage point difference from Gen Y), followed by attributes concerning environmental protection (35% for both generations). Respondents from Generation Z also showed the least concern for the social dimension (22%). Regarding the European region of residence, we noted that respondents from the West showed the greatest concern for the environmental pillar (44.33%) and the least for the economic pillar (30.86%). In contrast, participants from the Northern region prioritized economic sustainability (40.42%), indicating a more substantial concern with the destinations' cultural offering and available activities. Participants from the Eastern and Southern regions exhibited a more balanced focus across all three pillars, even though respondents from the East placed slightly more importance on the social pillar (28.26%) than those of the other regions. Figure 2 maps the regions according to the dominance of the sustainability dimension and highlights the difference among European regions concerning their residents' ability to become sustainable tourists.

Table 2. Number of respondents (percent) contributing to each of the sustainability pillars based on gender, generation, and region where they live (sample size of 19785).

	Environmental Sustainability	Social Sustainability	Economic Sustainability
Gender			
Male	3620 (37.95)	2243 (23.51)	**3676** (38.54)
Female	**3738** (36.83)	2952 (29.09)	3459 (34.08)
Other	**42** (43.30)	32 (32.99)	23 (23.71)
Generation			
Z	785 (34.89)	491 (21.82)	**974** (43.29)
Y	1828 (34.64)	1470 (27.86)	**1979** (37.50)
X	**2217** (37.58)	1609 (27.27)	2074 (35.15)
BBs	**2570** (40.42)	1657 (26.06)	2131 (33.52)
Region			
North	1542 (33.57)	1195 (26.01)	**1857** (40.42)
South	1383 (35.71)	1001 (25.85)	**1489** (38.45)
East	**2322** (35.94)	1826 (28.26)	2313 (35.80)
West	**2153** (44.33)	1205 (24.81)	1499 (30.86)

The highest absolute frequency is shown in bold.

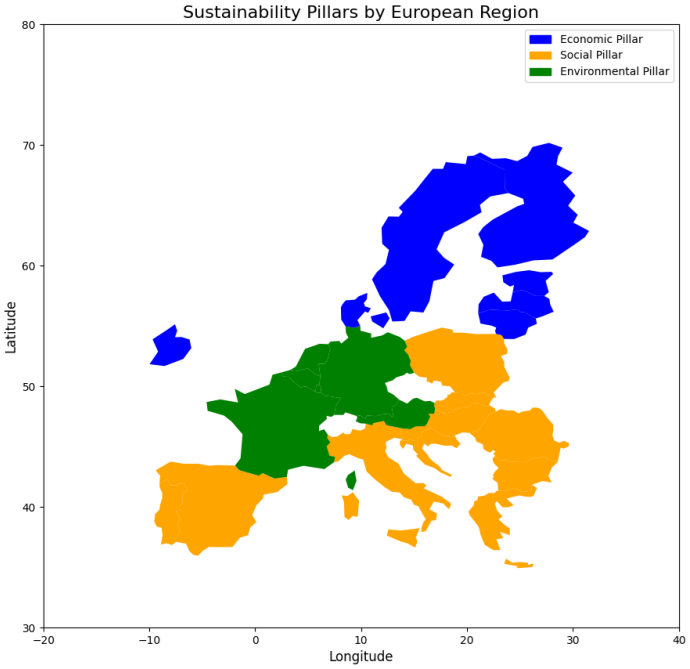

Figure 2. European map showing the sustainability pillars.

Even though the respondents who chose the trip total price as the primary attribute when choosing the destination to visit were removed from our analysis, we still found that around 20% of the respondents chose this option (ranging between 16% and 24% by generation, with a focus on the youngest, and between 17% and 21% by European region). We found that the value assigned by the respondents to the social dimension and the total price of the trip were very similar.

4.2. Classification

The classification of tourists into the three pillars of sustainability (environmental, social, and economic) was conducted using ML techniques based on age, generation, and region of residence. These data served as input features for the model, allowing it to predict which sustainability pillar a tourist was most aligned with. Class #0 represents respondents classified in the environmental pillar, while Class #1 stands for those classified

in the social pillar. Finally, Class #2 represents the economic pillar. Table 3 depicts the results of the classification.

Table 3. Performance of the classification.

Classifier	Accuracy	F-Measure			
		Macro	#0	#1	#2
Random forest	0.65	0.59	0.66	0.55	0.57

The performance shows an overall accuracy of 0.65, indicating that the model correctly classified 65% of the total samples. The macro F-measure is 0.59, which suggests that, on average, the classifier's performance across all classes is moderate but needs to be more balanced. The results suggest that the classifier performs better for specific classes, particularly for the environmental pillar. The exclusion of the trip's price, which was a highly valued item by the respondents, may explain the model's relatively low accuracy level.

4.3. Generative AI

After the intelligent classification system classifies the citizen as belonging to one of the pillars, a prompt is generated to be submitted to the Open AI API, which will direct the individual to the other two pillars with suggestions of attributes that best suit them. Thus, generative AI was used to obtain automatic corrective measures using OpenAI. By leveraging these corrective suggestions, OpenAI helps tourists appreciate the benefits of sustainability across all three pillars while still addressing their initial interests. Figure 3 presents a graphical summary of AI-generated recommendations for a citizen classified, for example, in the economic pillar.

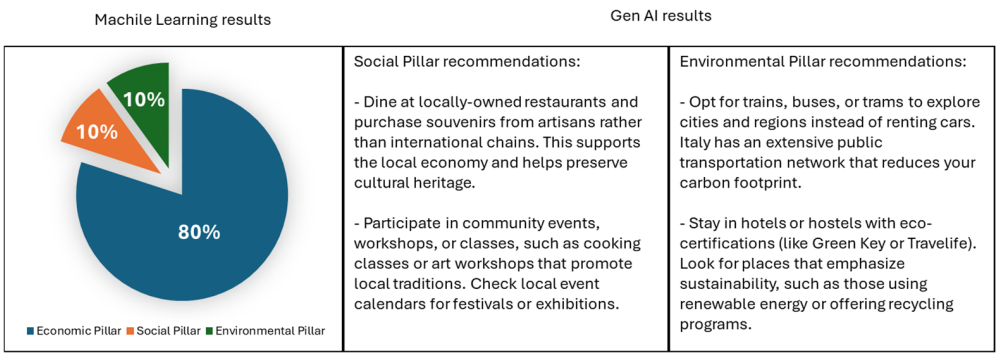

Figure 3. Graphical summary of AI recommendations.

The prompt and the results of this example can be described as follows.

Suppose a citizen is classified as primarily interested in the economic pillar. The AI system analyzes this classification and recommends personalized measures that help the individual to be equally involved in the environmental and social pillars. Based on our data, knowing that citizens prioritize cultural offerings and activities at the destination, the corrective measures can be:

Corrective measures for the environmental pillar include discounts on low-impact transport, discounts or loyalty programs for eco-certified hotels or restaurants, offering many outdoor activities, etc.

Corrective measures for the social pillar include low-cost or free cultural experiences that promote community engagement; local festivals; community-driven walking tours, which allow the tourist to explore the local culture and contribute to the local community's well-being; and volunteering tourism programs that allow tourists to engage directly with the local communities, etc.

5. Discussion

5.1. Discussion of Results

This study analyzed how EU citizens contribute to environmental, social, and economic sustainability when choosing a destination to visit, taking into account their demographic variables of gender and age (generation) and the European region where they live. Hence, an intelligent, sustainable classification system was developed. With 65% accuracy, the random forest algorithm classified respondents from the 27 EU countries into the three dimensions of sustainability (environmental, social, and economic) according to their gender, the generation they belong to, and their region of residence.

We were limited in our ability to compare our findings with those of other empirical studies. Although the database we used in this study has been used elsewhere [73–75], we applied a different methodology, making comparisons impossible. Nevertheless, whenever possible, we made fragmentary comparisons.

Our study provided interesting findings. Firstly, we found evidence that European participants are moderately committed to sustainable tourism, contrary to other evidence [73]. Although the overall analysis showed that around three-fifths of respondents choose their travel destinations based on environmental and social aspects, a separate analysis revealed that the social dimension is hardly considered. Indeed, of the three sustainability pillars, the social pillar aroused the least interest among the participants, contradicting the results of Richards [76]. Although this result is alarming, it is not unexpected, as the uprising of local populations against the tourism strategies pursued shows that the social dimension has been neglected. The same lack of interest in the social dimension of sustainable tourism is present among tourism researchers, who neglect the study of the social dimension [15]. We also realized that, when it comes to choosing a destination to visit, the attributes of the environmental and economic dimensions share, in general, the same interest among participants. It would be expected that environmental preservation in the touristic destination would be more valued since a recent survey from March 2024 showed that around four-fifths of European citizens believe in the negative impact that environmental deterioration has on their daily lives and their health and that embracing a circular economy and restoring nature are the most efficient ways of tackling environmental problems [77].

Secondly, expanding on earlier research regarding the individual determinants of sustainable tourism behaviors (e.g., [62,69]), we found evidence that demographic factors, gender and age, were significant predictors of the participants' predisposition to choose a sustainable tourism destination. Although the respondents generally showed less commitment to the social pillar, women and older people still showed a greater social awareness in their choices of a destination. The same pattern was found in support of the environmental and economic pillars, with younger respondents showing more interest in the cultural offerings and activities available in the destinations than in environmental preservation. Furthermore, members of Gen Z were less committed to the social dimension of sustainable tourism. These results corroborate the international evidence that women are more socially responsible and sociable and enjoy contact with host communities [58,65], as well as being more committed to protecting the environment [69]. Regarding age differences, our findings reinforce the lack of consensus in the literature on this subject, since while they are aligned with some empirical evidence [62,78], but they contradict those of others [65,79].

Third, we found some heterogeneity regarding the commitment to the three dimensions of sustainable tourism among citizens from different European regions. The environmental pillar was the most respected by Western European residents, who were also those who least valued available activities and cultural offerings when choosing a destination. Residents of Northern and Southern Europe make a greater contribution to the economic dimension of sustainable tourism. These findings align with international evidence stating that Western European economies are among the world's top innovative countries and show a remarkable commitment to environmental sustainability [80].

Lastly, although we excluded the trip price variable from our analysis, this attribute carries almost equal weight to or greater weight than the concern for the social dimension of

sustainable tourism, especially among younger people and those living in Southern Europe. Thus, tourists from some regions may prioritize cost over sustainability, reinforcing that price is still a determining factor when looking for a tourist destination and that tourists are not willing to pay more to visit sustainable destinations [46].

5.2. Limitations and Future Research Directions

A key strength of this study is its emphasis on the potential of using ML and AI to classify tourists based on their focus on the three pillars of sustainable tourism—economic, environmental, and social—and generates personalized recommendations that promote a more balanced engagement with all pillars. By addressing tourists' specific interests, intelligent corrective measures can be applied to promote more sustainable tourist behaviors. Despite its clear contributions, the present study has several limitations; so, the results should be interpreted cautiously. The findings cannot be generalized to all European citizens since the percentage of respondents by country was different, with citizens of some countries being underrepresented. A second limitation is related to data collection. The data were collected in October 2021 during the COVID-19 pandemic. People being somewhat conditioned in their movements may have biased some responses in favor of praising more attributes that contribute to their immediate well-being, such as the availability of activities at the destination. Moreover, we relied on secondary data from the Eurobarometer survey that are not collected periodically, preventing the analysis of a pattern of evolution. The third limitation relies on the fact that we used only one question (the fourth of the original questionnaire) with nine attributes to group respondents into the three pillars of sustainability. These statements may have been insufficient to capture all the dimensions. In other words, other attributes of the destinations should have been included. In this context, it would be interesting to extend the survey to include more attributes to measure the adherence to the three dimensions of sustainability in tourism and encompass more recent opinions and a representative sample from each of the 27 EU member states. Fourth, EU member states are economically, socially, and culturally very different from each other. Therefore, applying a survey to all citizens without considering these differences may bias the data. Thus, future research should explore these differences among countries and how they can impact citizens' sustainable attitudes. Moreover, future studies could also consider including economic and cultural factors unique to each European region to control for socio-economic variability that may influence the respondents' attitudes towards sustainable practices. We intend to explore the available socio-economic data to control for these regional differences, adding granularity to our analysis and addressing the potential confounding effects that might arise from cultural diversity. Finally, future work could use a more diverse set of machine learning models (e.g., support vector machines or gradient boosting) to provide a comparative analysis and improve the classification accuracy. Future work could also refine the classification models (which we used in this paper) with larger and more diverse datasets, as well as developing dynamic recommendation systems that adapt in real time to tourists' changing behaviors and preferences, thereby enhancing the impact of sustainability practices on a global scale.

5.3. Theoretical and Managerial Implications

This study significantly advances the theoretical understanding of the willingness and predisposition of European tourists to adopt sustainable practices across the three pillars—environmental, social, and economic—when choosing tourist destinations. By using AI to analyze demographic data and provide personalized suggestions for sustainable tourism, the study aims to develop actionable insights for promoting sustainability in the tourism sector. It addresses a specific gap by combining AI-driven recommendations with an analysis of attitudes toward sustainable tourism across demographic segments within the European Union. It is particularly relevant given the increasing focus on sustainability in tourism and the limited exploration of the social dimension of sustainable tourism in previous studies.

This research advances the field by introducing an AI-based approach to understanding and influencing sustainable tourism choices. It differs from previous studies by placing an equal emphasis on the social, environmental, and economic pillars, addressing the often overlooked social aspect of sustainable tourism and providing nuanced insights into demographic variations.

This work offers some implications for policymakers in the tourism sector. First, as we have seen, the European participants showed only a moderate inclination to contribute to sustainability in tourism, with the little importance assigned to the social dimension being worthy of highlight. Thus, although tourists' mindsets are changing, this is still far from what would be desirable and expected in 2024. Second, age and gender influence the tourists' commitment to sustainable actions. In this context, the little interest shown by Generation Z members in the social pillar seems worthy of note and concern. It is worrying that these young people will be the dominant tourist segment in the coming years. In this context, policymakers should focus on reinforcing campaigns to raise awareness among younger people about the damage that tourism can cause to local communities. Likewise, significant regional differences within European regions demonstrate that the EU is moving towards sustainability at different speeds. Finally, price continues to be a determining factor when choosing destinations, hindering the realization of sustainable tourism. Younger tourists and those from economically disadvantaged regions prioritize cost over sustainability, which, as an obstacle to sustainable tourism, must be carefully analyzed by those responsible for tourism policies. Labor policies that guarantee greater employability and income among young people and European policies that foster economic convergence among EU regions can be measures with a positive impact on sustainable tourism.

6. Conclusions

The contribution of this study is two fold: developing an intelligent classification system of European citizens' predisposition to contribute to the three pillars of sustainable tourism (environmental, social, and economic) when choosing a destination to visit, based on their gender, age, and region of residence, and generating intelligent corrective measures that allow citizens to be directed to the pillars where they have the lowest contribution. We found that European respondents, when choosing a destination to visit, show little concern for the pillar of social sustainability, and although they are concerned about environmental preservation, it competes with the cultural offer and the availability of activities at the destination. We also found that the willingness to contribute to the three pillars of sustainability differs by gender, age, and European region of residence.

In sum, achieving sustainable development is a marathon, not a sprint. Analyzing sustainable development in the context of tourism is crucial in this long stage. Although the tourism sector has shown resilience and the ability to change in favor of a greater good for all, there is still a long way to go.

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