

**Tourism Sustainability Index to Create a Roadmap of
Sustainable Tourism in São Miguel, Azores**

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Abstract

Nowadays tourism has been growing exponentially all over the world and the Azores Archipelago is no exception to this phenomenon, especially the island of São Miguel. With this rapid and strong growth of tourism, everyone can unmistakably see that the increase of touristic pressure on the current tourism resources contributes to their degradation and overload, making the management of mechanisms a necessity in the insurance of both the quality of the touristic experience and the longevity of the resources. Consequently, the present dissertation will take a major focus on a proposal for a general tourism sustainability index, since there is a gap in the literature review it was not available in an insular context. Firstly, a Benchmarking of several EarthCheck-certified tourist destinations was carried out, so that the actions present in each action plan could be taken to understand how they stood out from one another. Next, the general sustainability index was carried out through the M-MACBETH, which included a set of indicators. Using this index, the evolution of the Azores from 2016 to 2020 and how it ranks in relation to other tourist destinations were analyzed.

Based on the evaluation of the Azores through the sustainability index, it was observed that there was an improvement of the same from the year 2016 to 2019 and that the Azores stands out in relation to other tourist destinations. With this, a set of guidelines was proposed to be implemented in the Azores in order to further improve the performance of the sustainability index.

Keywords: Sustainability, Tourism sustainability, Multicriteria Analysis

Resumo

Atualmente, o turismo tem vindo a crescer exponencialmente em todo o mundo e o arquipélago dos Açores não é exceção, especialmente a ilha de São Miguel. Com este rápido e forte crescimento do turismo, é fácil perceber que a crescente pressão turística sobre os atuais recursos turísticos contribui para a sua degradação e sobrecarga, tornando os mecanismos de gestão necessários para assegurar tanto a qualidade da experiência turística como a longevidade dos recursos. Nesta sequência, a presente dissertação centra-se na proposta de um índice geral de sustentabilidade do turismo, sendo uma lacuna na revisão da literatura, uma vez que não estava disponível num contexto insular. Em primeiro lugar, foi realizado um Benchmarking de vários destinos turísticos certificados pela EarthCheck, de modo a que as ações presentes em cada plano de ação pudessem ser retiradas para compreender como se distinguiam umas das outras. Em seguida, o índice geral de sustentabilidade foi levado a cabo através do M-MACBETH, que incluiu um conjunto de indicadores. Utilizando este índice, foi analisada a evolução dos Açores de 2016 a 2020 e como estes se posicionam em relação a outros destinos turísticos.

Com base na avaliação dos Açores, através do índice de sustentabilidade, observou-se que houve uma melhoria do mesmo desde o ano 2016 até ao ano 2019 e que os Açores se destacam em relação a outros destinos turísticos. Com isto, foi proposto um conjunto de orientações a implementar nos Açores, a fim de melhorar ainda mais o desempenho do índice de sustentabilidade.

Palavras-chave: Sustentabilidade, Sustentabilidade do Turismo, Análise Multicritério

Table of Contents

Acknowledgments.....	I
Abstract.....	II
Resumo	III
Table of Contents	IV
List of Figures	VI
List of Tables	VII
List of Acronyms	VIII
1 Introduction	1
1.1 Context	1
1.2 Dissertation Goal	2
1.3 Structure of the Dissertation	2
2 Tourism.....	3
2.1 Tourism in Portugal	3
2.2 Tourism in the Azores.....	4
2.3 Tourism in São Miguel.....	10
2.4 Challenges and Opportunities of Tourism in São Miguel	13
2.5 Contextualizing the problem	14
2.6 Chapter Conclusion	14
3 State of the Art.....	15
3.1 Sustainability	15
3.2 Tourism Sustainability	17
3.2.1 Sustainable Tourism Indicators.....	21
3.2.2 Sustainable Tourism Certifications.....	23
3.3 Tourism Management Tools.....	24
3.4 Decision Support Methods	29
3.5 Chapter Conclusion	31
4. Methodology	32
Step 1 – Benchmarking	32
Step 2 – Multicriteria Analysis	33
Step 3 – Guidelines Proposal	35
5 Results.....	36
5.1 Benchmarking.....	36
5.1.1 Baião Municipality, Portugal.....	36
5.1.2 Melgaço Municipality, Portugal	38
5.1.3 Nuuk, Greenland	40
5.1.4 Rottneest Island, Australia	42
5.1.5 Azores, Portugal.....	43
5.1.6 Benchmarking Conclusions.....	46

5.2	Multicriteria Analysis	48
5.3	Guidelines Proposal	63
5.3	Limitations	67
5.4	Chapter Conclusion	67
6	Conclusions & Future Work	68
6.1	Final Conclusions	68
6.2	Future Work.....	69
	Bibliography	70

List of Figures

Figure 1: Number of overnight stays per year in million in Portugal	3
Figure 2: Passengers Arriving in the Azores	5
Figure 3: Methodology Steps.....	32
Figure 4: Stages of Multicriteria Analysis.....	33
Figure 5: Value Tree	55
Figure 6: Histogram obtained for the criterion weigh	57
Figure 7: Overall values of each option	57
Figure 8: Differences between the years 2019 and 2016	58
Figure 9: Sensitivity analysis on Indirect Emissions criterion	59
Figure 10: Sensitivity analysis Assault Rate criterion	59
Figure 11: Sensitivity analysis Unemployment criterion	60
Figure 12: Histogram obtained for the criterion weigh	61
Figure 13: Sensibility Analysis to the Nitrous Oxide Produced criterion	62
Figure 14: Sensibility Analysis to the Homicide Rate criterion.....	62

List of Tables

Table 1: Total number of overnight stays in the Azores	5
Table 2: Classification of touristic activities	6
Table 3: Action Plans in order to achieve the objectives intended	8
Table 4: Total number of overnight stays in São Miguel and change from 2015 to 2021.....	11
Table 5: Types of touristic resources available in the island of São Miguel	12
Table 6: Concepts of sustainable tourism.....	18
Table 7: Principles for Sustainable Tourism	19
Table 8: Dimensions and indicators of the present literature.....	22
Table 9: Indicators for assessing TCCI in Naxos Island	26
Table 10: Single Criteria Synthesis methods.....	30
Table 11: Benchmarking Summary	47
Table 12: Key performance areas of each criterion.....	54
Table 13: Table of Performances	55
Table 14: Ordination of the criteria in a descending order of attractiveness.....	56
Table 15: Table of performances.....	61
Table 16: Ranking of the options	61
Table 17: Percentage of overnight stays in São Miguel	63
Table 18: Categorization of indicators by evolution	64
Table 19: Existing actions for the respective indicators.....	65
Table 20: Actions to be added to the Action Plan of the Azores.....	66

List of Acronyms

- GSTC:** Global Sustainability Tourism Council
- MMAD:** Multicriteria Methodology Aid for Decision
- INE:** National Institute of Enumeration
- SREA:** Regional Service of Enumeration of the Azores
- RAA:** Region Autonomous of the Azores
- RevPAR:** Revenue per Available Room
- BTT:** All Terrain Bicycle
- PEMTA:** Strategic and Marketing Plan for Tourism in the Azores
- IPDT:** Portuguese Tourism Institute
- SME:** Small and Medium Enterprises
- DMO:** Destination Management Organization
- KPA:** Key Performance Area
- POTRAA:** Tourism Planning Program of the Azores Autonomous Region
- PNI:** Natural Island Parks
- NGO:** Non-governmental Organizations
- UN:** United Nations
- UNESCO:** United Nations Educational, Scientific and Cultural Organization
- UNTWO:** United Nations Tourism World Organization
- STCRC:** Australian Government Sustainability and Tourism Cooperative Research Centre
- ECSE:** Environmental Culture of Social Economics
- ASI:** International Accreditation Services
- CPE:** Comprehensive Performance Evaluation
- MST:** Measurement of Sustainable Tourism
- KPI:** Key Performance Indicator
- TCCI:** Tourism Carrying Capacity Index
- PSR:** Pressure-State-Response
- EFA:** Ecological Footprint Accounting
- TSDI:** Sustainable Tourism Development Index
- MODM:** Multi-Objective Decision Making
- TOPSIS:** Technique for Order of Preference by Similarity to Ideal Solution
- UTA:** Utility Theory Additive
- EVAMIX:** Evaluation of Mixed Data
- MAUT:** Multi-Attribute Utility Theory
- MAVT:** Multi-Attribute Value Theory
- AHP:** Analytic Hierarchy Process
- DM:** Decision Makers
- V2G:** Vehicle to Grid
- OTA:** Azores Tourism Observatory
- PY:** Person Year

1 Introduction

First and foremost, it will be presented the primary chapter which contains the introduction and the motivation for this Master's thesis. This chapter is divided into three sections. Section 1.1 is the contextualization of the problem that led to the development of this dissertation, section 1.2 represents the objectives and last, but not least, section 1.3 presents the structure, as well as a brief explanation of each of the chapters of this dissertation.

1.1 Context

In Portugal, tourism has been increasing in a vast manner over the last nine years, and the Azores has also been affected by this phenomenon, even more the island of São Miguel. The liberalization of airspace in the Azores in 2015 made the allowance for new airlines to enter the Portuguese territory, and the possibility of new routes being taken, thus improving the growth of tourism in the archipelago (Pinto, 2021). The increase in tourist flow in recent years represents not only an increase in economic flow in the Azores but also a constant concern in the adoption of standards and measures that enhance and preserve tourist environments. By managing tourist intensification, massification can be preserved. The Azores have a huge variety of natural, historical, and cultural resources that make them a privileged territory, which is why they have invested in initiatives focused on the protection and prevention of environmental, social and economic resources. Following this, in 2019, São Miguel became the first archipelago in the world to be certified as a sustainable touristic destination through a process accompanied by EarthCheck, an entity accredited by the GSTC (Global Sustainable Tourism Council). São Miguel is the main island of the Azores, possessing the largest number and diversity of tourism resources and infrastructures, greater accommodation capacity, and therefore this island can more easily meet any demand (Regional Directorate of Tourism, 2019). The degradation and increased significant pressure on the natural and touristic resources due to the increase in touristic flows is one of the biggest challenges of sustainable tourism, leading to negative impacts that, if not minimized and mitigated, could be very damaging for the future of tourism.

Furthermore, the intense growth of tourism, enables us to easily see that the increase in touristic pressure on the current tourism resources contributes to the degradation and overstress of the land, consequently making the management of mechanisms a necessity to guarantee the quality of the tourism experience, the longevity of the resources, and the reduction of negative impacts.

These mechanisms include not only the environmental component, but also the social and economic part, which are fundamental for a sustainable long-term tourism development.

Therefore, this dissertation aims to contribute to the optimal management of the continuous growth of tourism in the Azores, in particular São Miguel island, through the creation of instruments that make it possible to monitor and create a review of the set of measures and actions that would potentially contribute to the practice of more sustainable activities in this highly touristic destination.

1.2 Dissertation Goal

The main objective of this Master Thesis is the design of an overall tourism sustainability index and the proposal of a set of measures and actions that should be implemented in São Miguel. This proposal of measures and actions aims to minimize the harmful impacts caused by the increase in touristic flow that leads to the degradation and overstress of the current touristic resources, as well as to a decrease in the quality experience held by the tourists and the local community.

The overall Tourism Sustainability Index contributes to an easier monitoring of the performance of destinations and in addition to a comparison between the several destinations.

In order for this to happen, this essay has the following intermediate purposes:

- Firstly, the supervision of a benchmarking to extract the actions carried out by some of the EarthCheck-certified tourism destinations and compare them with the current sustainability practices adopted by the Azores;
- Secondly, the creation of a general tourism sustainability index through a Multicriteria Analysis, in which the Multicriteria Decision Support Methodology (MMAD) will be carried out, using the MACBETH method with the M-MACBETH decision support system. This analysis will be divided into two parts: the analysis of the evolution of touristic sustainability in the Azores and how the Azores is positioned about a set of destinations, regarding this index.
- Thirdly, a proposal for actions to be made in order to obtain more sustainable tourism. Taking into account the information gathered in the Benchmarking and the results of the multicriteria analysis carried out in the previous two phases.

1.3 Structure of the Dissertation

This dissertation consists of 6 chapters. The first chapter corresponds to the introduction to this Master's thesis, as well as its aims and structure. Chapter 2 is dedicated to the contextualization of tourism in Portugal, Azores, and in island of São Miguel, as well as the sustainability associated with the Azores' destination. It also includes the challenges and opportunities of tourism in São Miguel and the contextualization of the problem that gave rise to this dissertation. Chapter 3 is an extensive literature review, firstly on the subject of "sustainability", then on "tourism sustainability", the different indicators for assessing it, and the various existing sustainable tourism certifications. In this chapter, there will be an introduction to the management tools and decision support methods used in tourism. Chapter 4 presents the detailed methodology. Chapter 5 presents the results arising from all the stages of the applied methodology, as well as their discussion. Finally, the conclusions and future work will be addressed in chapter six.

2 Tourism

This chapter aims to provide background information on the evolution of tourism in Portugal and the Azores, and how tourism growth can affect sustainability.

This chapter starts with the evolution of tourism in Portugal (Section 2.1), followed by tourism in the Azores and the sustainability issues in the Region (section 2.2). Next, a summary of tourism in São Miguel is tackled (Section 2.3), presenting the structure of tourist and natural resources and the implications of the increase in tourism on the island. The opportunities and challenges of tourism in São Miguel (Section 2.4) and the contextualization of the problems are addressed in this dissertation (Section 2.5) and, finally, a conclusion on what was discussed in this chapter (Section 2.6) is presented.

2.1 Tourism in Portugal

Tourism is the main sector of the Portuguese economy, playing a very important role in generating employment and wealth (Carvalho, 2022). Portugal takes advantage of its privileged position on the map and its cultural and landscape diversity, as a means to attract a large number of tourists every year (Portal Diplomático, n.d.)

Over the last nine years, Portugal has recorded an annual growth rate of 7.2% in overnight stays, therefore a growth from 37 million overnight stays in 2010 to 70 million in 2019, this being the highest value ever recorded. Concerning tourism revenue, the average annual rate of change was 10.3% in the last nine years, rising from 7.6 billion in revenue in 2010 to 18.4 million in 2019 (Turismo de Portugal, 2022b). Through observation of figure 1, it is possible to look at the evolution of overnight stays between the years 2013 and 2021. It should be noted that there was an increase until the year 2019 and a very large decrease in 2020 and 2021 due to COVID-19.

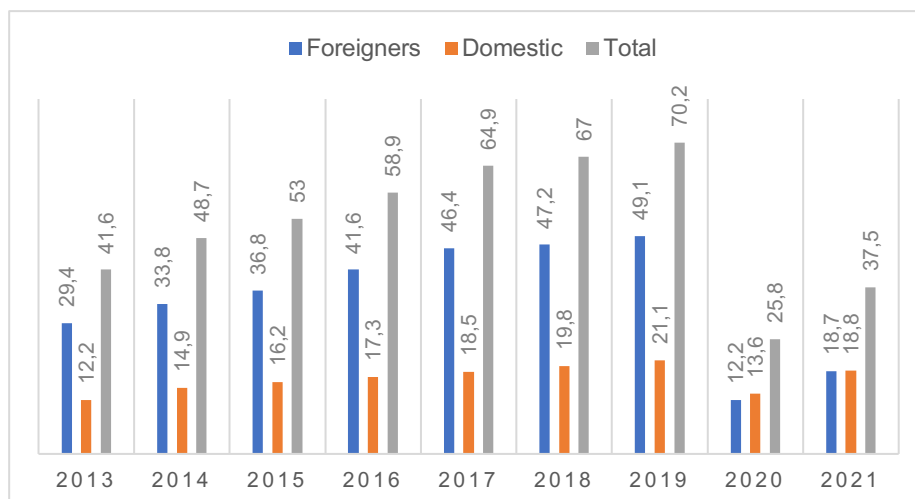


Figure 1: Number of overnight stays per year in million in Portugal

Source: INE

In 2019, Portugal was considered the 15th global destination by the World Tourism Organization Barometer (Governo de Portugal, 2020) but in the next year, 2020, due to COVID-19, tourism suffered

a major recession with only 25,8 million overnight stays registered in Portugal with only 12,2 million being foreigners (TravelBI, 2022a). There was a decrease from the previous year of -61.6% concerning the overall number of guests and -75.1% concerning the number of foreign guests (TravelBI, 2022b).

In 2021, the effects of the pandemic by COVID-19 are still evident, however, Portugal registered a slight recovery in demand with an increase of 44,7%, compared to the previous year, in the accommodation for tourists. Regarding international demand, there was an increase of 53%, compared to 2020 (TravelBI, 2022c). The signs of recovery in the domestic market are close to the numbers recorded in 2019. The percentage of the total number of overnight stays in touristic accommodation was 50.2% related to the domestic market, with 18.8 million overnight stays, being equivalent to -10.9% compared to 2019. Regarding revenues, an increase of 28.9% was recorded compared to 2020, indicating an increase of €2.2 billion for the economy in 2021 (INE, 2022).

In the current year of 2022, 1,577.7 thousand guests and 4,023.3 thousand overnight stays have already been registered in the month of March, representing an increase of 464.1% in guests and 543.2% in overnight stays compared to March 2021. Compared to March 2019, there was a decrease of 15.3% for guests and 12.7% less for overnight stays (INE, 2022).

The growth and improvement seen until 2019 were due to the Strategy for Tourism 2027, with concrete objectives that aimed to promote and boost tourism in Portugal (Cabral, 2017).

The vision of the 2027 Tourism Strategy is based on the statement "Tourism as a hub for economic, social and environmental development throughout the territory, positioning Portugal as one of the most competitive and sustainable tourist destinations in the world", so the 2027 Strategy sets goals in each of the three pillars of sustainability, Environment, Society and Economy (Cabral, 2017).

As Portugal is a quality destination for tourists, it focuses in its competitive advantage through the principles of sustainability, in the diversity it offers, and in the valorization of its innovative characteristics (*Sustentabilidade e Turismo*, 2022).

Considering that the present paper focuses on the Azores, the following section will reveal in detail the situation occurring in the Region in regards to tourism.

2.2 Tourism in the Azores

The Autonomous Region of the Azores is an archipelago containing 9 islands in total. The islands are Santa Maria, São Miguel, Terceira, Graciosa, São Jorge, Pico, Faial, Flores, and Corvo, and a total of 236 657 thousand inhabitants. The largest island is the São Miguel island with 744.6 km^2 and 133 390 thousand habitants, Corvo is the smallest with 17.21 km^2 and with only 386 habitants (SREA, 2021b). The eastern group of the archipelago includes São Miguel and Santa Maria, the central group includes Terceira, Graciosa, São Jorge, Pico and Faial, and the western group includes Flores and Corvo.

Tourism in the Azores suffered a period of stagnation until 2015, i.e. tourism demand grew only slightly, due to challenges related to air accessibility and the qualification of the human resources of the archipelago (IPDT, 2020a). With the liberalization of the airspace in the Azores in 2015, the entry of new airlines and the attraction of new routes were allowed, thus improving the growth of tourism in the archipelago (Pinto, 2021).

Figure 2 shows the evolution in the number of passenger arrivals in the Autonomous Region of Azores, RAA, which is then reflected in an increase in tourism.

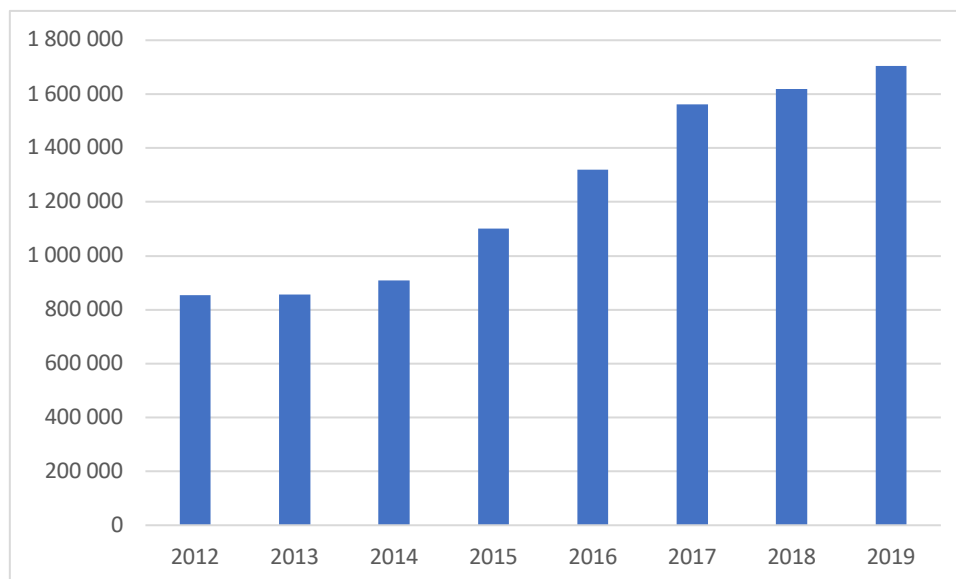


Figure 2: Passengers Arriving in the Azores

Source: SREA

Many indicators are used to measure the evolution of tourism and some of the most important are: the number of guests, number of overnight stays, RevPAR (Revenue per available room), income in hotel establishments, bed occupancy rate, room occupancy rate, number of passengers disembarked by air and sea, seasonality and the number of average stay (IPDT, 2020b). However, the number of overnight stays per day/month/year, is the most accurate and realistic metric to control the evolution of tourism, as it represents the "Stay of an individual in an accommodation establishment, for a period between 12 hours of one day and 12 hours of the next day" (INE, 2020) and allows a better perception of the impact of tourism in the Region.

Table 1 reflects the evolution of the total number of overnight stays in the RAA, in all types of tourist resorts.

Table 1: Total number of overnight stays in the Azores

Year	Type of Tourist		Total	Variation (%)	Source
	Nacional	Foreigner			
2015	652 902	895 487	1 548 389	-	(SREA, 2016)
2016	824 455	1151 628	1 976 083	21,64	(SREA, 2017)
2017	981648	1402 409	2 384 057	17,11	(SREA, 2018)
2018	1 045 200	1 518 440	2 563 640	7,01	(SREA, 2019)
2019	1 222 039	1787 806	3 009 845	14,82	(SREA, 2020)
2020	574 974	291 247	866 221	-247,47	(SREA, 2021)
2021	1 148 903	742 096	1 890 999	41,64	(SREA, 2022)

From Table 1, it is possible to see that from 2015 tourism was increasing until the maximum observed value of total overnight stays, 3 009 845 million in 2019, the year that the RAA reached its peak. From

2020, there was an exponential decrease of -247.47 % compared to 2019, due to the global pandemic COVID-19, which brought great challenges to the development of tourism in the region. In 2021, the total number of overnight stays increased as well, showing that the Region is managing to recover from the pandemic.

The Azores offer a set of products that meet the ever-increasing demand from tourists arriving in the region, these being (1) Nature Tourism; (2) Nautical Tourism; (3) Cultural and Landscape Tourism; (4) Health and Well-being; (5) Sun and Sea; (6) Congresses and Incentives and (7) Golf. These products are divided into three categories: i) priority products; ii) complementary products and, finally, iii) secondary products.

Nature Tourism is the priority product because it is the most consolidated in the region and therefore the core product of the Azores. Nautical Tourism, Cultural and Landscape Tourism, and Health and Well-being are complementary products, and Sun and Sea, Congresses and Incentives, and Golf are secondary products. The definition of the products at these three levels was based on the stakeholders' perspective and aims to strengthen Natural Tourism as the center of tourism development in the Azores, its complementarity between islands, and the enhancement of the tourist experience (IPDT, 2020b).

Table 2 classifies each activity into each of the types of tourism existing in the Azores (IPDT, 2020b).

Table 2: Classification of touristic activities

Source: (IPDT, 2020b)

Priority Products	Nature Tourism		
	Walking / Hiking Equestrian Walks Biosphere Reserve Tourism in Rural Areas Birdwatching Geotourism	BTT Canoeing / kayaking Canyoning Downhill Paragliding Abseiling and climbing Trekking	
Complementary Products	Nautical Tourism	Cultural and Landscape Touring	Health and Wellness
	Cruises Boat trips Whale watching Yachting Diving Sport fishing Surf and Bodyboard Sailing Windsurfing	Culture Events / Entertainment Gastronomy and Wine Heritage World Heritage Religion	Thermal waters
Secondary Products	Sun and Sea	Congresses and Incentives	Golf

As expected, the evolution and growth of each tourism resource associated with a type of tourism can cause effects that can have negative repercussions if regulation and management of the tourism resource are not properly addressed.

Further below, reference will be made to touristic resources centered on the island of São Miguel which, due to their strong popularity, may undermine the safeguarding and management of the touristic resource itself (IPDT, 2020b).

2.2.1 Azores Strategic and Marketing Plan for Tourism

The Strategic and Marketing Plan for Tourism in the Azores (PEMTA) was drawn up by the Portuguese Tourism Institute (IPDT) to provide specific guidelines and define intentions and measures to develop a tourism model focused on sustainability. The aim is to improve the tourism experience and performance and quality of activities linked to the tourism sector, as well as to make good use of the available tourism enterprises, enhancing their value so that maximum use can be made of them without compromising their future exploitation (IPDT, 2020b).

To this end, PEMTA has defined a set of priorities that include the development of the destination in a sustainable manner, support for entrepreneurs in the recovery of the sector after the crisis imposed by COVID-19 development of the region's attractiveness with a strategy of complementarity between the Azorean islands. This strategy focuses the marketing effort on attracting high-value markets and diversifying demand, as well as strengthening cooperation with the appropriate means and channels of communication and distribution, and finally, developing partnerships with the various economic agents (IPDT, 2020b).

The strategy defined seeks to achieve four objectives: O1) Improving and enriching the tourist experience for visitors; O2) Contributing to the preservation of natural and cultural areas; O3) Contributing to the economic development of the Azores; O4) Improving the performance of tourist activities (IPDT, 2020b).

To achieve the above objectives and the intended vision, the Region will implement a set of four action programs consisting of a set of targets present in table 3. Program 1 (P1) is focused on the qualification of the tourism offer, program 2 (P2) on the prevention of the territory, program 3 (P3) on the communication of the destination and program 4 (P4) is Destination and Market Monitoring.

Table 3: Action Plans in order to achieve the objectives intended

Source: (IPDT, 2020b)

P1	P2	P3	P4
<p>1. Innovation and modernization of Tourism Offices;</p> <p>2. Creation and Implementation of Multimedia Tourism Information Kiosks in historical centers and main tourist sites;</p> <p>3. Training/qualification of the public and private sector for service quality and differentiation in the Azores;</p> <p>4. Campaign to raise public awareness of the importance of tourism;</p> <p>5. Integrating 'educating for tourism' content in the 1st and 2nd cycle citizenship course in schools in the Azores;</p> <p>6. Improve and innovate the infrastructures and support facilities for activities related to the Region's strategic tourism products;</p> <p>7. Identification, diagnosis and evaluation of regional resources with potential for tourism and their geo-referencing based on the activities defined for each product;</p> <p>8. Creation of an institutional newsletter;</p> <p>9. Creation of a tourism investment support manual, presenting opportunities and specific needs of the territory;</p> <p>10. Digital Marketing training programme for SMEs - selling the Azores online.</p>	<p>1. Identification of cases of good practice in the region and development of a guide of good practice for regional tourism;</p> <p>2. Using the Azores Brand as a certificate of environmental quality in the tourism sector;</p> <p>3. Cleaning and maintenance of the Touristic Spots;</p> <p>4. Rehabilitation and maintenance of historic centers and improvement of the urban environment of cities and towns in the Azores;</p> <p>5. To promote, encourage and reward the implementation of good practices that bring together the three levels of sustainable development: economic, environmental and socio-cultural;</p> <p>6. Energy efficiency and the use of renewable energies in tourist enterprises;</p> <p>7. Energy efficiency, intelligent energy management and use of renewable energies in public infrastructures that support tourism.</p>	<p>1. Development of Promotional Material</p> <p>2. Development of Marketing Campaigns with tour operators</p> <p>3. Organization of Famtrips with tour operators</p> <p>4. organization of Presstrips for the production of reports/news</p> <p>5. Organization of Fairs and meetings with operators</p> <p>6. Carrying out of charm shows - Roadshows on the destination's tourism products in partnership with airlines, Aicep Global, businessmen and tourism operators (Portugal's Agency for Foreign Trade and Investment)</p> <p>7. Organization of events</p> <p>8. Organization of the Promotional Campaign "I'm in the Azores</p> <p>9. Increase public relations, advertising and digital marketing</p> <p>10. Marketing campaigns with Airlines</p> <p>11. Exchange program between the Region and the Azorean population in the Diaspora</p>	<p>1. Creation of a map of statistics of the characteristic and related sectors that will allow the monitoring of the destination's performance and the implementation of the options and actions until 2020;</p> <p>2. Monitor the development of support infrastructures for tourism products, enhancing each island's offer based on existing resources;</p> <p>3. Monitor visitor satisfaction;</p> <p>4. Monitor the satisfaction of the population and trade (regional and international);</p> <p>5. Monitor and evaluate the new transport model for the region and between islands;</p> <p>6. Monitoring global trends in travel and tourism: creating an evolutionary map;</p> <p>7. Monitoring travel preferences and habits of relevant and high potential source markets: creation of an evolutionary map;</p> <p>8. Monitoring of destination notoriety in priority international issuing markets.</p>

To monitor the implementation of the actions defined above and to evaluate the objectives, PEMTA also focuses on defining the implementation management structure to achieve a more independent and impartial evaluation.

A set of control indicators were presented regarding tourism demand and supply, the development of infrastructure to support tourism products, the satisfaction of visitors, residents, and tour operators, transport to and from the island, and overall tourism demand. These indicators include the number of guests, overnight stays, average stay, number of accommodation units, catering establishments, passenger flow by any means, and level of recognition of the destination, among many others. All these indicators are essential for the monitoring and follow-up of the respective action plan, to evaluate the implementation of the actions and the strategy defined in the current plan (IPDT, 2020b).

With this, and to give this monitoring continuity, the next section will talk about tourism sustainability in the Azores. Namely, what has already been done, how it has been done, and what will need to be done moving forward.

2.2.2 Sustainability of tourism in the Azores

The Azores has an enormous variety of natural, historical, and cultural resources that make it a privileged territory, which is why numerous proposals focused on the protection and prevention of the environment have been requested. A big emphasis on social and on economics has been insured in means to attain more sustainable resources. The increase in touristic flow in the most recent years embodies not only an increase in the economic flow but also a constant concern on the part of the destination in regard to the adoption of norms and measures that value and preserve tourist environments, managing tourist intensification, and preventing massification. Given the growing concern for the conservation and prevention of the destination, the Region assumed the commitment to be Certified as a Sustainable Tourism Destination credited by the GSTC criteria and, therefore, assumes a continuous improvement of its objectives and actions.

In 2019, the Azores then became the first archipelago in the world to be certified as a sustainable tourism destination, through a process accompanied by EarthCheck, an entity accredited by the GSTC. Being certified, allows the Region to assert itself as a world reference territory in the indicators of evaluation. (DMO, 2021)

To respond to the growing importance concerning the tourism sustainability of the Azores Destination, the Government created, in 2018, the Azores Tourism Destination Sustainability Management Structure (Azores DMO), one of its missions being to monitor and manage the procedures necessary for the certification of the destination by EarthCheck. The DMO made official and streamlined the strategies, objectives and commitments made in this theme through the Sustainability Management Policy. Consequently, 12 key action areas (KPA) were selected to create measures and to implement them, so that the Azores could become a sustainable tourism destination reference. Each KPA is associated with actions that will be developed throughout the region, to achieve the best results regarding sustainability standards (DMO, 2021).

The 12 KPA's are:

- Energy Efficiency
- Drinking Water Resources
- Solid Waste
- Greenhouse Gases
- Protection of the ecosystem and biodiversity
- Environmentally Harmful Substances
- Air quality, noise control and light pollution
- Land use planning
- Society and Culture
- Wastewater
- Transport
- Economy

Monitoring the environmental, social, cultural, and economic performance of the Azores tourist destination is key to improving and achieving the sustainability targets set out in the Azores DMO Action Plan. To improve and achieve the sustainability goals proposed in the Action Plan, it is necessary to monitor the social, cultural, and economic performance of the destination. To this end, it is important to create data collection mechanisms that allow answers to be given to the selected indicators (IPDT, 2020b).

The mechanisms considered are (1) Regulatory meetings with key members of the Azores tourism structures (Green Teams), (2) Analysis of the evolution of environmental, social, cultural, and economic indicators and performance, as well as on the state of sustainability of the destination by the Advisory Committee and Monitoring Committee, (3) Resident Surveys, (4) Visitor Surveys and (5) Use of data from the National Institute of Statistics and the Regional Office of Statistics of the Azores, relating to the main areas of EarthCheck certification, to monitor the evolution of these and control the degree of compliance with the targets set (IPDT, 2020b).

Since this dissertation will focus specifically on the tourism sustainability of São Miguel Island, it is necessary to address the evolution of tourism on the island, the tourism resources available, and how they are monitored. The following section undertakes this task.

2.3 Tourism in São Miguel

São Miguel is the main island of the Azores which has the largest number and diversity of tourist resources and infrastructures, greater accommodation capacity, and therefore easier to meet demand (Direção Regional do Turismo, 2019).

It is on this island that the main airport of the region, João Paulo II Airport, is located, therefore receiving the largest number of flights and consequently the largest number of tourists per year, being the main gateway to the archipelago.

Tourism in São Miguel has been increasing intensely, especially since 2015, through the growth in the number of passenger arrivals, by air and sea, and the number of overnight stays (IPDT, 2020b). Table

4 reflects the evolution of the total number of overnight stays in São Miguel island from 2015 until 2021, in any type of tourist resort, as well as the variation of the total number of overnight stays concerning the previous year.

Table 4: Total number of overnight stays in São Miguel and change from 2015 to 2021

Year	Type of Tourist		Total	Variation (%)	Source
	Nacional	Foreigner			
2015	410 504	636 485	1 046 989	-	(SREA, 2016)
2016	528 548	762 856	1 291 404	18,93%	(SREA, 2017)
2017	635 712	969 642	1 605 354	19,56%	(SREA, 2018)
2018	657203	1 039 848	1 697 051	5,40%	(SREA, 2019)
2019	783 012	1 290 270	2 073 282	18,15%	(SREA, 2020)
2020	333 364	200 342	533 706	-288,47%	(SREA, 2021a)
2021	686 689	526 247	1 212 936	56,00%	(SREA, 2022)

Similarly, to the evolution of tourism in the RAA, it is possible to see, through table 4, that from 2015 tourism was increasing until the maximum observed value of total overnight stays, 2 073 282, in 2019, being this number approximately 69% of the total overnight stays that the Region reached in that same year. From 2020, there was an exponential decrease of -288.47% compared to the previous year, even more accentuated than the decrease in the region as a whole (-247.47 %), relatively to 2019, due to the global pandemic COVID-19. The global pandemic brought great challenges to the development of tourism in the region and mainly on the island of São Miguel. It is also possible to observe that in 2021, the total number of overnight stays increased again, which shows that São Miguel, together with the Region, is managing to recover from the pandemic and making good use of the newly developed tourism models that focus on sustainability standards.

The tourism resources presented on the island of São Miguel are divided into four structures: 1) Natural and Landscape Tourism Resources, 2) Cultural Tourism Resources, 3) Tourism Services, Equipment, and Infrastructures and 4) Other infrastructures.

Table 5 exemplifies the types of tourism resources at hand in São Miguel island.

Table 5: Types of touristic resources available in the island of São Miguel

(Direção Regional do Turismo, 2019)

Natural and Landscape Tourism			Cultural Tourism	Tourism Services, Equipment, and Infrastructures	Other Infrastructures
Waterfalls	Farm	Volcanic Caves - visitable or with potential	Golf Course	Tourism Offices	Airport
Hydro-mineral springs	Recreational Forest Reserve	Diving Spots	Lighthouses	Cultural Centers	Commercial Port
Hiking Trails	Endemic Nursery	Whale Watching			
Biking - Enduro	Bathing areas	Contemplation Areas and Viewpoints	Archaeological and Land Heritage	Environmental/Interpretation Centers	Fishing Port
Cross Country Biking	Ponds	Unique Elements			
Garden/Park	Geosites	Cultural Landscapes	Classified Buildings	Museums	Marina

By observing the table 5, it can be seen that there are a total of eighteen different types of natural and landscape tourism resources on the island of São Miguel. Four types of Cultural tourism, four types of Services, Equipment and Tourism Infrastructure, and four other structures.

After collecting the tourist resources available on the island of São Miguel, it should be noted that in many of them there are limitations associated with the number of visitors, carrying capacity, access control, and relocation of car parks, among others. These limitations are necessary due to the growth of tourism and the overload of resources over the years (Direção Regional do Turismo, 2019).

In the document POTRAA, Tourism Planning Program of the Azores Autonomous Region is specified the tourism resources that are threatened by the high affluence are specified. This high prosperity leads to significant degradation and pressure on natural resources. The touristic resources that are suffering stress are: (1) Vista do Rei and Cumeeiras das Sete Cidades viewpoint, (2) Ferraria natural pools, (3) Caldeira Velha, (4) Lagoa do Fogo (viewpoint and trail), (5) Vila Franca do Campo islet, (6) Caloura (harbor and beach), (7) Santa Barbara beach, (8) Furnas (Caldeiras Vila), (9) Salto do Prego (trail), (10) Lagoa do Congro and (11) Pico do Ferro viewpoint (Direção Regional do Turismo, 2019).

A set of proposals were drawn to try to reverse and minimize the negative impacts caused on the respective resources, but it is also necessary: i) The implementation of specific management systems for tourism activities and usufruct in the protected areas for nature conservation belonging to the Natural

Island Parks (PNI) such as visitation plans; ii) The management of pedestrian and bicycle trails, where car circulation should be restricted to certain periods of the day as is the case of Cummeiras in Sete Cidades; iii) The adjustment of the access and use models to the places identified as being a current or future constraint; iv) The review of the regulation of some maritime tourist activities, such as whale watching (Direção Regional do Turismo, 2019).

The degradation and increase of significant pressure on the natural and tourist resources presented are one of the great challenges of sustainable tourism, for this reason, both the challenges and opportunities of tourism on the island of São Miguel will be addressed in the next section.

2.4 Challenges and Opportunities of Tourism in São Miguel

The increase in tourism in the Azores has brought immense opportunities to the region, but also many challenges (IPDT, 2020 ; Direção Regional do Turismo, 2019).

Opportunities for the Region:

- **Increased concern for sustainability:** Currently, the concern with sustainability is increasing and the fact that the Azores are a sustainable tourist destination is an asset to the Region.
- **Entry of low-cost airlines into the archipelago:** The growth of the global tourism sector and the increased demand for unique experiences and the appreciation of experiences closer to the locals have made the Azores increasingly more attractive and valued by tourists.

Challenges:

- **Growing pressure on tourism resources:** With the increase in tourism in the Azores also comes greater pressure on tourism resources which, if not minimized and mitigated, could be very damaging to the future of tourism in the Region. The negative impact that the growth of tourism brings to the sustainability of the environmental domain is, perhaps, the greatest challenge for the Azores. The territory's vulnerability has been growing with the increase in the number of tourists simultaneously in the various tourist resources presented in the archipelago, especially in São Miguel, and it is essential to ensure their quality, protection, and durability
- **Regional asymmetries:** The regional asymmetries that exist concerning the benefits and opportunities of tourism in the other islands of the archipelago, the difficulty of tourists to reach some islands, determines a limitation of the development and performance of tourism, as well as the attractiveness of the same, being this a great challenge of the development of the region.
- **Seasonality:** The seasonality of tourist flows, with a strong accentuation in the summer months, is also a factor of concern about the return on investment, financial liquidity, human capital hiring, and innovation capacity. Therefore, efforts are needed to reduce the large difference in turnover between high and low seasons.
- **Shortage of qualified human resources:** There is also a shortage of qualified human resources to operate in the tourism sector. This is a serious problem as it undermines both the quality of services offered in the region and their continuous development.

2.5 Contextualizing the problem

In recent years, there has been a strong growth in tourism in the Azores and especially on the island of São Miguel, leading to negative and positive impacts, as seen above. One of the main problems of this growth is the contribution to the degradation, dilapidation, and overloading of tourism resources that compromises the environmental, social, and economic sustainability of tourism. For this reason, it is essential to create instruments that support sustainable tourism in the long term, contributing to the quality and longevity of tourism resources, and reducing the negative impacts caused on them. Following this, the present dissertation focuses on a monitoring and support tool in sustainable tourism planning. This tool includes a general tourism sustainability index, which makes evaluating and comparing tourist destinations easier. It also shows an overview of the various indicators that make up this index and their performance so that the necessary improvements can be identified. It also includes a set of proposed guidelines to better the performance of this index.

2.6 Chapter Conclusion

Tourism in Portugal has been increasing a lot in the past nine years, and the Azores has also accompanied this growth, especially São Miguel Island. The Azores has an enormous variety of natural, historical, and cultural resources that make it a privileged territory, which is why it has invested in initiatives focused on the protection and prevention of the environment, society and economy towards the sustainability of resources. With the accentuated growth of tourism, it is easy to realize that the growing tourist pressure on the present tourist resources contributes to the degradation and overstress of the present tourist resources, making their management mechanisms necessary to ensure the quality of the tourist experience, longevity of the resources and reduction of the negative impacts caused by the growing tourist flow. To this end, a set of proposals has been drawn up to try to reverse and minimize the negative impacts caused on the affected resources, as well as to prevent a decrease in the quality of both the tourist experience and the local population experience.

3 State of the Art

This chapter refers to the literature review that focuses on the concepts that will be necessary for this thesis.

Firstly, sustainability is addressed in section 3.1, as well as sustainable development and the respective Sustainable Development Goals, finally, the three pillars of sustainability will be approached.

Then, in section 3.2, sustainability in tourism is addressed, as well as the various concepts and definitions found, the principles of tourism sustainability and sustainable tourism development, the importance of sustainability indicators, and the various certifications of sustainable tourist destinations that exist. Next, tourism management tools are discussed in section 3.3 as well as the decision support models in section 3.4.

3.1 Sustainability

The concept of sustainability has been the subject of discussion by various authors, since very early on, and today it is a complex issue discussed daily all over the world.

The idea of sustainability first appeared with author Hans Carl von Carlowitz in his book *Sylvicultura Oeconomica* in 1713, where he formulated clearly the concept of sustainability in forestry (Carlowitz, 1713). Next, it was the political economists who during the industrial revolution, from 1760 until 1870, began to question the limits concerning the economy and population growth eventually relating these issues to sustainability, hence making a huge contribution to the topic (Purvis et al., 2018).

In the 19th and early 20th centuries, ecologists and natural scientists also made a great contribution to the study of sustainability as they explored the differences between anthropocentric and biocentric conservationists. While anthropocentric conservationists argue that sustainable consumption is what is underlying the conservation of natural resources, biocentric conservationists argue the inherent value of nature is what leads to its preservation (Purvis et al., 2018)., therefore, natural scientists and ecologists thinking about the various reasons behind sustainable development.

In the 20th century, the increased concern for various environmental problems caused by humanity such as pollution, destabilizing soils through logging, fossil fuels, increase in greenhouse gases, and climate change among others, led to environmental concern being more and more discussed and questions started to raise about whether humanity was (or could be) harming the ecosystem itself (Environmental Science, n.d.). It was these questions and concerns that launched the modern concept of sustainability and led to important research on this topic (Purvis et al., 2018).

Sustainable development, also known as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987) is one of the most cited definitions ((Azapagic, 2003); (Seuring & Müller, 2008)). This is presented in the Brundtland report of the World Commission on Environment and Development (WCED) in 1987. This report presented the strong need to redefine the system limits and requirements necessary to build new strategies coordinated among all parties involved, employees, suppliers, community groups, governments, agencies, and NGOs in order to achieve sustainability both in the internal and external operations (Ciliberti et al., 2008; Halldórsson

et al., 2009; Sarkis et al., 2012; (Seuring & Müller, 2008)). However, some authors argue that there is a lack of clarity concerning the concept of sustainability.

Also, during the 20th century, the United Nations Organization (UN) was founded, and UNESCO (United Nations Educational, Scientific and Cultural Organization) was also established. These two organizations play a key role in sustainability at a global level. UNESCO's mission is "to contribute to peace building, poverty eradication, sustainable development and intercultural dialogue through education, sciences, culture, communication and information" (UNESCO, n.d.). One of the most important roles of the UN was the creation of the seventeen Sustainable Development Goals (SDGs), these being (United Nations, n.d.):

1. No poverty
2. Zero hunger
3. Good health and well-being
4. Quality of education
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, innovation and infrastructure
10. Reduced inequalities
11. Sustainable cities and communities
12. Responsible consumption and production
13. Climate action
14. Life below water
15. Life on land
16. Peace, justice and strong institutions
17. Partnership for the goals

Sustainability is related to the Triple Bottom Line (TBL) concept (Elkington, 1997). This concept recognizes that to achieve sustainable development it is necessary to consider profit, the planet, and people (Hassini et al., 2012). Thus, sustainability derives from the intersection of the objectives of the economic, environmental, and social dimensions (Tascioglu, 2015 in (Correia, 2016)). Edum-Fotwe and Price stated that, generally, only the economic pillar is explored and evaluated by companies, since it is necessary that the initiatives and strategies concerning the organization's sustainability bring a positive return to the organization (Edum-Fotwe & Price, 2009 in Dias, 2014). The economic pillar is also known as the governance pillar, representing the harmonization of the interests of all stakeholders (Andrew Beattie, 2021), being responsible for avoiding conflicts between all parties involved, and ensuring good governance policies (Gaspar, 2021).

The environmental pillar is, for many, the main concern for the future of humanity (Environmental Science, n.d.) and represents the protection of the environment. For there to be a healthy development of society and the environment that surrounds it, it is necessary that there exists protection of the

environment and not the degradation of it and for this, measures and models of prevention of the same are necessary. Nowadays, there is already concern on the part of the entities regarding this issue, however, it continues to be a topic that needs to continue to be debated and spoken due to the fact that it still lacks clarity. This all has to be achieved in order to limit and regress the degradation of the environment, which is fundamental for the survival of humanity. This pillar is, also, the centre of sustainable tourism survival, contributing to its proper functioning and development, without there being a degradation of the environment and the touristic natural resources presented, thus leading to the longevity of the environment and tourism sector "hand in hand".

The social dimension is related to the well-being and fair treatment of all stakeholders involved in a corporation and the entire surrounding community (Andrew Beattie, 2021).

As sustainability is essential in the tourism context, tourism sustainability will be addressed in the next chapter.

3.2 Tourism Sustainability

The tourism sector is the branch of the economy with the highest growth rate, bringing, therefore, innumerable economic and social benefits (Kostić et al., 2018). However, this large growth has created a negative environmental impact from the overexploitation of natural resources, leading to their degradation and lapidation, excessive consumption of water and electricity, and the destruction of natural habitats (Pan et al., 2018). The continuous aggravation of these problems will result, not only in the degradation of the environment but also in the dissatisfaction of the local community and poor tourism quality, which will contribute to a decrease in tourism flow in the future, damaging society and the economy (Carvalho, 2022).

In order to be able to prevent and retract these problems, it is necessary to have very complex planning of tourism and its growth, with aim of achieving sustainable tourism (Angelevska-Najdeska & Rakicevik, 2012).

In the present literature review, several concepts of sustainable tourism have been found over the years, as shown in Table 6.

Table 6: Concepts of sustainable tourism

Year		Concept
1980	UNWTO (Manila Declaration)	"The satisfaction of tourism requirements must not be prejudicial to the social and economic interests of the population in tourist areas, to the environment or, above all, to natural resources, which are the fundamental attraction of tourism, and historical and cultural sites."
1993	UNWTO In (Kostić et al., 2018)	Sustainable tourism is a development model that should stimulate the adaptation of tourism practices to the correct structuring of destination territories, so as to simultaneously satisfy and respect the three very essential aspects of any tourist destination: residents, environmental and cultural resources and visitors.
2013	(Liu et al., 2013 in Pan et al., 2018)	Sustainable tourism is tourism that balances economic benefits, environmental protection, social justice, and cultural integrity to fulfil the needs of the host community and enhance the standard of living.
2013	Grabara K. Janusz, Paula Bajdor	The meaning sustainable tourism does not only refer to environmental protection but also includes living conditions of the environment in conjunction with the economic and social dimensions of the tourist area.
2015	Stefan Gössling and Psul Peeters in (Chakraborty, 2020)	The global tourism sustainability scenario is one in which despite an increasing number of tourists, the absolute resource use decreases.
-	UNWTO In (Shape Tourism Observatory, 2022)	"Tourism that takes full account of its future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities."

All the concepts mentioned in table 6 are in agreement with each other and therefore it is possible to see that sustainable tourism is a balance between the three pillars of sustainability.

According to Garrod and Fyall (1998), there are ten principles for sustainable tourism which are represented in table 7 (Garrod & Fyall, 1998 in (Yfantidou & Matarazzo, 2017)).

Table 7: Principles for Sustainable Tourism

Adapted from (Yfantidou & Matarazzo, 2017)

Using resources sustainably	The sustainable use and conservation of natural, social and cultural resources is crucial and has long-term commercial sense.
Reducing overconsumption and waste	Reducing excessive consumption and waste leads to avoided restoration costs of long-term environmental damage and contribution to the quality of tourism.
Maintaining diversity	Natural, social and cultural diversity should be maintained and promoted in the long term as it is essential for a sustainable destination and creates a resilient base for the industry.
Integrating tourism into planning	Integrating tourism into a national and local planning framework that carries out environmental impact assessments boosts the long-term viability of tourism.
Supporting local economies	Tourism supporting a range of local economic activities taking into consideration environmental costs and values, protects these economies and avoids environmental damage.
Involving local communities	The full involvement of local people in the tourism sector improves the quality of the tourism experience and also benefits not only them but the overall environment.
Consulting stakeholders and the public	Consultation between the tourism industry and local communities, organizations and institutions is essential so that they can work together and overcome any potential conflicts of interest.
Training staff	Recruiting local staff together with training them to integrate sustainable tourism into their working practices improves the quality of the tourism product.
Marketing tourism responsibly	Marketing that actively provides tourism with comprehensive and responsible information promotes respect for the destination's natural, cultural and social environment and improves customer satisfaction. Continuous research and monitoring by the industry, collecting and analysing effective data, is essential to help solve future problems and benefits destinations, the industry and consumers.

In order to achieve sustainable tourism, it is necessary to plan and develop it, that is, it is necessary to have the means to achieve the desired end.

Through the literature studied it was possible to reach some conclusions on this subject. Firstly, sustainable tourism development is that which meets the needs of tourists and tourist destinations in the present, while protecting and increasing opportunities for the future. It is a guiding principle for managing all resources in a way that meets economic, social, and aesthetically pleasing needs without undermining the maintenance of cultural integrity, essential ecological processes, biodiversity, and life-supporting systems (UNWTO, 1998 in Kostić et al., 2018).

In this way, sustainable tourism is highly dependent on the ability to enhance financial benefits by all parties involved, including the ability to maintain the social, environmental and cultural heritage (Harris, Griffin, Williams, 2002 in Janusz & Bajdor, 2013).

It can be confirmed that tourism must be developed according to the principles of sustainability and the principles of sustainability require a change of values and mindset, in which present changes must be interdependent on each other (Drumm et al., 2004 in Kostić et al., 2018).

The concept of sustainable tourism development involves an economic, social, environmental, and cultural balance without deteriorating and depleting the resources on which it is based (Angelevska-Najdeska & Rakicevik, 2012).

Nowadays, there are more and more tourist destinations that do tourism planning and present projects and guidelines in order to achieve this desired balance in the tourism sector. Some of the solutions that aim to stop the negative impacts caused on the environment, namely the degradation of natural resources, are the limitation of the number of tourists in a determined place (Janusz & Bajdor, 2013). Therefore, to achieve the sustainable development of tourism it is necessary to limit, reduce or balance the concentration of tourists through the diversification of tourist products and the development of annual tourism (Kostić et al., 2018).

The limits resulting from the Club of Rome's economic, environmental and demographic analyses were manifested in 3 specific ways by the economist Herman Daly, these being (Meadows et al. 2004 in (Chakraborty, 2020)).

- For a renewable resource, its sustainable use cannot exceed the rate of its regeneration;
- For a non-renewable resource, its sustainable use cannot exceed the rate of availability of similar resources;
- For pollutants or precipitation, its sustainable emission rate must be lower than its rate of absorption/neutralization in natural sinks.

It is easy to see that these limits are very important for the conservation and responsible use of resources, as exceeding them can cause their collapse, causing disastrous consequences for humanity. It is possible to conclude then that "sustainable development that gives priority to continued economic growth while ignoring biophysical limits is unrealistic in the long term" (Chakraborty, 2020).

3.2.1 Sustainable Tourism Indicators

The evaluation of the progress of sustainable tourism development cannot be foreseen without the use of appropriate indicators (Miller, 2001 in Kostić et al., 2018). Sustainable tourism indicators are composed of measurable and monitorable variables that help detect changes in the state of a specific phenomenon. They represent tools for gathering up-to-date information that can be filtered, facilitating the identification of trends and threats, and allowing the necessary measures be taken (Angelevska-Najdeska & Rakicevik, 2012). Sustainable planning and development can be analysed in terms of the local community and the concept of tourism quality. The local community should be involved in the tourism planning and development process, especially when it comes to the development of those segments of the tourism sector that bring more value to the surrounding community. The concept of quality in tourism means a successful development of the marketing aspect that also benefits the local people and the environment (Angelevska-Najdeska & Rakicevik, 2012).

Comparative sustainability indicators integrate factors at the economic, cultural, social, and environmental levels as well as the satisfaction of tourists. The application of these indicators is based on a coding system, whereby it is determined the border values for each indicator (Jovičić, Ilić, 2010 in Kostić et al., 2018).

Table 8 shows which monitorable variables of sustainable tourism and, in some cases, the respective indicators that are addressed in the literature studied.

Table 8: Dimensions and indicators of the present literature

Stojanovic, V. (2011), *Turizam i održivi razvoj*, Novi Sad: Prirodno-matematički fakultet in (Kostić et al.,2018)

Dimensions	Indicators	(Angelevska-Najdeska & Rakicevik, 2012)	(Janusz & Bajdor, 2013)	(Yfantidou & Matarazzo, 2016)	(Kostić et al., 2018)	(Pan et al., 2018)	(Costa et al., 2019)	(Wolf et al., 2019)	(Perkumienė et al., 2020)	(Chakraborty, 2020)	(Singh et al., 2020)	(Haibo et al., 2020)	(Lee et al., 2021)	(Leka et al., 2021)	(Mancini et al., 2022)
Economic	Seasonal character of the circulation: % visits in full season (3 months)				x										
	Ratio of nights and accommodation capacities				x										
	Coefficient of local tourist increase				x										
	Other indicators	∇	∇	∇		x	∇		∇	∇			x		
Satisfaction of tourists	Repeated visits: % repeated visits in the period of 5 years				x										
	Other indicators	∇	∇				∇		∇				x		
Cultural	Relationship of accommodation capacities and number of local population				x										
	Tourism intensity: number of nights (000) according to population (00)				x										
	Other indicators	∇	∇	∇			∇		∇				x		
Social	Share of tourism in local net social product				x										
	% of tourists who do not come through the tour operators				x										
	Other indicators	∇	∇	∇			∇	∇	∇				x		
Indicators of the state of life environment	Land: % land in which construction was built but it is not implemented				x										
	Usage and occupation of land: % change in construction of region within 5 years				x										
	Transport: % of arrival of tourists who do not use private cars				x										
	Other indicators	∇	∇	∇		x	∇	∇	∇	Carbon Footprint	∇	∇	x	x	Ecological Footprint

∇: No specific indicators are mentioned, only the dimension

As can be seen in table 8 it is possible to note that most of the articles mentioned only discuss the dimensions that should be addressed in the development of sustainable tourism, however, they do not mention specific indicators in the assessment of sustainable tourism, being, therefore, more theoretical articles and not so practical. Out of a set of 14 articles, only 4 refer to specific indicators, while the remaining 10 only report the dimensions studied or that should be approached.

3.2.2 Sustainable Tourism Certifications

The number of certifications by sustainable touristic destinations has been increasing significantly over the past few years, mainly driven by the standards and guidelines designed by the Global Sustainable Tourism Council (GSTC) (Costa et al., 2019). Certification by an accredited Certification Body means that the destination meets the market's highest social and environmental standards and offers the tourism destination credible solutions to complex environmental and social issues. Achieving it means meeting a wide range of criteria, which are assessed annually in order to be renewed. If the same is not achieved, the certified status can be lost (GSTC, n.d.). To become certified destinations, a choice has to be made between three of the following certification bodies that are accredited by GSTC: EarthCheck, Green Destinations, or Vireo Srl (Costa et al., 2019).

EarthCheck is a leading scientific benchmarking, certification, and advisory group for travel and tourism that was developed by the Australian Government's Sustainable Tourism Cooperative Research Centre (STCRC). Since 1987, it has focused on helping businesses, communities and governments provide clean, safe, prosperous, and healthy destinations for travellers to visit, live and work. The EarthCheck program is based on the Agenda 21 principles for sustainable development and is currently used in over 70 countries around the world.

EarthCheck science is reviewed annually to ensure compliance with international standards for greenhouse gas protocol, responsible tourism, and certification (Earth Check, 2015).

The EarthCheck Destination Standard underpins the World EarthCheck Programme's Top Destinations and establishes an environmental, cultural, social, and economic (ECSE) performance framework for communities wishing to achieve EarthCheck Destination Certification, it also provides a set of guidelines that are based on the twelve Key Performance Areas (KPA's) aimed at improving the overall sustainability of the destination. These KPA's are:

1. Energy efficiency, conservation and management
2. Greenhouse gas emissions
3. Air quality protection, noise control, & light pollution
4. Freshwater resource management
5. Wastewater management, drainage and watercourses
6. Ecosystem conservation and management
7. Land use planning and development
8. Transport
9. Solid waste management

10. Management of environmentally harmful substances
11. Cultural and Social Management
12. Economic management

Certified Green Destinations is a GSTC-accredited program for destinations that provides the GSTC-Recognized tools and framework for sustainable tourism development, comprehensively assessing destinations' sustainability policies and practices, planning improvements, and celebrating achievements with Awards or Certifications that meet the UN Sustainable Development Goals. It is the ultimate recognition for ambitious destinations aiming for full compliance with globally agreed sustainability standards, assessed with an evaluation process, with an on-site audit required every 3 years (Green Destinations, 2022).

The standards cover six main themes: Destination Management, Culture and Tradition, Nature and Scenery, Social Well-Being, Environment and Climate Business and Communication (Green Destinations, 2021).

Vireo Srl is a certification company whose business activities consist of providing globally recognized environmental certification services to Italian and foreign companies.

In 2018, Vireo became the second GSTC accredited body to certify according to the GSTC criteria, which criteria must be adapted to the specific conditions of each region.

Vireo is leading the ASI (Accreditation Services International) accreditation process to emit GSTC certification for destinations, hotels, and tour operators.

The GSTC criteria are organized within four main themes:

1. Demonstrating effective sustainable management;
2. Maximizing social and economic benefits for the local community and minimizing undesirable impacts ;
3. Maximizing benefits to cultural heritage and minimizing negative impacts;
4. Maximize benefits for the environment and minimize negative impacts.

These criteria are reviewed every 3 to 5 years and audits are undertaken to ensure that destinations meet the proposed requirements. Audits are carried out by an accredited certification body and ASI (Accreditation Services International) is the Accreditation Body for the GSTC.

To conclude, being certificated with the Global Sustainable Tourism Council criteria is a big step that requires a significant commitment of financial resources and time so that credibility can be obtained for the touristic destination (Nagy, 2021).

3.3 Tourism Management Tools

As previously stated, the evaluation of the progress of sustainable development of touristic destinations is extremely relevant so that there is high quality and correct management of them.

In the present literature review, some methodologies of tourism destination sustainability management are addressed.

Only three articles and one thesis used specific management tools to calculate the impact of tourism, in the others only sustainability indicators were used or were tackled by a theoretical aspect where no model or indicator was applied to assess the sustainability of destination tourism.

Shu-Yuan Pan (2018) focused on establishing a comprehensive performance evaluation (CPE) program, more specifically the Statistical Framework for Measuring Sustainable Tourism (MST), developed by the UNWTO, supported by the United Nations Statistics Division, that is important in balancing economic growth and environmental protection, and are an essential component for achieving sustainable tourism. This framework is divided into three stages: Stage I is where the data is treated, Stage II is where the KPIs are chosen through methods such as Delphi Method, Ad-Hoc Committees, and weighting and, finally, Stage III is where strategies, policies, and programs are formulated according to the study in question. Such framework can provide a general understanding of the sorts of trade-offs that can be expected when considering tourism development in a natural location and the infrastructure's role in increasing carrying capacity for tourism in this particular area.

It is important to look at the case study presented in this paper as it deals with "the Green Island in Taiwan", this is a volcanic island, just like São Miguel. On this island, a low carbon program in cities was initiated in order to promote the development of ecotourism, and for this purpose, an interdisciplinary perspective was referred to cover energy, transport and green buildings, circular economy, management of the information system, and the implementation of educative/training programs for the establishment of sustainable tourism. In addition, a KPI system has also been developed to assess sustainable development on the island which has been incorporated within the frameworks of the National Sustainability Development Policies, and the principles of low carbon community and green infrastructure. This system includes 26 KPIs broken down into three phases through an Ad Hoc committee which in total resulted in only 10 KPIs related to (1) Renewable Energy, (2) Energy Saving, (3) Green Transport, (4) Low-Carbon Building, (5) Environmental Greening, (6) Circular Resources, (7) Low-Carbon Life, (8) Management Mechanism, (9) Education and Training and (10) Partnership. These KPIs can serve as a basis for the development of metrics by governments and businesses to calculate and evaluate progress in developing and achieving sustainable tourism given their own personal objectives (Pan et al., 2018).

The tourism Carrying Capacity Index (TCCI) was addressed by Akrivi Leka (2021) using the Pressure-State-Response (PSR) framework as a base that focuses primarily on environmental and manmade decisions. The author seeks to outline the TCC as a means for the evaluation and a continuous monitoring of tourism development, guiding towards a more sustainable future planning of Mediterranean island coastal areas. TCCI analysis proves to be an important approach to the application of indicative and upper limits of tourism development and based on them, optimal and conscious exploitation of natural and cultural resources, in this case, to tourism in coastal zones. The challenge of TCC is the definition of a model applicable to different types of tourism development that allows the definition of indicators and standards specific to each location.

The case study presented in this document addresses the carrying capacity associated with sustainable coastal tourism on the island of Naxos through the Pressure-State-Response framework: the pressures exerted on the environment by anthropogenic activities, the state of natural resources in qualitative and quantitative terms resulting from the pressures exerted and the responses associated with the changes in state. For this purpose, the indicators fall into three categories: (i) environmental pressure indicators; (ii) indicators of the state of the environment, and (iii) indicators of society's responses. Considering the main impacts of tourism activity, four key fields that have to be addressed by the PSR framework were identified in order to assess the TCCI index: (v1) Climate/Atmosphere, (v2) Water Resources, (v3) Land Resources and (v4) Management Quality. These major areas have been subdivided into their respective indicators which are represented in table 9.

Table 9: Indicators for assessing TCCI in Naxos Island

v1: Climate/Atmosphere	Temperature Humidity Index - THI
	Air Pollutants (NO_2 ; O_3 ; SO_2 ; PM_{10})
v2: Water Resources	Water consumption per capita/per day
	Water losses in the network
	Sea water quality
v3: Land Resources	Coastal erosion (%)
	Changes in land use, built up expansion/sprawl
	Capacity of coasts
	Total of Daily Visits (TDV) in protected areas
v4 :Management Quality	Solid waste per capita per day
	Use of Renewable Energy (RE) (percentage)
	Number of beds/inhabitants (Tourism Operation Index)

TCCI in the present case study was addressed through two diversified scenarios based on "Policy Response/Resource Management) to State Pressures/Intensity". The first scenario with a less stringent response (Scenario I - P/S 75% and R 25%) and the second scenario with a stronger response (Scenario II - P/S 60% and R 40%). Each scenario is evaluated with values of TCCImin being the best response to the pressures and TCCImax being the worst. Next, the TCCI for Naxos Island, relative to the overcrowded western coastal zone, is assessed and compared with the minimum and maximum TCCI values calculated previously (Leka et al., 2021). The TCCI evaluation is calculated as a weighted linear sum with the variables included in table x.

The carrying capacity was also used by Inês Carvalho (2022) in her thesis " Calculating Tourism Cargo Capacity in Mainland Portugal: Optimization Model for Identifying Sustainable Futures ".

In response to the growing demand for certain tourist destinations, in this case in mainland Portugal, the process of touristification was analyzed. This process results from the development of touristic activity in a given location, generating economic, social, and environmental transformations. In order to prevent over-tourism, the carrying capacity is calculated. The World Tourism Organization designates tourism carrying capacity as the maximum number of tourists that can visit a place without compromising

the physical, economic and socio-cultural environment and also without reducing the quality of the visitor experience (World Tourism Organization, 1981 in Carvalho, 2022). The tourism carrying capacity is then a mechanism for establishing the standards of sustainability in the tourism sector and in land development and planning (Jangra & Kaushik, 2017 in Carvalho, 2022), with an attempt to, in a measurable way, set limits to the number of visits and the degree of development that can be achieved, without causing damage to the natural and artificial environment (Lorente, 2001 in(Carvalho, 2022)).

The calculation of the tourism capacity in Portugal's mainland was made through the Cifuentes method. This method considers the physical aspects of the destination and social, environmental, and ecological variables, in addition, the necessary distance between tourists for their satisfaction and psychological comfort is recognized and determines the maximum desirable limits of development, i.e. the optimal use of tourism resources. This method is sequenced into six steps: (1) Analysis of tourism policies and management of protected areas, (2) Analysis of protected area objectives, (3) Analysis of the situation of visited sites, (4) Definition, strengthening, or change of policies and decisions, (5) Identification of factors influencing each site and (6) calculation of the carrying capacity of each site. In the last step, three levels of carrying capacity are considered: Physical carrying capacity, Actual carrying capacity, and Effective carrying capacity. Each of the subsequent levels, in the order mentioned above, constitutes a corrected (reduced) capacity in relation to the immediately preceding one.

For the optimization model carried out in the dissertation in question, a predictive model of quantitative forecasting was applied through regression analysis based on the sum of squares, with the purpose that the dispersion of the data points is found. Thus, it is possible to obtain the smallest possible sum of squares and draw the line that most closely matches the data. This methodology consisted in the application of a simple linear regression, identifying which municipalities may exceed their carrying capacity in the future taking into account two scenarios. The first corresponds to the maximization of the value of the objective function, that is, a constant growth trend in tourism, in the particular case of the indicator "number of guests" and the second scenario in the minimization of the value of the objective function, i.e. a decrease of the same indicator (Carvalho, 2022).

Maria Mancini (2022), in her article "Ecological Footprint and Tourism: Developing and monitoring the sustainability of ecotourism packages in Mediterranean Protected Areas" presented the analysis of a customized version of Ecological Footprint accounting in order to evaluate its usefulness as an analytical tool that quantitatively analyzes the environmental pressures associated with ecotourism packages developed in Protected Areas of the Mediterranean Region. A bottom-up and participatory approach was developed for a set of 13 ecotourism packages for their management and monitoring that involves local tourism stakeholders and service providers and is fundamental for the sustainability of the tourism offer. The Strategic Environmental Assessment allows the identification of the main ecosystems under pressure, as well as the main factors causing these pressures, and when combined with tangible recommendations for improvement and biophysical limits of the ecosystems helps to reduce environmental impacts.

The application of EFA (Ecological Footprint Accounting) was based on data provided by local services in order to complement existing statistics and datasets, using an empirical interactive process to provide local tourism stakeholders with recommendations for managing a low-impact tourism offer.

Applied to an ecotourism package, the ecological footprint calculation is done by adding up the demand for natural resources and ecosystem services needed to sustain four products and services offered to tourists at the destination, (1) Accommodation, (2) Food and Beverage, (3) Mobility and (4) Activities plus Services and bring tourists to the destination (via flight or via train and/or ferries), through the equation 1:

$$EF = \sum_i \left(\frac{P_i}{Y_{w,i}} \times EQF_i \right) \quad (1)$$

“ P_i is the amount of any product or service i offered to tourists (e.g., the amount of food provided or the amount of CO₂ released because of a service provided); $Y_{w,i}$ is the annual *world-average yield* for the production of i (or its carbon uptake capacity in cases where P is CO₂); and EQF_i is the *equivalence factor* for the type of ecosystem (e.g., crops, forests, etc) producing the product or service i ” (Mancini et al., 2022).

The Sustainable Tourism Development Index (TSDI) was then found. This is an index that combines earth observation data with statistical data in order to assess the sustainability of a geographical region and its correlation with the development of tourism activities, thus helping to improve the region's strategy and drive sustainable decision-making for the future of tourism. The TSDI index is an adjustment of the development index for tourism, as there is a new generation of dashboards that includes the Biodiversity Pressure, and Green Index, calculated by adding the indicator of proximity to protected areas and forest land, and also metrics that adjust the human and economic part, Human Index, calculated by multiplying between the number of international tourists and the urbanization indicator (Murmuration Sas, 2021).

One can also refer to the balanced scorecard, which is a methodology for managing a company's performance with the aim of improving its internal operations and transforming its planning into objectives, goals, and actions. The balanced scorecard can also be applied to sustainable tourism that aims to achieve 80 million overnight stays in the territory, and 26 billion tourism receipts, to reduce seasonality from 37.5% to 33.5%, to increase the local population's satisfaction with tourism by 90%, to increase the number of tourism enterprises developing water and energy efficiency measures and waste management measures by 90%. The target for all these objectives is 2027 (Guerreiro & Seguro, 2018). The balanced scorecard has 43 indicators inserted in 11 domains and 3 areas. To the economic area of domains of seasonality belong employment and economic benefits, to the environmental area belongs environmental management, energy management, water, and solid waste management and to the social area belong the domains tourist satisfaction, site satisfaction, pressure, and accessibility (Guerreiro & Seguro, 2018).

3.4 Decision Support Methods

Following on from the above and due to the need to create a model to assess the performance of sustainable tourism on the island of São Miguel, the Multicriteria Decision Support Methodology (MMAD) will be discussed.

MMAD allows the evaluation of the alternatives, considering complex qualitative and quantitative information based on objective and subjective data and their relative importance (Hanan et al., 2013). This is used in the identification of the preferred option, ranking of alternatives, or, only, in the distinction between acceptable or non-possibilities (Figueira et al., 2005). MMAD requires the involvement of an expert in decision analysis, who assists decision-makers in the evaluation process (Zeleny and Cochrane, 1982 in (Dias, 2014)). This expert identifies relevant criteria for decision-making, determines the weights of the respective criteria, scores the options on each of the criteria, and determines the aggregate score of each option (Hanan et al., 2013).

According to Giard & Roy (1985) and Vincke (1989) it is possible to classify MMAD methodologies into three groups: Single Criteria Synthesis Methods, Outranking Methods, and Interactive Methods with Trial-and-Error Approach.

In the single criterion synthesis methods, the preferences of the decision group were represented through value or utility functions, considering only situations of preference and indifference, not accepting the possibility of the existence of valid justifications when two alternatives are incomparable (Guitouni & Martel, 1997).

Methods based on the outranking approach aim to aggregate the preferences established by the decision maker (DM) when comparing alternatives along each criterion. The outranking relation (S) is a binary relation that defends the fact that, with respect to all criteria, an alternative a is at least as good as alternative b , i.e. a is not worse than b . In order to establish this relationship the concepts of "thresholds", "agreement" and "disagreement" are used (Guitouni & Martel, 1997).

Interactive methods, or Multi-Objective Decision Making (MODM), are based on mathematical programming models where a large or infinite (continuous) number of alternatives exist. These models are based on multi-objective mathematical programming models "in which a conflicting set of objectives is optimized and subjected to a set of mathematically defined constraints", in order to select the "best" alternative (Sadok et al., 2008).

Taking all of this into account, in the present dissertation, the objective is the sustainability assessment of several tourism resources, where there are a finite number of alternatives and the existence of an alternative that dominates all of the others is unlikely, the use of discrete multicriteria methods is the most suitable to this problem. For the identification of the respective method to be usable, a literature review of some of the Single Criteria Synthesis methods was conducted as represented in table 10.

Table 10: Single Criteria Synthesis methods

Adapted from: (Dias, 2014)

Method	Description	Reference
TOPSIS (Technique for Order Performance by Similarity to Ideal Solution)	The alternative chosen should have the profile that is closest (in distance) to the positive ideal solution and furthest from the negative ideal solution.	(Hwang e Yoon, 1981)
UTA (Utility Theory Additive)	Through the evaluation of alternatives using (partial) value functions in each of the criteria, the value addition is obtained in order to establish an overall value function V. This function can be obtained in an additive or multiplicative way, under certain conditions.	(Jacquet- Lagreze e Siskos, 1982)
EVAMIX	Using ordinal regression, the value functions in each criterion are estimated. The total value function is obtained additively.	(Voogd, 1983)
MAUT (Multi-Attribute Utility Theory)	The (partial) utility functions in each of the criteria are evaluated in order to aggregate the values obtained and established an overall utility function, U. This function can be obtained in an additive or multiplicative way, under certain conditions.	(Bunn e Bunn, 1984)
MAVT (Multi-Attribute Value Theory)	It is a compensatory methodology, which uses pairwise comparisons of criteria in a quantitative way. Each criterion must be compared with all the others through a numerical scale, in order to compile a final matrix.	(Keeney e Raiffa, 1993)
AHP (Analytic Hierarchy Process)	In this method, two dominance indices are calculated: one for ordinal and one for cardinal evaluations. Their combination leads to a measure of dominance between each pair of alternatives.	(Kiker et al., 2005)

The model selected for the sustainability assessment of São Miguel Island's tourism resources was then the MAVT methodology. The objective of this methodology is the association of a real number to each alternative, producing an order of preference consistent with the decision maker's value judgments. In this methodology, the preferences of the decision group are synthesized through individual building blocks, where the preferences of the key factors that have been identified are described in each of these blocks (Belton, 1999). With this, the decision maker focuses on evaluating the performance of an alternative, A, on each of the n evaluation criteria, through partial value functions $vi(Ai)$ (with $i = 1, \dots, n$), to then evaluate the overall performance of the alternative V(A) (Bana e Costa et al., 2008).

"MACBETH (Measuring Attractiveness by a Category-Based Evaluation Technique) is a decision aid approach to multicriteria value measurement" (Bana E Costa et al., 2012) and was chosen in the

implementation of the problem in this dissertation. This approach allows the measurement of the attractiveness or value of alternatives through qualitative judgments of the difference in the attractiveness of pairwise comparison. This qualitative measurement scale divides into seven categories which are the following: very weak, weak, moderate, strong, very strong, or extreme indifference or difference (Bana E Costa et al., 2012).

The M-MACBETH decision support system, which implements the MACBETH method, allows for the validation of the consistency of the value judgments coming from the DMs, the creation of multicriteria additive value models, and the performance of sensitivity and robustness analyses of the model results (Bana E Costa et al., 2012). The MACBETH approach, according to the literature studied, has been inserted in environmental assessment processes such as the evaluation of flow control options in Ribeira do Livramento in Setúbal (Bana et al., 2004) and construction of a project evaluation model in Bolivia (Sanchez-Lopez et al., 2012). However, there is a gap in the literature when applying the MACBETH methodology to sustainability assessment in any context, including tourism sustainability.

3.5 Chapter Conclusion

In the present chapter literature based on sustainability and sustainability focused on tourism has been studied. It was found that several actors use sustainability measurement indicators at environmental, social, and economic levels in the context of tourism, however, they are very diverse and scattered. It was also noted that sustainable tourism management tools have already been developed, but not a general sustainability index made up of several sustainability indicators applied to any touristic destination. As such, this dissertation will be based on the construction of a general management tool applicable to any touristic destination. For that, Multicriteria Decision Support Methodology (MMAD) will be used, with the MACBETH method (Measuring Attractiveness by a Category-Based Evaluation Technique) through the M-MACBETH decision support system.

4. Methodology

This chapter is dedicated to the methodology applied to the problem presented in this dissertation. It is composed of three steps: (1) Benchmarking, (2) Multicriteria Analysis and (3) Guidelines Proposal, as it is possible to see in figure 3.

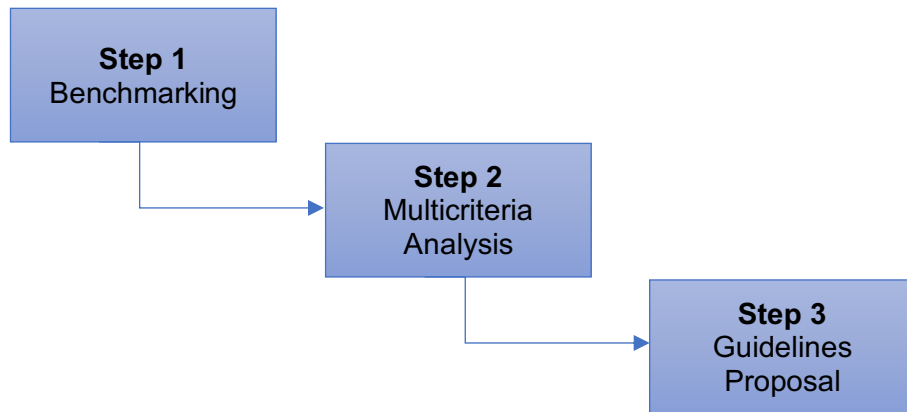


Figure 3: Methodology Steps

Step 1 – Benchmarking

Benchmarking is understood as a process of searching for the best operational and management practices and their adaptation leads to improved performance (Saleem et al., 2021). It was first introduced in 1970 by Xerox Corporation in an attempt to compete with Japanese companies (Marques and Witte, 2007 in (Saleem et al., 2021)). This concept is an ongoing process consisting of three main levels: 1) Where there should occur improvement (installation)?; 2) What to improve (activities and services)?; and 3) How to prove (processes and procedures)? (Sharma, 2006 in (Saleem et al., 2021)). In the context of this dissertation, benchmarking will be applied to five sustainable destinations, five including the Azores, in order to extract the best practices used by them. The Benchmarking process consists of five steps: (1) Choice of the material under study; (2) Choice of the indicators under analysis; (3) Collection of data; (4) Analysis and comparison of information; (5) Survey of high and low points; (Benetti, n.d.). In the first step, taking into account that for the realization of the Benchmarking would be necessary the action plan of each destination, a search was made of which destinations certified by Earthcheck that made available the sustainability action plan. In this way, only five action plans were found, together with the Azores, and so these were the destinations chosen for the Benchmarking. In steps 2 and 3, a summary of all actions was made for each key performance area of each destination, previously discussed in chapter 2.2, and then a comparison between them in step 4. Finally, in step 5, the high and low points of each destination were gathered.

Step 2 – Multicriteria Analysis

The second step is related to the Multi-Criteria Analysis. As previously mentioned, the Multicriteria Decision Support Methodology (MMAD) will be performed, using the MACBETH method with the M-MACBETH decision support system. The MACBETH approach is a process comprising three main phases: i) Structuring, ii) Evaluation and iii) Testing (Bana e Costa et al., 2008), as shown in figure 4. Before the start of these phases, a group of experts, in this case in the area of tourism sustainability on the island of São Miguel should be chosen as Decision Makers (DM).

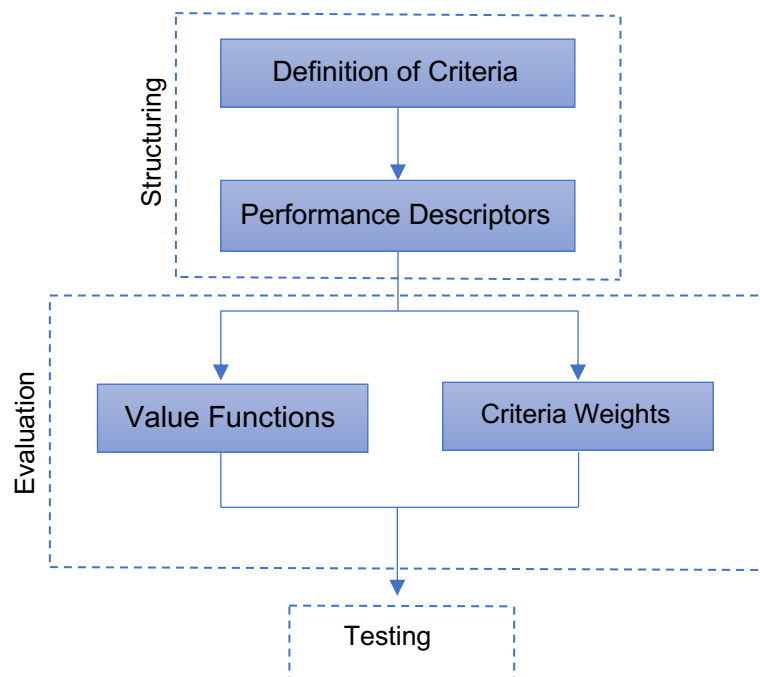


Figure 4: Stages of Multicriteria Analysis

Adapted from (Bana e Costa et al., 2008b) in (Dias, 2014)

Structuring

The Structuring phase consists of two stages, the first is the definition of the assessment criteria, identification of the DM's views, and selection rejection criteria, in order to determine the non-acceptable alternatives, and the definition of criteria to assess the attractiveness of the alternatives (Bana e Costa et al., 2008). In this case, the evaluation criteria are the sustainability indicators identified in the Benchmarking Assessment Report, an annual report made by EarthCheck to manage the evolution of the touristic destination in some sustainability indicators. The Evaluation criteria must be consensual, isolable, and intelligible and their set must be exhaustive, non-redundant, concise, decomposable, and consensual (Beinat & Costa, 2005). With this definition of objectives and criteria, the value tree is conducted in the M-MACBETH software. The second step focuses on the association of a performance descriptor to each of the assessment criteria. The performance descriptor of a criterion is a scale of admissible performance levels ordered by decreasing order of activity, allowing the measurement of the

degree of satisfaction that each alternative provides in a given criterion (Beinat & Costa, 2005). In each descriptor, it is necessary to define reference levels of intrinsic value. For some descriptors, additional performance levels can also be defined, which are then used in the next phase for the construction of the value scales of the respective criteria (Belton, 1999).

Evaluation

The definition of the value functions and the determination of the weighting coefficients is carried out in the evaluation phase. Using the M-MACBETH software, the value function for each of the criteria is elaborated. These are made based on the judgments expressed by the Decision Maker regarding the attractiveness differences between every two levels of performance in each one of the criteria. Decision Maker qualitatively evaluates, through the semantic MACBETH scale (Very Weak, Weak, Moderate, Strong, Very Strong, and Extreme), the attractiveness between two performance levels at a time. Next, the judgment matrix is filled in so that the triangular upper portion of the matrix is complete. As the judgment matrix is filled, the M-MACBETH software tests the compatibility of the information that is entered, so that if any inconsistency occurs, possible ways to resolve it are suggested. After checking the consistency of the judgments in question,

M-MACBETH suggests a numeric scale compatible with the absolute judgments of the DM and assigns a score or value to each performance level. The distances relative to the intervals of each value function obtained can be adjusted after discussion with the DM, without violating the consistency of the judgment matrix (Bana e Costa et al., 2008).

To determine the weights of the criteria, it is necessary to request the DM to order the swing of moving from the base level to the target level in each criterion, according to its attractiveness. Next, there needs to be qualitative judgment by the DM of (1) the attractiveness of these swings by filling in the last column of the judgment matrix, and (2) the difference in attractiveness between each pair of swings. After verifying the consistency of the judgments under study, the software proposes a weight for each criterion. Similarly, to what happens with value functions, the weights can be modified and adjusted after the discussion with the DM, because M-MACBETH presents limits between which it is possible to modify the values, without violating the consistency of the judgment's matrix (Bana e Costa et al., 2008).

Testing

In the Testing phase, sensitivity analyses are carried out on the results obtained by the model which will result in a recommendation on the decision to be taken. The sensitivity analysis enables observation of what happens to the final result of the model when the weight of any criterion changes, i.e., how the overall scores of the options change and what implications they have on the final ranking of the options when the weight of the criterion changes, maintaining the same proportional relationships between the weights of the other criteria (Bana e Costa et al., 2008).

Step 3 – Guidelines Proposal

The last stage of this methodology is the creation of a set of guidelines, taking into account the information gathered in the Benchmarking and the results of the multicriteria analysis carried out in the previous stage.

Firstly, in the multicriteria analysis, it was observed which tourism sustainability indicators are critical (negative evolution) and the ones that have not been improving their performance over the years in the Autonomous Region of the Azores, being these the ones that need improvement.

Next, the existing actions in the Azores for each of the Key Performance Areas mentioned in section 2.2 in which these indicators are included were observed and compared to the actions of the other destinations so that relevant actions and projects could be added. When the actions of the destinations in the first step were not sufficient, the collection of actions from other tourist destinations was carried out.

5 Results

This chapter is composed of four sections and refers to the application of the methodology proposed in chapter 4 and the respective results.

Firstly, section 5.1 addresses the benchmarking performed, then the multicriteria analysis is addressed in section 5.2, the guideline proposal is introduced in section 5.3 and, finally, the limitations of the methodology are referred to in section 5.4.

5.1 Benchmarking

To perform the Benchmarking, some of the EarthCheck-certified touristic destinations were chosen. For this analysis to be carried out it is necessary to elaborate the action plan of each destination to be able to compare in detail the sustainability actions of the different destinations. Considering that not all EarthCheck-certified touristic destinations have available the corresponding action plan, the four destinations below, together with the Azores, were those in which the action plan was available and therefore were the ones chosen for the benchmarking. These destinations are:

- Destination 1 – Baião Municipality, Portugal – Certified Bronze
- Destination 2 – Melgaço Municipality, Portugal – Certified Silver
- Destination 3 – Nuuk, Greenland – Certified Silver
- Destination 4 - Rottneest Island, Australia - Certified Silver
- Destination 5 –Azores Autonomous region, Portugal – Certified Silver

The action plans made for each destination are divided into the 12 Key performance areas previously discussed in section 2.2. In each of these areas are designated goals and actions to meet the objectives for each destination. Below is a summary of the key actions for each of the areas in each destination chosen.

5.1.1 Baião Municipality, Portugal

A summary of the actions was made for each of the key action areas present in the action plan of the tourist destination of Baião and each action was inserted in the respective area according to the respective action plan under analysis (Mendes, 2020).

Energy Efficiency

- Awareness campaigns in schools were made with the sole purpose of adopting energy efficiency practices like the reduction of plastic in schools, and the creation of initiatives in which students clean previously designated areas, for example, woods, and rivers;
- Making school clusters environmentally responsible to be EarthCheck certified;
- Promotion actions of energy efficiency for hotels and restaurants, by disseminating and discussing good practices and divulging possible financing sources.;
- Study for the possible installation of a biomass power station;
- Renewal of the fleet through the phased acquisition of electric vehicles;
- Conversion of all public lighting to LED.

Greenhouse Gases

- Reforestation of the area with indigenous species from the municipality of Baião through the distribution of trees to local entities, the local community, and to the school's students.

Air Quality, noise control and light pollution

- Construction of a footpath and upgrading of road axes through environmental improvements to pedestrian accesses, the creation of parking facilities, traffic regulation and the introduction of cycle paths.

Drinking Water Resources

- Awareness campaigns for the rational use of water and water saving and reduction of plastic;
- Expansion and maintenance of the drinking water network;
- Awareness-raising campaigns on the maintenance of water collection structures for consumption and to check their quality.

Wastewater

- Awareness-raising actions for the population, industry, catering, hotels, and commerce, to avoid contamination of the waters with oils, grease, rubbish, and various sediments.
- Extension of the wastewater network.

Protection of the ecosystem and biodiversity

- Classification and promotion of the Regional Protected Area, Valuing the native forest of the Iberian Peninsula, Reixele Oak and the creation of a Geopark;
- Reforestation of the sierras and repopulation of inland rivers with autochthonous species;
- Youth volunteering actions for nature and forests for fire surveillance, the need for cleaning and the development of partnerships with universities for the territory's resilience against wildfires;
- Adoption of an acquisition policy that favours recycled paper products.

Land use planning

- Dissemination of the municipal master plan and public discussion of it.

Transport

- Programme to support the reduction in public transport fares, rationalisation and efficiency in the school transport network and electrification of the Douro line.

Solid Waste

- Application of the user pays principle for waste, so as to make users co-responsible for environmental impacts and the importance of recycling, and campaigns to raise awareness of recycling.

Environmentally Harmful Substances

- Awareness-raising campaigns on the use of products containing substances harmful to the environment.

Society and Culture

- Involving the community in the process of certifying, valuing and monitoring the tourist destination and also in valuing and promoting the material and immaterial heritage;
- Drawing up a Tourism Strategy for Baião based on the Ancede Monastery and its requalification;

- Carrying out a youth and sustainability festival.

Economy

- Creation of gastronomic fairs and promotion of the territory;
- Promotion of the existing Motonáutica prize in the Douro with an environmentally sustainable event;
- Construction of business welcoming areas in compliance with the legal norms of environmental protection;
- Involvement of tourism and agriculture stakeholders in sustainable practices and projects, thus making them agents of sustainability;
- Creation of a logistics and promotion centre for the Douro Verde agrifood sector.

5.1.2 Melgaço Municipality, Portugal

A summary of actions was made for each of the key performance areas presented in the action plan of the touristic destination of Melgaço and each action was inserted in the respective area according to the respective action plan under analysis (Gestão da Sustentabilidade do Destino Melgaço, 2021).

Energy Efficiency

- Implementation of LED lighting systems;
- Installation of photovoltaic panels and replacement of boilers by heat pumps in municipal buildings;
- Implementation of a software for the management and monitoring of water and energy consumption.

Greenhouse Gases

- Reforestation of green spaces and habitat recovery;
- Preparation of an implementation to formulate a programme that calculates the carbon footprint of each traveller and the possibility of compensation;
- Electrification of the municipality's vehicle fleet and reinforcement of the installation of charging points;
- Continuance of the natural gas network in the municipality;

Air Quality, noise control and light pollution

- Nothing reported related to this topic

Drinking Water Resources

- Awareness-raising campaigns for residents and businesses to save water;
- Implementation of a programme for using water from municipal and river pools for irrigation;
- Requalification and construction of water supply infrastructures and the development of a water safety plan for human consumption;
- Reinforcement of the network consumption monitoring system to obtain hybrid balances, with the implementation of smart meters being one of the initiatives considered.

Wastewater

- Strengthening the connection of the sewerage network and raising awareness among residents of the advantages of connecting to the public sewerage network.

Protection of the ecosystem and biodiversity

- Continued implementation of the Environmental Education Plan for the Lamas de Mouro Gate and the Biosphere Educational Plan;
- The act of cleaning infested plants;
- Creation of a cleaning point used for washing instruments for viticulture;
- Forest fire surveillance and development of a landscape plan to minimise the impact of forest fires.

Land use planning

- Nothing reported related to this topic

Transport

- Continuation of the free school transport service to municipal transport routes and analysis of the feasibility of increasing the coverage of the public transport network in under-served areas;

Solid Waste

- Reinforce supervision of construction and demolition waste;
- Conclusion of the eco-center;
- Implementation of a bio-waste selective collection system and continuation and increase of the composting of green waste in the existing infrastructure;
- Study of the composition of undifferentiated solid urban waste (SUW) and implementation of a SUW sorting system, especially for bio-waste with a view to its potential recycling and reuse;
- Environmental awareness and dynamization actions and eco-events.

Environmentally Harmful Substances

- Reinforcement of the training of professionals in the handling of these substances.

Society and Culture

- Incentives to attract and settle the population;
- Implementation of the Social Development and Health Plan and reinforcement of social support to the population in need, actions to collect and deliver foodstuffs to the needy;
- Promotion of gender equality;
- Make local products and main tourist attractions known to residents through a voucher.
- Recovery, preservation and maintenance of the edited cultural heritage.

Economy

- Implementation of a certification project for companies, attribution of a sustainability seal and creation of an award to recognize companies in terms of innovation and sustainability;
- Training of tourism professionals in sustainability;
- Development of the Safety Plan for trails;
- Development of guidelines for greener events and continued organization of the Zero Footprint event.

- Reinforcing the commitment to green activities and events in the low season to counteract seasonality and reinforcing innovation initiatives in the ALTICE space;
- Attraction of new companies according to sustainability criteria;
- Implementation of the actions of the Strategic Marketing Plan for tourism.

Others

- Creation of a sustainability dashboard;

5.1.3 Nuuk, Greenland

A summary of actions was made for each of the key performance areas presented in the action plan of the touristic destination of Nuuk and each action was inserted in the respective area according to the respective action plan under analysis (Colorful Nuuk, 2021).

Energy Efficiency

- Lower taxes on hybrid and electric cars;
- Power and heating in Nuuk provided by Nukissiorfiit, the energy supply company, is 100% green;
- Expansion of the existing hydro power plant;
- Introduction of carbon capture with the new waste incineration plant, turning it into green fuel;
- Collaboration to test green energy technologies in Nuuk.

Greenhouse Gases

- 100% green electricity from hydropower;
- Investigate major fossil fuel consumers with ways to decrease their consumption by testing new green energy technologies;
- Collect data for stationary fuel combustion for heating;

Air Quality, noise control and light pollution

- Research and mitigation of the impacts on air quality that large dimensional building contain;
- Annual monitoring and data collection;
- Noise pollution being regulated by laws in municipalities;
- The Destiny Management Organization seeks to become certified by the International Dark Sky Association in which, for example, there could be the creation of a semi-remote area where citizens and tourists can turn off the streetlights.

Drinking Water Resources

- Monitoring of water consumption and increasing the reservoir dam when it is most needed;
- Monitoring of water quality;
- Signage and regular patrolling of the water protection area.

Wastewater

- Monitoring of rainfall and drainage through urban planning;
- Testing of mechanical water treatment;

Protection of the ecosystem and biodiversity

- There are no habitat conservation areas.

Land use planning

- Allocate housing and non-polluting business areas in industrial zones;
- Investigate and mitigate the impact of large constructions on human use of the area, health, fauna, flora, soil, etc;
- Construction of new housing;
- Expansion of a tunnel to alleviate traffic congestion;
- Acceleration of the largest housing project in Greenland.

Transport

- Prohibition of heavy fuel oils in the Arctic and collaboration on E-fuel;
- Conversion from fossil fuels to E-power;
- Reduction of taxes on electric and hybrid vehicles and free charging points offered by businesses and public charging stations throughout the city;
- Improved conditions for pedestrians and cyclists;
- New public transport plan with electric transport.

Solid Waste

- Waste and environmentally harmful substances are sent to Denmark for recycling and proper treatment;
- Establishment of a new waste incineration and treatment plant;
- Provision of wind and bird proof containers;
- Existence of an annual clean-up day and annual cleaning of the fjord;
- Hiring of 3 street sweepers to clean the city center every summer.

Environmentally Harmful Substances

- Environmentally harmful substances are treated at waste management facilities and sent to Denmark for proper and environmentally friendly processing.

Society and Culture

- Maintenance of the planning regarding significant sites;
- Open a new youth club, 2 day care centers and a new school to improve education and income opportunities, which will decrease violence in the long term;
- Create projects to reduce violence and add a violence and theft prevention specialist to the green team;
- Projects to make the city safer and create a group of volunteers to patrol the city at night.

Economy

- Encouragement of the acquisition of a certification for operators. Creation of a certification programme tailored to Greenland;
- Investigation of the possibility of the destination being certified by the International Dark Sky Association to promote winter tourism, especially the northern lights;
- Trade workshop on reducing seasonality and Greenland conference that would also address the topic;

- Diversify the economy by increasing the size of the tourism industry and new branding campaigns.

5.1.4 Rottnest Island, Australia

A summary of actions was made for each of the key performance areas presented in the action plan of the touristic destination of Rottnest Island and each action was inserted in the respective area according to the respective action plan under analysis (*Rottnest Island Sustainability Action Plan*, n.d.).

Energy Efficiency

- Measure and review all sites using renewable energy;
- Maintain a stable power supply, through an automated control system that is known as 'demand-side management', managing the consumption of energy produced in response to the system demand and availability of renewable energy.
- Investigation of Energy Efficiency measures and initiation of business planning.

Greenhouse Gases

- Continued measurement of carbon emissions as part of EarthCheck annual benchmarking process and investigation into possible carbon sequestration from revegetation programmes.

Air Quality, noise control and light pollution

- Review of the cleaning chemicals and pesticides currently used and change them to environmentally friendly products.

Drinking Water Resources

- Groundwater extraction and water quality control;
- Maintenance of the desalination capacity and the operation of the recycling water system;
- Continuation of the conservation and monitoring of conformity;

Wastewater

- Irrigation of the golf course and sports oval with treated wastewater.

Protection of the ecosystem and biodiversity

- Pursue the process of Conservation Action Planning and the implementation of key strategies.
- Preparation and implementation of the marine conservation action plan.

Land use planning

- Review the development of the planning policy to support sustainable development;
- Sustainable assessment of visitor capacity by monitoring the capacity of operational, holiday, and recreational infrastructure to identify risks and opportunities of increased visitor numbers and address them to identify risks and opportunities to increase visitor numbers.

Transport

- Preparation of transport strategy;
- Support and monitor bicycle use and walking trail;
- Transition of the island's vehicle fleet to low-emission vehicles;

Solid Waste

- Develop a Waste Reporting Framework to improve the collection and monitoring of waste data;

- Initiation of a project involving Rottnest Island businesses in reducing waste contamination levels and improving recyclable waste streams;
- Organic waste feasibility analysis to determine options for waste recovery.
- 3 bin system - This system consists of three containers, one for rubbish that is taken to landfill, another for anything that can be recycled and finally a final container for organic waste in order to recycle it and create rich soil that will help with plant growth and decrease methane gas that pollutes the air (Rottnest Island, n.d.).

Environmentally Harmful Substances

- Preparation of hazardous substance plans and operating facility inspection procedures.

Society and Culture

- Monitor visitor feedback through annual surveys;
- Improve facilities, services and experiences to meet tourist needs and expectations.
- Implementation of the Aboriginal Burial Project, this is a project to reconcile the history of the imprisonment of Aboriginal people on Rottnest Island. Between the years 1838 and 1903, Rottnest Island was used as an Aboriginal prison. During this time men and boys died who were buried at the site known as the Wadjemup Aboriginal cemetery. The aim of this project is the development of a cultural authority process to lead Aboriginal community engagement across the State.
- Integration of volunteers and commercial operators in the sustainability plans.
- Development and implementation of a plan that prioritises works in order to preserve and improve the condition of heritage sites.

Economy

- Development of a strategy for involvement in the sustainability programme for island companies.

5.1.5 Azores, Portugal

A summary of actions was made for each of the key performance areas presented in the action plan of the touristic destination of the Azores and each action was inserted in the respective area according to the respective action plan under analysis (DMO, 2021).

Energy Efficiency

- Awareness-raising actions for the local community, students and the touristic sector in order to adopt good energy efficiency practices;
- Embrace innovative projects that promote energy efficiency such as Life IP climaz - Regional Programme for Climate Change in the Azores", V2G (Vehicle to grid) Azores Project- Making electric vehicles into decentralised batteries with the aim of storing energy in them when there is an oversupply of renewable energy and injecting that energy into the grid whenever it is needed, with the owner receiving the respective compensation for that service (RESOR, 2020), RESOR - Project that aims to support energy efficiency and the use of renewable energies by

promoting best practices in secondary and tertiary sector companies (RESORT Interreg Europe, n.d.) and EMOBICITY - strives to improve low carbon economy policies by facilitating the uptake of electric mobility at national and regional level (RESOR Interreg Europe, n.d.).

Greenhouse Gases

- Empowerment of the territory with solutions focused on sustainable mobility and reduction of greenhouse gases through the electrification of the vehicle fleet of the public administration and public business sector, creation of incentives for the purchase of electric vehicles by private individuals and creation of charging points around the island;
- Installation and expansion of energy production and storage plants using renewable and endogenous sources;
- Installation of photovoltaic systems in public and private buildings;

Air Quality, noise control and light pollution

- Nothing to report on this subject.

Drinking Water Resources

- Implementation of systems to monitor water consumption through drinking water meters and losses in public drinking water supply networks through flow meters;
- Measures to mitigate the impacts generated by periods of drought and water scarcity;
- Raising awareness campaigns to the local community on the efficient use of water and the consumption of water in plastic bottles.

Wastewater

- Infrastructure and technology upgrading of urban wastewater sanitation systems and evaluation and redefinition of targets for their treatment and drainage services attendance.

Protection of the ecosystem and biodiversity

- Regulation and efficient management of the network of terrestrial protected areas in order to preserve biodiversity and well-functioning ecosystems through the creation of ecological corridors;
- Increasement of the regional network of marine protected areas through the Blue Azores project.
- Creation of an observatory to analyse the impact of microplastics and emergence of contaminants on the beaches of the Canary Islands, Cape Verde, Madeira, and the Azores.
- Promoting environmental volunteering projects.
- Implementation of innovative projects like RAGES - Definition of an approach to define risk analysis methodologies in order to assess the environmental status of the marine environment, MARCET2 - Promotion of whale watching tourism activity as a form of sustainable economic development through species conservation and protection and enhancement as Macaronesian natural heritage, MISTIC-SEAS III - Support the implementation of a sub-regional approach for the evaluation of the good environmental status of the marine waters in Macaronesia and OCEANILT - Management of coastal protected natural spaces that are affected by marine litter in oceanic archipelagos.

Land use planning

- Implementation of prevention measures against the impact of climate change and preparation of the territory to act effectively against external meteorological phenomena through specialised studies and development of management plans;
- PLASMAR + Project : Promoting progress in the sustainable planning of marine areas in Macaronesia;
- Maritime spatial planning through monitoring and assessment, licensing, bridging knowledge gaps and management of oceanic marine protected areas.

Transport

- Capacity building of the public transport network by providing vehicles powered by sustainable fuels and promoting alternative sustainable mobility solutions such as pedestrian and cycling networks.

Solid Waste

- Revision of the Strategic Plan for the Prevention and Management of Waste of the Azores;
- Legislation to replace single-use plastic products with recyclable solutions;
- Raising awareness campaigns in the local community to adopt environmentally friendly practices and behaviours;
- Project "Give another value to packaging" - System of depositing non-reusable drinks packaging through machines, in exchange for monetary value.
- Cleaning actions for the Azorean coastline and water lines, in the context of the Eco Freguesia programme - clean parish.

Environmentally Harmful Substances

- Nothing reported on this subject.

Society and Culture

- Development of online platforms for the promotion of the Azores such as the redesign of the "Culture Azores" web site, the Azores Online Training and Capacity Building Platform and the Azores Digital Cultural Heritage Platform;
- Enhancement of heritage through the updating and recognition by the GSTC of the Azores Miosotis Award;
- Awarding good sustainability practices through the Green Spirit Award;
- Awareness-raising campaigns and initiatives to engage residents, young people and the school community in cultural and environmental sustainability;

Economy

- Technological capacity building of enterprises and training of professionals;
- Promotion and certification of Azorean fishing through publicity campaigns and tourism programmes;
- Promotion campaigns for "good practices" in agriculture;
- Programme to reduce the seasonal nature of tourism, increasing overnight stays and revenue in the low season.

5.1.6 Benchmarking Conclusions

Through table 11 it is possible to observe which are the actions of each of the destinations in a summarized way and also to compare them with each other taking into consideration each specific key performance area.

In the areas of energy efficiency and greenhouse gases, most destinations have actions related to awareness campaigns, change of public lighting to LED, reforestation, electrification of the car fleet, and implementation of photovoltaic panels. In these two areas, Melgaço's destination stands out, on the positive side, with the measurement of the carbon footprint of each traveler.

Regarding the area of air quality, noise control, and light pollution, the actions of the destinations are quite different and two of them, Melgaço and Azores, have no actions regarding this area. In this area, Nuuk stands out positively through the aspiration for certification by the International Dark Sky Association. In the area of Drinking Water Resources, monitoring and the maintenance actions regarding the drinking water of the network tend to be used by destinations, as well as awareness campaigns. In this area, Melgaço's destination stands out with the use of water previously used for irrigation. Taking into account the area of Wastewater, awareness campaigns and monitoring and maintenance of the wastewater and sewage network are addressed. In the area of Ecosystem and Biodiversity, the destinations bet on environmental education plans, the preservation of fauna and flora through innovative projects, and the promotion of protected areas. Taking into account that Nuuk has no protected area, it has no actions on this theme. Prevention measures and investigation and minimization of negative environmental impacts are some of the actions addressed in the area of Land Use Planning, where the Azores stands out for the management of maritime space and Rottneest Island for the Sustainable Visitor Capacity assessment. Melgaço stands out negatively as it has no actions on this topic. In terms of transport, the reduction of taxes on electric and hybrid cars is one of the most used actions, as well as the electrification of the vehicle fleet and implementation of charging points, as well as the promotion of sustainable mobility alternatives such as bicycle and walking trails. Regarding solid waste, this is an area in which most destinations stand out. Baião stands out for the user pay principle, Melgaço for the Bio-waste selective collection system and the Solid urban waste sorting system, Nuuk for the annual cleanup, Rottneest Island for the Waste Reporting Framework and 3-Bin System, and the Azores for the initiative "Give packaging another value". The area of Environmentally Harmful Substances is a poor area for action. Baião refers to awareness-raising actions, Melgaço to the training of professionals in the handling of these substances, Nuuk sends these substances to Denmark and Rottneest Island mention the preparation of hazardous substance plans and operating facility inspection procedures. The Azores doesn't make any reference to actions on this issue. In the area of Society and Culture, the actions involve the community, social development, health incentives, and promote education. In this area, the Azores highlight the development of online platforms to promote the destination as an innovative action. Finally, in the area of economy, many of the actions involve motivation to certification and promotion of destinations, green events and sustainable activities, training of professionals, and, in the case of Nuuk and the Azores, the reduction of seasonality.

Taking into account the actions addressed by the Azores, it is observed that it is well positioned among the other destinations, with similar measures and often innovative actions

Table 11: Benchmarking Summary

Destiny/ Key Performance Area	Energy Efficiency	Greenhouse Gases	Air Quality, noise control and light pollution	Drinking Water Resources	Wastewater	Ecosystem and biodiversity	Land use planning	Transport	Solid Waste	Environmentally Harmful Substances	Society and Culture	Economy
Baião	Awareness campaigns; Promotion actions of energy efficiency in hotels and restaurants; Biomass Power Station; Electric Vehicles; LED	Reforestation with indigenous species	Footpath; Upgrade road axes	Awareness campaigns; Expansion and maintenance of drinking water network	Awareness campaigns; Extension of waste water network	Classification and promotion of Protected Areas; Reforestation; Volunteering actions; Policy for recycled paper products	Dissemination and discussion of the master plan	Reduction of public transport fares; Electrification; School transport network efficiency	Awareness campaigns; User Pays Principle	Awareness Campaigns	Involving the community; Developing a tourism strategy; Youth and sustainability festival	Involvement of all stakeholders; Logistics and promotion center (agrifood sector); Promotion of Prizes; Business networking areas
Melgaço	LED; Photovoltaic panels and heat pumps (municipal buildings); Software for monitoring	Reforestation; Carbon footprint for each traveller; Electrification of municipality's vehicle fleet; Natural gas network	No actions on this subject	Awareness campaigns; Requalification of water supply infrastructures; Network consumption monitoring Used water for irrigation;	Strengthen the connection to sewerage network	Environmental Education Plan; Cleaning points; Forest fire surveillance	No actions on this subject	Free school transport; Examine the possibility of increasing the coverage of the public transport network	Ecocenter; Awareness campaigns; Bio-waste selective collection system; Solid urban waste sorting system	Training of professionals	Incentives; Social Development and Health Plan; Promotion of gender equality; Recovery, preservation and maintenance	Certification project; Training of professionals; Safety plan for trails; Green events and activities
Nuuk	Lower taxes on hybrid and electric cars; Energy 100% green; Hydro power plant; Green energy technology	100% green electricity; Investigate; Collect data	Annual monitoring and data collection; Regulation of noise pollution; Certification by the International Dark Sky Association	Monitorization; Signage and regular patrolling	Monitoring; Testing of mechanical water treatment	No actions on this subject	Allocation of housing in industrial zones; Investigate and mitigate impacts;	Prohibition of heavy fuel oils in the Arctic; E-power; Reduction of taxes on electric and hybrid vehicles; Free charging points; New public transport plan	Waste and environmentally harmful substances sent to Denmark; New waste incineration and treatment plant; Annual clean up	Sent to Denmark	Improve education and income opportunities; Patrol the city at night	Encouraged certification; New branding campaign; Reduce seasonality Increase the size of the tourism industry;
Rothenstein Island	Stable Power Supply; Measure and review all sites using renewable energy; Investigation of Energy Efficiency measures	Measure of carbon emissions; Investigation into possible carbon sequestration from revegetation programmes	Review cleaning chemicals and pesticides	Monitoring; Maintain desalination capacity	Irrigation of the golf course and sports oval with treated wastewater	Conservation Action Planning and the implementation of key strategies; Marine conservation action plan	Review development planning policy; Sustainable visitor capacity assessment	Support and monitor bicycle use and the walking trail; Fleet of low emission vehicles	Waste Reporting Framework; Reducing waste contamination levels and improving recyclable waste streams; 3 Bin System	Hazardous substance plans and operating facility inspection procedures;	Monitor visitor feedback; Improve facilities, services and experiences; Aboriginal Burial Project; Integration of volunteers and commercial operators	Sustainability programme for island businesses
Azores	Awareness campaigns; Embrace innovative projects	Electrification of the vehicle fleet; Photovoltaic systems; Creation of incentives; Increase the use of renewable energies	No actions on this subject	Awareness Campaigns; Monitoring systems and mitigation plan for impacts;	Infrastructure and technology upgrading; Evaluation and redefinition of targets	Regulation and efficient management; Programmes to preserve fauna and flora; Increase the regional network of marine protected areas	Prevention measures; Study and management of the maritime space	Vehicles powered by sustainable fuels; Promoting alternative sustainable mobility solutions	Strategic Plan for the Prevention and Management of Waste; Project "Give another value to packaging"; Cleaning actions	No actions on this subject	Online platforms Heritage valorisation; Awareness-raising campaigns	Promotion of Azorean fish and certification of Azorean fishing; Training of professionals; Reduce the seasonal nature of tourism

5.2 Multicriteria Analysis

The multi-criteria analysis was carried out on two levels. Firstly, an analysis of the evolution of tourism sustainability from 2016 to 2020 was carried out for the Azores and then the position of the Azores about other touristic destinations was evaluated.

To carry out these two evaluations, the group of decision-makers was first defined and met once. The group is made up of three specialists in tourism sustainability, Carolina Maçanita, Coordinator of the Tourism Destination Sustainability Structure, Azores DMO, Rui Pereira former Adjunct to the Office of the Regional Secretary for Energy, Environment and Tourism, and finally, Rui Apresentação former Adjunct to the Office of the Regional Secretary for Energy, Environment and Tourism and now the current SATA (*Serviço Açoriano de Transportes Aéreos*) representative at the Observatório do Turismo dos Açores (OTA).

The first step consists of building a value tree with the definition of the objectives and evaluation criteria. The criteria chosen were taken from the Benchmarking evaluation report that is carried out annually by EarthCheck, taking into account a set of indicators presented in it, some of them mandatory for all destinations and others optional. Considering the values demonstrated by each destination about the respective indicators, EarthCheck carries out this report and compares the respective values with an average value, which will be used as the neutral level, and with the value of the best practice, which will be used as the Good level. Thirty indicators are present in this report, however, for the Multicriteria assessment only twenty were chosen, these being the criteria that the group of decision-makers considered most relevant for this assessment (Earthcheck, 2015b).

The indicator measurements in the EarthCheck report are assessed by directly evaluating destination performance against a measure that reflects the key activity of the destination, taking into account the type of impact. These activity measures are "Person Years (PY)" and "Total Destination Area (ha)". A Person-Year is equivalent to 365 full person-days, incorporating the resident population and guests. Guests can be characterised as "Guest Nights" or "Day Guests", the latter being a guest who arrives and departs on the same day. A "Guest Night" is counted as one person-day and a "Guest Day" as one-third person-day (Earthcheck, 2015a). Given that the indicators in the Benchmarking Assessment Report were calculated this way, the input of the indicator values into M-MACBETH will also be in this unit.

Equation 2 reflects how the Total Person-Years is calculated.

$$\text{Total Destination Residents} + \frac{\text{Total Number Guests Nights}}{365} + \frac{\text{Total Number of Day Guests}}{365} = \text{Total Person - Years} \quad (2)$$

The indicators chosen for this multicriteria analysis are described by EarthCheck as follows (Earthcheck, 2015b):

- **Energy Consumption (EC) (GJ/Person Year):** All energy used related to the Destination's activities. Total Energy Consumption is calculated by summing the inputs from the following

calculators, Stationary Fuels, Mobile Fuels (road), Mobile Fuels (air), Mobile Fuels (road), Mobile Fuels (water), Onsite Wastewater Treatment, and Purchased Electricity. The goal is to minimize overall energy consumption. This criterion is defined using a quantitative measure. The upper reference measurement (Good) was 38.9 GJ/ Person Year with 100 points and the lower (Neutral) was 55.6 GJ/Person Year with 0 points.

Indicator measurement:

$$\frac{\text{Total energy used (GJ)}}{\text{Person Years}} = \frac{\text{GJ}}{\text{Person Years}} \quad (3)$$

- **Greenhouse Gas Emissions (GhG) (t CO2-e / Person Year):** This is related to the direct emissions from fuel combustion and the Indirect emissions from purchased electricity due to the Community's activities. The goal is to minimise the net production of the greenhouse gas, CO2 equivalent (CO2-e), from energy consumption. This criterion was defined using a quantitative measure. The upper reference measurement (Good) was 2.8 with 100 points and the lower (Neutral) was 4 with 0 points.

Indicator measurement:

$$\frac{\text{Total greenhouse gas emissions produced (tonnes)}}{\text{Person Years}} = \text{t/Person Year} \quad (4)$$

- **Indirect Emissions(IE) (t CO2-e / Person Year):** This optional reporting category allows tool users to estimate other indirect emissions such as those arising from solid waste disposal at centralized landfill sites, at centralised incineration sites and from visitor and employee transport. This criterion was defined using a quantitative measurement. The upper reference measure (Good) was 0.33 with 100 points and the lower (Neutral) was 0.35 with 0 points.

Indicator measurement:

$$\frac{\text{Total indirect emissions produced (tonnes)}}{\text{Person Years}} = \text{t/Person Year} \quad (5)$$

- **Potable Water Consumption (PW C) (kL/ PersonYear) :** Total potable water consumed relating to the Destination's activities. The goal is to minimise consumption of potable water. This criteria using a quantitative measurement with the upper reference (Good) being 56.53 with 100 points and the lower level (neutral) being 80.75 with 0 points.

Indicator measurement:

$$\frac{\text{Total volume of potable water used (kL)}}{\text{Person Years}} = \text{kL/Person Year} \quad (6)$$

- **Waste Send to Landfill (WSTL) (m³ / PersonYear)** : All material sent to landfill by the Destination. The goal is to reduce the amount of waste generated. This criterion was defined using a quantitative measurement with the upper level (Good) with 100 points being 0.62 and the lower level (Neutral) with 0 points being 0.89.

Indicator measurement:

$$\frac{\text{Total volume of waste landfilled (m}^3\text{)}}{\text{Person Years}} = \text{m}^3/\text{Person Year} \quad (7)$$

- **Recycled / Reused / Composted Waste (R/R/C W) (%)** : This is an optional criterion related to the percentage of waste recycled, reused or sent for composting. The higher the percentage, the better. This criteria was defined using a quantitative measurement with the upper level (Good) with 100 points being 38 and the lower level (Neutral) with 0 points being 27.7.

Indicator measurement:

$$\frac{\text{Total waste recycled/reused/Composed (m}^3\text{)}}{\text{Total waste produced(m}^3\text{)}} = \text{ratio} \quad (8)$$

- **Waste Sent for incineration (WSI) (L/ Person Year)** : This is an optional criterion related to the volume of waste sent for incineration. The lower the value, the better. This is a quantitative criterion where the Upper level (Good) is 94.6 with 100 points and the Lower level (Neutral) is 126.7 with 0 points.

Indicator measurement:

$$\frac{\text{Total volume of waste incinerated (L)}}{\text{Person Years}} = \text{L/Person Year} \quad (9)$$

- **Nitrous Oxides Produced (NOP) (kg/PersonYear/Hectare)** : The total Nitrous Oxides produced due to the Destination's activities from burning fossil fuels to produce energy, from burning agricultural crops and waste, from the incineration of solid waste, from emissions from industrial chimneys, etc. The lower the production, the better. This is a quantitative criterion where the Upper level (Good) is 6.3 with 100 points and the Lower level (Neutral) is 9 with 0 points.

Indicator measurement:

$$\frac{\text{Total weight of nitrous oxide produced (kg)}}{\text{Person Years / Total Destination Area}} = \text{kg/Person Year/Hectare} \quad (10)$$

- **Sulphur Dioxide Produced (SDP) (kg/PersonYear/Hectare)** : The total of Sulphur Dioxide produced due to the Destination's activities from burning fossil fuels to produce energy, from burning agricultural crops and waste, from the incineration of solid waste, from emissions from industrial chimneys, et.. The lower the production, the better. This is a quantitative criterion where the Upper level (Good) is 9 with 100 points and the Lower level (Neutral) is 12.8 with 0 points.

Indicator measurement:

$$\frac{\text{Total weight of sulphur dioxide produced (kg)}}{\text{Person Years / Total Destination Area}} = \text{kg/Person Year/Hectare} \quad (11)$$

- **Particulate Matter Produced (PMP) (kg/PersonYear/Hectare)** : The total Particulate Matter Produced due to the activities of the Destination from burning fossil fuels to produce energy, from burning agricultural crops and waste, from the incineration of solid waste, from emissions from industrial chimneys, etc. The lower the production, the better. This is a quantitative criterion where the upper level (Good) is 45.8 with 100 points and the lower level (Neutral) is 51.4 with 0 points.

Indicator measurement:

$$\frac{\text{Total weight of particulate matter produced (kg)}}{\text{Person Years / Total Destination Area}} = \text{kg/Person Year/Hectare} \quad (12)$$

- **Water Samples Passed (WSP) (%)** : Percentage of samples from waterways (fresh and salt) within the defined target area that pass the quality guidelines. The more samples that pass, the better. It is a quantitative criterion where the Upper Level (Good) is 100 with 100 points and the Lower Level (Neutral) is 70 with 0 points.

Indicator measurement:

$$\frac{\text{Total waterways samples passing quality}}{\text{Total number of waterways samples tested}} = \text{ratio} \quad (13)$$

- **Habitat Conservation Area (HCA) (%)** : Percentage of all land and waterways within the defined target area. Habitat conservation is a land management practice that aims to conserve, protect and restore areas of natural habitat and waterways for native or regenerated vegetation and native flora and fauna species. The greater the percentage of protected area, the better. It

is a quantitative criterion where the Upper Level (Good) is 26% with 100 points and the Lower Level (Neutral) is 20% with 0 points.

Indicator measurement:

$$\frac{\text{Area set aside for conservation of native species (ha)}}{\text{Total Destination Area (ha)}} = \text{ratio} \quad (14)$$

- **Green Space (GS) (%)** : Green space is defined by EarthCheck as "a plot of land separating or surrounding areas from intensive residential or industrial use, which is maintained for recreational enjoyment". The purpose of green space is to provide both environmental and social benefits, including continuous habitat for wildlife, protection of natural or semi-natural environments, provision of areas for recreational enjoyment and improvement of air quality. The higher the percentage the better. This criterion is defined through a quantitative measurement. The Upper Level (Good) is 20% with 100 points and the Lower Level (Neutral) is 15% with 0 points.

Indicator measurement:

$$\frac{\text{Green space area of destination (ha)}}{\text{Total Destination Area (ha)}} = \text{ratio} \quad (15)$$

- **Homicide Rate (HR) (%)** : Percentage of Police-recorded Homicide Offences. In a visitor economic levels of crime can directly impact on the attractiveness of a location for existing and potential visitors¹, not to mention residents. This criterion is defined through a quantitative measure. The Upper Level (Good) is 0.0008 with 100 points and the Lower Level (Neutral) is 0.0011 with 0 points.

Indicator measurement:

$$\frac{\text{Police reported homicide offences}}{\text{Total resident population}} = \text{ratio} \quad (16)$$

- **Theft Rate (TR) (%)** : Percentage of Police-recorded Theft Offences. In a visitor economic levels of crime can directly impact on the attractiveness of a location for existing and potential visitors, not to mention residents. This criterion is defined through a quantitative measure. The Upper Level (Good) is 1.6 with 100 points and the Lower Level (Neutral) is 2.28 with 0 points.

Indicator measurement:

$$\frac{\text{Police reported theft of fences}}{\text{Total resident population}} = \text{ratio} \quad (17)$$

- **Assault Rate (AR) (%)** : Percentage of Police-recorded Assault Offences. In a visitor economic levels of crime can directly impact on the attractiveness of a location for existing and potential visitors, not to mention residents. This criterion is defined through a quantitative measurement. The Upper Level (Good) is 0.16 with 100 points and the Lower Level (Neutral) is 0.23 with 0 points.

Indicator measurement:

$$\frac{\text{Police reported assault offences}}{\text{Total resident population}} = \text{ratio} \quad (18)$$

- **Significant Site Maintenance Fund (Maintenance Fund) (%)** : Percentage of the Destination Authority budget allocated to the maintenance of important sites. Noteworthy improvement in the management of significant cultural and heritage sites can be achieved through a greater percentage of the Destination Authority's annual government budget associated with site maintenance. This criterion is defined through a quantitative measurement. The Upper Level (Good) is 4.6 with 100 points and the Lower Level (Neutral) is 6.5 with 0 points.

Indicator measurement:

$$\frac{\text{Destination Authority budget allocated to the maintenance of significant sites}}{\text{Total Destination Authority budget}} = \text{ratio} \quad (19)$$

- **Unemployment Rate (UR) (%)** : Unemployment rates measured within the Destination, data of which is made available to the Destination Authority. Monitoring of unemployment rates in Destinations which include significant visitor economies can assist Destination Authority's in the planning of education programs, seasonal fluctuations of employment, and understanding the links between unemployment rates and potential spikes in crime. Reductions in unemployment rates can also benefit poverty reduction strategies. This criterion is defined through a quantitative measurement. The Upper Level (Good) is 1.1 with 100 points and the Lower Level (Neutral) is 0.7 with 0 points.

Indicator measurement:

Overall Destination Unemployment rate as a percentage.

- **Sustainability Policy (Policy)**: The Sustainability Policy is a Destination's statement with respect to its assessment, control and where appropriate, continual improvement, of environmental, economic, cultural, social (ESCE) impacts. These include policies addressing travel and tourism activities and development and a focus on ESCE outcomes established through local community participation. This criterion was defined using the "qualitative performance levels". There are three performance levels: "Policy is produced and in place" (Upper Level); "Policy is produced but not implemented" (Neutral Level); "Policy does not exist".

- Accredited Operations (Accredited Op) (%)**: Percentage of the Environmentally accredited operators (All travel and tourism operators). The involvement of individual travel and tourism operations located within the Destination in environmental accreditation schemes is a reflection of the level of commitment made by the local industry to the Destination's environment. This criterion is defined through a quantitative measurement. The Upper Level (Good) is 6.5 with 100 points and the Lower Level (Neutral) is 5 with 0 points.

Indicator measurement:

$$\frac{\text{Environmentally accredited operators}}{\text{Total number of operators in the Destination}} = \text{ratio} \quad (20)$$

Each of the above indicators covers several of the Key Performance Areas previously mentioned in section 2.2, which are important factors to consider in a good sustainability management (Earthcheck, 2015b). Table 12 shows the key performance areas covered by each criterion.

Table 12: Key performance areas of each criterion

Adapted from (Earthcheck, 2015b)

	Energy Efficiency	Greenhouse Gases	Air Quality, noise control and light pollution	Drinking Water Resources	Wastewater	Protection of the ecosystem and biodiversity	Land use planning	Transport	Solid Waste	Environmentally Harmful Substances	Society and Culture	Economy
Energy Consumption	x	x	x			x		x				
Greenhouse Gas Emissions	x	x	x			x	x	x				
Indirect Emissions	x	x	x			x	x	x				
Potable Water Consumptions	x	x	x	x	x		x		x			
Waste Send to Landfill	x	x	x			x			x			
Recycled/Reused/Composed	x	x	x			x			x			
Waste Sent for incineration	x	x	x			x			x			
Nitrous Oxide Produced	x	x	x			x						
Sulphur Dioxide Produced	x	x	x			x						
Particulate Matter Produced	x	x	x			x						
Water Samples Passed		x		x	x	x				x	x	
Habitat Conservation Area		x	x	x	x	x	x		x	x	x	
Green Space		x	x	x	x	x	x		x		x	
Homicide Rate											x	x
Theft Rate											x	x
Assault Rate											x	x
Significant Site Maintenance Fund											x	x
Unemployment Rate											x	x
Sustainability Policy	x	x	x	x	x	x	x	x	x	x	x	x
Accredited Operations	x	x	x	x	x	x	x	x	x		x	

After defining the indicators , figure 5 shows the value tree, organized with nodes in red, criteria nodes, used to evaluate the alternatives and then the recommended solution and non-criteria nodes in blue were chosen.

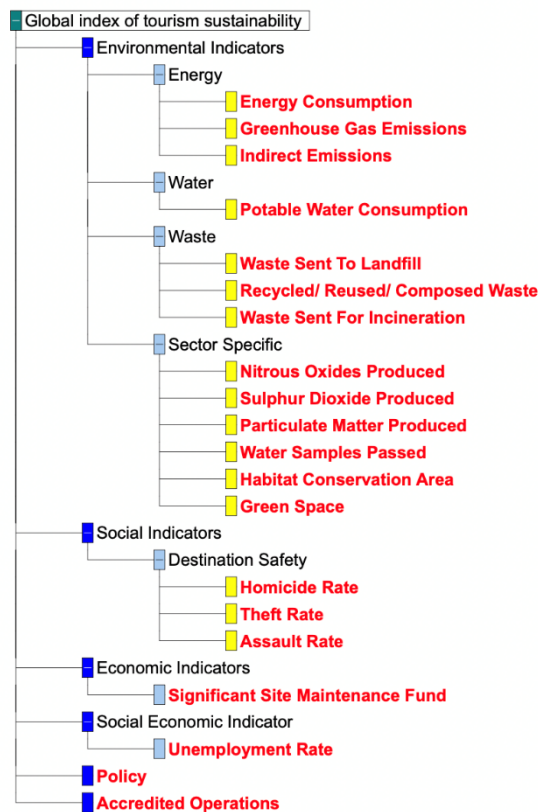


Figure 5: Value Tree

Once all the criteria have been defined, it is necessary to quantify all the options for all criteria in the years 2016 to 2020. Each year will be assessed as an alternative, so that sustainability evolution can be assessed. There are five options corresponding to the years 2016, 2017, 2018, 2019 and 2020. Each option is filled with the respective values for each criterion, as represented in table 13.

Table 13: Table of Performances

Options/Criteria	Energy Consumption	Greenhouse Gas Emissions	Indirect Emissions	Potable Water Consumptions	Waste Sent to Landfill	Recycled/Reused/Composed	Waste Sent for incineration	Nitrous Oxide Produced	Sulphur Dioxide Produced	Particulate Matter Produced	Water Samples Passed	Habitat Conservation Area	Green Space	Homicide Rate	Theft Rate	Assault Rate	Significant Site Maintenance Fund	Unemployment Rate	Sustainability Policy	Accredited Operations
2016	50,3	3,63	0,35	81,4	0,92	27,7	94,6	12,61	1,2	48,6	98,8	39	92	0,008	0,21	0,1	0,9	11,1	In Place	1,9
2017	57,6	4,15	0,34	79,4	0,89	28,8	103,4	12,88	1,22	49,9	98,9	39	92	0,011	0,23	0,008	0,7	9	In Place	2,4
2018	58,8	4,23	0,33	81,5	0,86	28,9	123	12,93	1,22	50,6	98,9	39	92	0,014	0,24	0,016	0,7	8,6	In Place	2,3
2019	57,7	4,15	0,33	73,4	0,87	38	121,9	13,03	1,22	51,4	98,9	39	92	0,007	0,21	0,14	1,1	7,9	In Place	3,4
2020	52,9	3,51	0,33	83,3	0,87	37,8	126,7	11,91	1,13	45,8	96,3	39	91,4	0,014	0,24	0,016	0,7	8,6	In Place	3,2

After filling in the table of performances, the options for each criterion were peer-assessed by the group of decision makers using the M-MACBETH qualitative semantic scale. This scale is composed of six levels: very weak, weak, moderate, strong, very strong and extreme, allowing the process to be carried out without losing scientific rigor and consistency. After filling in the matrix of judgements made to each criterion, M-MACBETH creates a numerical value scale for each one.

The last step is the attribution of weights to the criteria. For this, it is first necessary to rank the criteria in a descending order of attractiveness in relation to the importance that the criteria has when preserving the destination with the evolution of the touristic flow for the group of decision-makers, as shown in table 14, and filled in the judgement matrix.

Table 14: Ordination of the criteria in a descending order of attractiveness

Position	Criteria
1°	Potable Water Consumption
2°	Habitat Conservation Area
3°	Waste Send To Landfill
4°	Recycled / Reused / Composted Waste
5°	Green Space
6°	Indirect Emissions
7°	Greenhouse Gas Emissions
8°	Waste Sent to Incineration
9°	Energy Consumption
10°	Accredited Operations
11°	Assault Rate
12°	Theft Rate
13°	Water Samples Passed
14°	Unemployment Rate
15°	Nitrous Oxides Produced
16°	Sulphur Dioxide Produced
17°	Particulate Matter Produced
18°	Homicide Rate
19°	Sustainability Policy
20°	Significant Site Maintenance Fund

The judgement matrix is also filled in using the M-MACBETH qualitative semantic scale comparing each pair of criteria. Only the last column, the first row and the space of the column immediately above the diagonal were filled in, the rest was filled in by transitivity by the software itself. Finally, the software scores each criterion based on the filling of the matrix and calculates the scale of weights. Figure 6 represents the final histogram obtained for the criteria weight, where the values represented in the figure are the weights of each of the criteria.

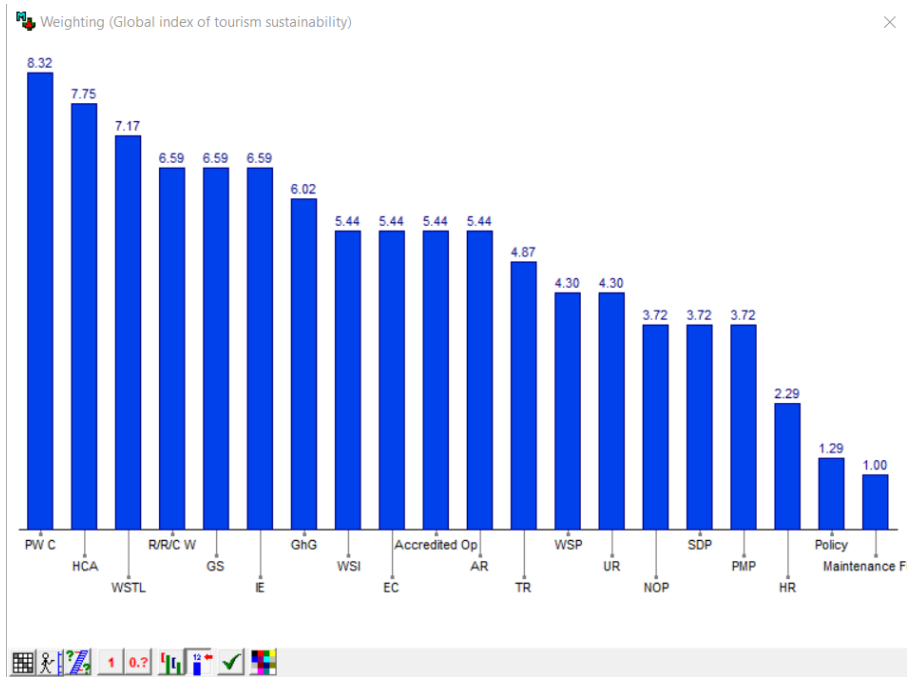


Figure 6: Histogram obtained for the criterion weigh

Next, through figure 7 it is possible to extract the order of preference of the options in relation to the overall value, which in this case is the overall sustainability index calculated through M-MACBETH.

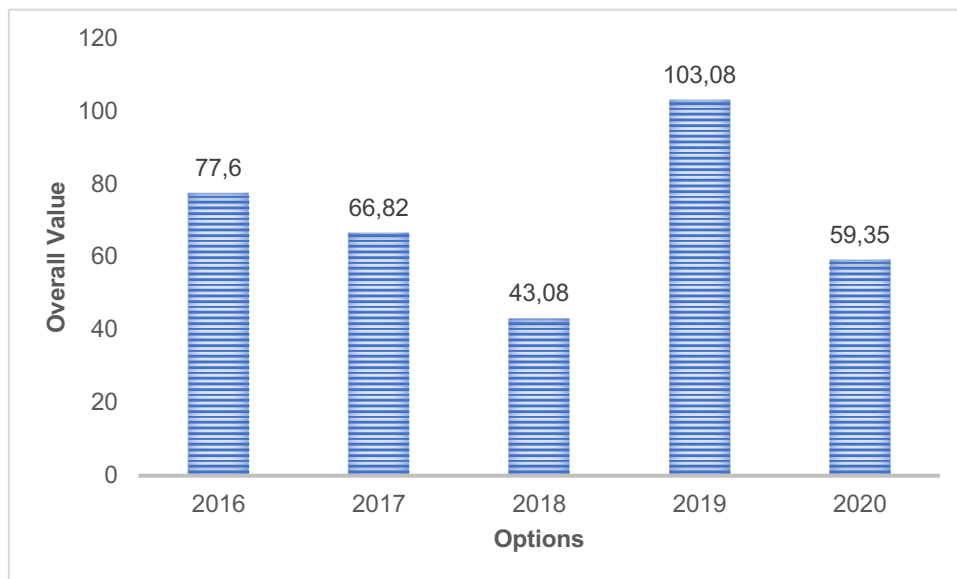


Figure 7: Overall values of each option

Figure 7 represents the evolution of the sustainability index of the Azores Autonomous Region. Note that the year 2019, even being the year of the highest tourist inflow, is also the year with the highest sustainability index, since it obtained a higher overall performance of the sustainability indices studied. This order is logical and can be explained through the following paragraph: 2016 was the first year in which an increase in the number of tourists started to be noticed, therefore being a year in which, in the beginning, there was no great negative impact and therefore it has a better overall sustainability index, placing it in position two. The years 2017, and 2018 were critical years because they were the years in

which the measurements for sustainable tourism were still being designed by the government of the Azores. As there were no procedures implemented yet. The implementation of the procedures only took place in 2019, the general sustainability index decreased with the growth of tourism in those years. In 2019 improvements have already been observed at the level of the unemployment rate, homicide rate, indirect emissions, recycled/reused/composed waste, accredited operations, potable water consumption, waste sent to landfill, and maintenance fund as can be seen in figure 8.

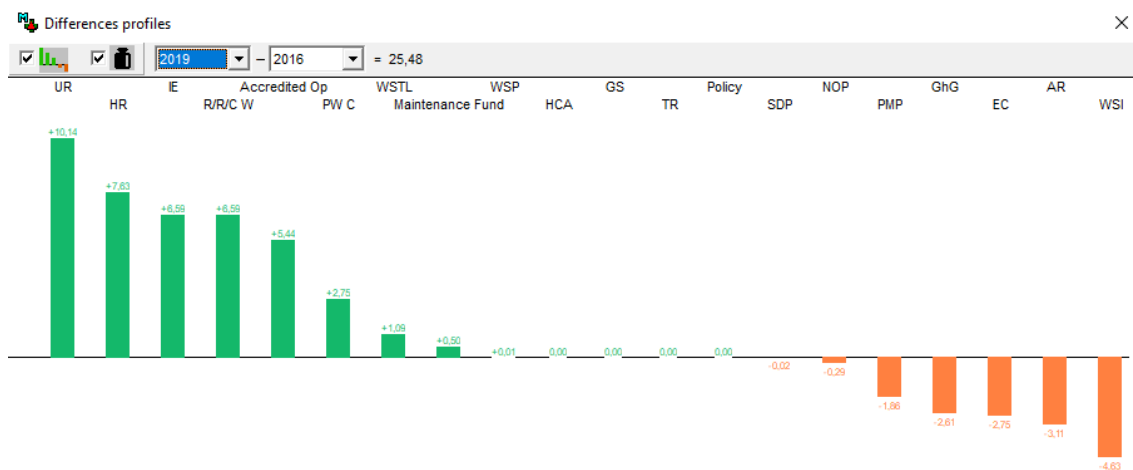


Figure 8: Differences between the years 2019 and 2016

The year 2020 is in the penultimate position, as it was a very atypical year because of the pandemic, in which no tourist activity was in its normalcy, the number of tourists dropped abruptly, and the fixed population spent most of their time at home. With all this, this year cannot be compared to any of the others because it did not suffer a normal evolution.

After everything said above, it is possible to say that the overall tourism sustainability index has been improving over the years, as soon as measures are implemented and put into practice, improvements in the overall sustainability index are being noticed.

The above-mentioned values are the result of the combination of the partial scores of each option with the assigned weights. Thus, the variation of the values attributed to the criteria weights may lead to a change in the value of the general sustainability index and therefore in the variation of the ranking mentioned above. For this reason, a sensitivity analysis of some of the criteria was performed, raising the weight of those criteria with a large variation so that the order of preference of the options would be changed. To carry out the sensitivity analysis it was decided to use only the options for the years 2016, 2017, 2018, and 2019, taking into account that the conditions for the year 2020 are not comparable with the other years. With this, it was observed that for the criteria Indirect Emissions, Assault Rate, and Unemployment Rate and Accredited Operations a variation of less than 20% was required for the ranking of the options to change and therefore sensitivity analysis was only performed on these criteria. For the remaining criteria, a variation of more than 20% would be required.

Through the sensitivity analysis of the Indirect Emissions criterion, it was possible to observe that from a weight of 23.2%, which is the current weight by 16.61% increased. The year of 2016 is surpassed by the year of 2017, as can be observed in figure 9. A variation of more than 20% is already required for the other options to be surpassed.

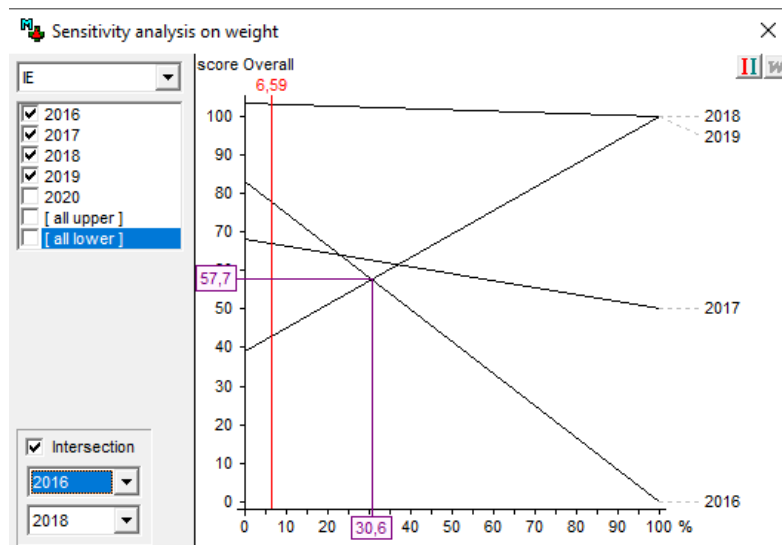


Figure 9: Sensitivity analysis on Indirect Emissions criterion

With regard to the Assault Rate criterion, it was observed through figure 10 that only a mere increase of 7.16% occurred, i.e. increasing the weight of the criterion from 5.44% to 12.6%, the 2016 option is surpassed by the 2017 option and from a weight of 20.7% the 2019 option is also surpassed by the 2017 option.

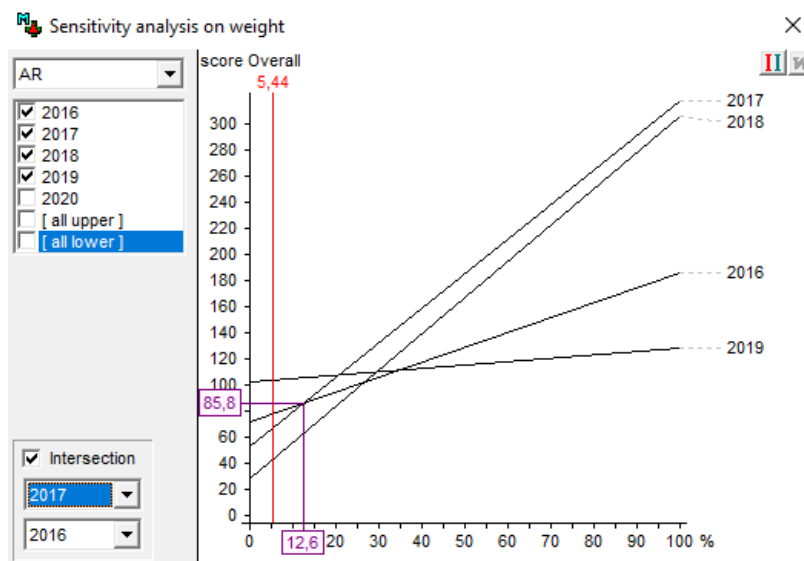


Figure 10: Sensitivity analysis Assault Rate criterion

Finally, in the Unemployment Rate criterion, it was noted that an increase from 4.30% to 10.5% is required for the 2016 option to be overtaken by the 2017 option as shown in figure 11 and an increase up to 19.4% for the 2016 option to also be overtaken by the 2018 option.

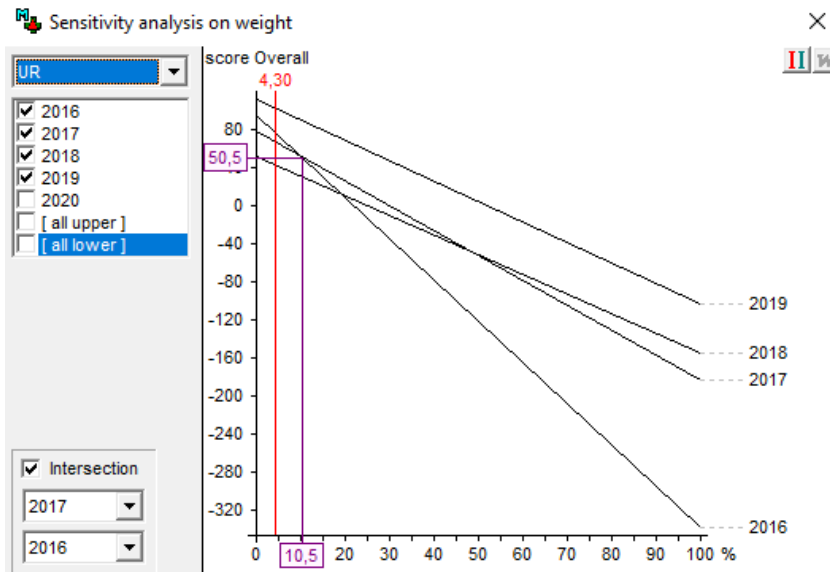


Figure 11: Sensitivity analysis Unemployment criterion

Thus, it can be seen that there are only 3 indicators where a change of less than 20%, which is still a considerable variation, changes the attractiveness ranking of the options. Through this sensitivity analysis, it is concluded that the results are robust and the change of the weighting of the criteria is unlikely to modify the ranking of the options.

In the second part of this analysis, it was evaluated how the Azores positioned itself in relation to other destinations in the year of 2019. This was the year chosen because it was the most recent year, with exception of 2020. To this end, the Benchmarking destinations that provided the Benchmarking Assessment Report, Baião and Nuuk, were chosen because it is from there that the values of the indicators to be inserted into M-MACBETH are taken, as it was done in the first part. The destination Snaefellsnes, Iceland, was also added, even though it was one of the destinations where the action plan was unknown. However, the Benchmarking Assessment Report was found and so it was one of the destinations used in the comparison of the Azores with the other destinations to make the analysis richer.

Taking into account that the Benchmarking Assessment Report contains mandatory and optional indicators, only the indicators common to the selected destinations were chosen as criteria, these being: Energy consumption, Greenhouse gas emissions, Drinking water consumption, Waste sent to Landfill, Waste recycled/reused/composted waste, Nitrous oxides produced, Sulphur dioxide produced, Particulate matter produced, Water samples passed, Habitat Conservation Area, Green space, Homicide rate, Burglary rate, Assault rate, Unemployment rate, Policy and Accredited Operations.

First, the options table was filled in as shown in table 15.

Table 15: Table of performances

Options/Criteria	Energy Consumption	Greenhouse Gas Emissions	Potable Water Consumptions	Waste Send to Landfill	Recycled/Reused/Composed	Nitrous Oxide Produced	Sulphur Dioxide Produced	Particulate Matter Produced	Water Samples Passed	Habitat Conservation Area	Green Space	Homicide Rate	Theft Rate	Assault Rate	Unemployment Rate	Sustainability Policy	Accredited Operations
Baião	14,03	1,69	31,05	1,124	11,6	5,61	0,51	15,27	0	12,1	63,5	0,0053	0,17	0,23	12,2	In Place	0
Nuuk	156,62	8,9	73,2	0,6	0	0,024	0,00215	0,0453	99,3	0	64	0	0,884	1,5	2,5	In Place	0
Azores	57,7	4,15	73,4	0,87	38	13,03	1,22	51,4	98,9	39	92	0,007	0,21	0,14	7,9	In Place	3,4
Snaefellsnes	144,5	2,9	475	1,7	41	0,75	0,17	0,02	100	14	99	0	0,68	0	1,9	In Place	1,9

After filling in the performance table, the options for each criterion were evaluated terms of quality in the same way as in the previous analysis, as well as assigning weights to the criteria. The judgment matrix also remained the same taking into account the indicators presented and therefore, the weights for each criterion were those obtained in figure 12.

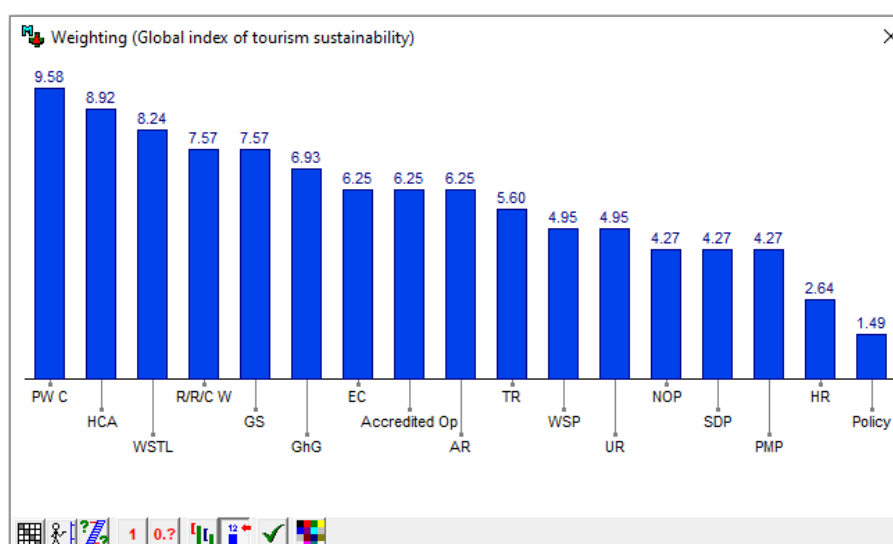


Figure 12: Histogram obtained for the criterion weigh

Following this, it is possible to extract the order of preference of the options in relation to the global sustainability index calculated through M-MACBETH, i.e. it is possible to observe that the Azores ranks first with 108.65 points, Baião second with 36.01, Snaefellsnes third with 7.29 and, finally, Nuuk with -85.38 points in table 16.

Table 16: Ranking of the options

	Option	Sustainability Index
1°	Azores	108,65
2°	Baião	36,01
3°	Snaefellsnes	7,29
4°	Nuuk	-85,38

With this analysis, it is possible to conclude that the Azores, in terms of tourism sustainability, is the destination with the best performance, and therefore other destinations should look to their practices as

an example to follow. Nevertheless, there are actions practiced by other destinations that the Azores does not contemplate, and, therefore, it would be interesting to include some of these actions in the Azorean action plan to be able to further improve the archipelago's performance.

For the sensitivity analysis, the criteria chosen were those where a variation in the weight of the criterion (less than 20%) would cause the Azores to fall from first place in the ranking of destinations. The criteria chosen were the following: Nitrous Oxide Produced and Homicide Rate.

For the criterion nitrous oxides produced, it was observed through figure 13, that it was necessary to change the weight of the criterion from 4.27% to 23.4%, i.e. a variation of 19.13% for the Azores destination to be overtaken by Snaefellsnes. From a weight of 33.9%, the Azores move to the last place in the ranking.

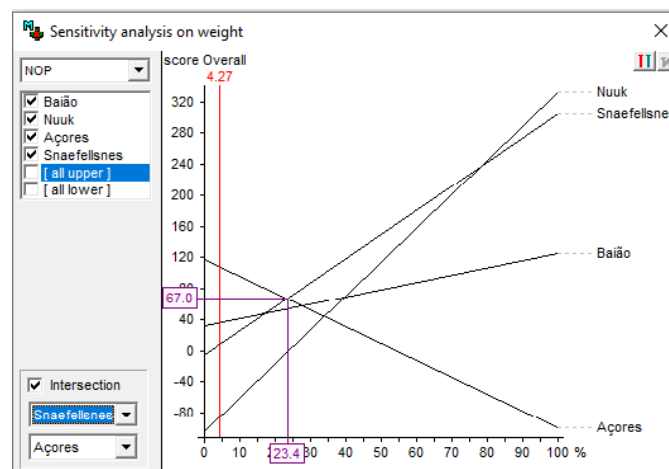


Figure 13: Sensibility Analysis to the Nitrous Oxide Produced criterion

For the homicide rate criterion, it was observed through figure 14, that it was only necessary to change the value of the weight of the criterion from 2.64% to 6.7%, that is, a variation of 4.06% for the Azores destination to be surpassed by Snaefellsnes. From a weight of 13.7% the Azores move to the last place in the ranking.

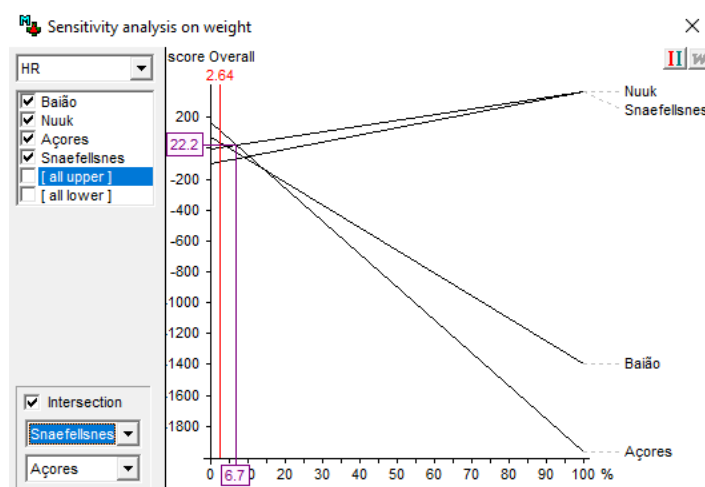


Figure 14: Sensibility Analysis to the Homicide Rate criterion

With this, it can be seen that for the Azores to move out of first place in the ranking a relatively minor change is required in only one measurement. Substantial changes of more than 20% are required in the remaining criteria, which significantly makes the results of this analysis robust.

5.3 Guidelines Proposal

In order to create a set of suggestions regarding tourism sustainability actions for the island of São Miguel, the percentage of overnight stays on the island was calculated in relation to the rest of the Autonomous Region of the Azores (RAA) so as to understand to what extent can São Miguel Island contribute to the value of the indicators presented in section 5.2. As represented in table 17, the average percentage of overnight stays on the island of São Miguel was 69% between the years 2016 and 2021, reaching 82% in the year 2021, a value that is extremely high and unsustainable, as it indicates a lot of concentration of tourists on the island of São Miguel, worsening the indicators of tourism sustainability of the same.

Table 17: Percentage of overnight stays in São Miguel

	2016	2017	2018	2019	2020	2021
RAA	1976083	2384057	2563640	3009845	866221	1484192
São Miguel	1291404	1605354	1697051	2073282	533706	1212936
%	65%	67%	66%	69%	62%	82%
Average			69%			

Taking into account this percentage of almost 70%, it can be assumed that the island of São Miguel has a large weight in the value of the indicators measured in section 5.2 and that, for this reason, if a set of measures are applied to the island of São Miguel with the purpose of an improvement in the general index of tourism sustainability there will be, not only an improvement on the island of São Miguel but also in the rest of the autonomous region of the Azores. Following this statement, the indicators mentioned in section 5.2 will be used as a reference for a proposal of measures and actions to be implemented in São Miguel in order to improve tourism sustainability on the island, which in turn will also improve the region's index.

In table 18 all the indicators studied previously are represented, the indicators in green are those in which the evolution from 2016 to 2019 was declared as positive, the indicators in yellow were stable and those in red underwent a negative evolution, i.e. a worsening of the value of the indicators. Taking into account this assessment, the yellow and red indicators are those that need improvement.

Table 18: Categorization of indicators by evolution

Indicators with good progress	Indicators with no progress	Negative evolution of indicators
Unemployment rate; Homicide rate; Indirect Emissions; Recycled/Reused/Composed Waste; Accredited Operations; Potable Water Consumption; Waste Sent to Landfill; Maintenance Fund; Water Samples Passed; Policy	Habitat Conservation Area; Green Space; Theft Rate	Sulphur Dioxide Produced; Nitrous Oxide Produced; Particulate Matter Produced; Greenhouse Gas Produced; Energy Consumption; Assault Rate; Waste Send for Incineration

In order to understand what actions and measures can be applied in order to improve the above mentioned indicators, the document "Sustainability Action Plan 2019-2030" for the autonomous region of the Azores was used as in section 5.1.5. Table 19 demonstrates which actions in the action plan affect the indicators in need, as well as the respective key performance areas that each indicator covers (key performance areas represented in table 12 of section 5.2).

Table 19: Existing actions for the respective indicators

Existing Actions	Indicators that the actions affect	Key Performance Areas covered
<p>Awareness-raising actions for the local community, students and the tourist sector in order to adopt good energy efficiency practices;</p> <p>Embrace Innovative Projects;</p> <p>Electrification of the vehicle fleet of the public administration and public business sector, creation of incentives for the purchase of electric vehicles by private individuals and creation of charging points around the island;</p> <p>Installation of photovoltaic systems in public and private buildings;</p>	<p>Energy Consumption;</p> <p>Greenhouse Gases;</p> <p>Nitrous Oxide;</p> <p>Sulphur dioxide;</p> <p>Particular Matter Produced;</p>	<p>Energy Efficiency;</p> <p>Greenhouse Gases;</p> <p>Air Quality, Noise Control and Light Pollution;</p> <p>Ecosystem and Biodiversity;</p> <p>Land Use Planning;</p> <p>Transport</p>
<p>Installation and expansion of energy production and storage plants using renewable and endogenous sources;</p> <p>Capacity building of the public transport network by providing vehicles powered by sustainable fuels and promoting alternative sustainable mobility solutions such as pedestrian and cycling networks.</p>	<p>Greenhouse Gases;</p> <p>Nitrous Oxide;</p> <p>Sulphur dioxide;</p> <p>Particular Matter Produced;</p>	<p>Energy Efficiency;</p> <p>Greenhouse Gases;</p> <p>Air Quality, Noise Control and Light Pollution;</p> <p>Ecosystem and Biodiversity;</p> <p>Land Use Planning;</p> <p>Transport</p>
<p>Regulation and efficient management of the network of terrestrial protected areas</p> <p>Blue Azores project</p> <p>Creation of an observatory to analyse the impact of microplastics and emerging contaminants</p> <p>innovative projects</p> <p>PLASMAR + Project</p> <p>Maritime spatial planning</p>	<p>Habitat Conservation Area</p>	<p>Greenhouse Gases;</p> <p>Air Quality, Noise Control and Light Pollution;</p> <p>Drinking Water Resources;</p> <p>Wastewater;</p> <p>Ecosystem and Biodiversity;</p> <p>Land Use Planning;</p> <p>Solid Waste;</p> <p>Environmentally Harmful Substances;</p> <p>Society and Culture</p>
<p>Promoting environmental volunteering projects.</p> <p>Implementation of prevention measures against the impact of climate change and preparation of the territory to act effectively against external meteorological phenomena</p>	<p>Habitat Conservation Area</p> <p>Green Space</p>	<p>Greenhouse Gases;</p> <p>Air Quality, Noise Control and Light Pollution;</p> <p>Drinking Water Resources;</p> <p>Wastewater;</p> <p>Ecosystem and Biodiversity;</p> <p>Land Use Planning;</p> <p>Solid Waste;</p> <p>Environmentally Harmful Substances;</p> <p>Society and Culture</p>
<p>Revision of the Strategic Plan for the Prevention and Management of Waste of the Azores;</p> <p>Legislation to replace single-use plastic products with recyclable solutions;</p> <p>Raising awareness campaigns in the local community to adopt environmentally friendly practices and behaviours;</p> <p>Project "Give another value to packaging"</p> <p>Cleaning actions for the Azorean coastline and water lines</p>	<p>Nitrous Oxide;</p> <p>Sulphur dioxide;</p> <p>Particular Matter Produced</p> <p>Waste Sent for Incineration</p>	<p>Energy Efficiency;</p> <p>Greenhouse Gases;</p> <p>Air Quality, Noise Control and Light Pollution;</p> <p>Ecosystem and Biodiversity;</p> <p>Solid Waste</p>

After observing the existing actions, it is concluded that the actions present in the action plan start from 2019 and, in that way, it is normal that their effect is not felt in the results of section 5.2, which in turn are until 2020, this being an atypical year due to COVID-19. For this reason, it is advisable to continue

the practice and implementation of the previously existing actions. Furthermore, it is important that other actions from the benchmarking carried out in section 5.1 and other actions considered relevant to improve the indicators are added in order to improve the sustainability of tourism on the island of São Miguel.

The actions that should be added to the Azores action plan, taking into account the indicators that did not undergo a positive evolution, are represented in table 20.

Table 20: Actions to be added to the Action Plan of the Azores

Actions to be added	Source	How the indicators are affected	Indicators affected
Changing public lighting to LED	Baião and Melgaço	LED lamps are more efficient, consume less energy and therefore reduce the Energy Consumption Indicator	
Implement energy efficiency measures specifically for hotels and restaurants	Baião	It was noted that there was a lack of actions directly related to energy efficiency in hotels and restaurants and therefore, implementing this action will improve their energy efficiency, reducing energy consumption	
Hotel Energy Solutions (HES) Project: Project initiated by the World Tourism Organization (UNWTO), which provides information, technical support and training to small and medium-sized enterprises in the tourism and accommodation sector. One tool provided to businesses under this project is the e-toolkit which provides an assessment of the current energy situation and recommends suitable renewable energy and energy efficiency technologies. This project helps businesses and tourist destinations adapt to changing climate conditions, the attenuation of greenhouse gas emissions and use of renewable energy resources and technologies	(UNWTO, n.d)	The aim is to increase energy efficiency and the use of renewable energies by reducing energy consumption and the production of greenhouse gases, nitrous oxides, sulphur dioxide and Particular Matter.	Energy Consumption; Greenhouse Gases; Nitrous Oxide; Sulphur dioxide; Particular Matter Produced;
Water and energy consumption management and monitoring software	Melgaço	Monitor energy consumption in order to reduce energy consumption.	
Electrification of the rent-a-car, taxi fleet and Collective tour vans		Reducing energy consumption and the production of greenhouse gases, nitrous oxides, sulphur dioxide and particulate matter.	
Calculation of the carbon footprint of each traveller and the possibility of compensation	Melgaço	Encourage the reduction of the carbon footprint of each passenger, in order to decrease the emission of greenhouse gases.	
Carbon Neutral Programme: Programme that aims to neutralise greenhouse gas emissions emitted by the local and tourist community through the acquisition of green bonds or carbon credits in international markets, specifically purchased from sustainable conservation and reforestation projects for forests and jungles in Mexico supported by the United Nations	Huatulco	Neutralise greenhouse gas emissions	Greenhouse Gases;
Improving the island's public transport network by creating tourist routes, increasing the number of buses and better managing the bus fleet		Contribute to the increased use of public transport in order to reduce greenhouse gas emissions.	
Bio-waste selective collection system	Melgaço		Waste Sent for incineration; Nitrous Oxide; Sulphur dioxide; Particular Matter Produced;
3 Bin system	Rottneist Island	Reduce the volume of waste sent for incineration, promote recycling which will consequently reduce the production of greenhouse gases, nitrous oxides, sulphur dioxide and particulate matter	
Improve education and income opportunities	Nuuk		
Measures to reinforce security in the areas of greatest concentration	Brainstorm		
Education on security issues for the various stakeholders involved	Brainstorm	Promote education and training of the locals in order to reduce crime (assault rate and theft rate)	Assault Rate; Theft Rate
Improvement of the communication between tourism authorities and the tourism industry	Brainstorm		
Sustainable visitor capacity assessment	Rottneist Island		
Creation of a tool to monitor the capacity of tourism resources in real time	Brainstorm	Prevent and delay the degradation of tourism resources which will contribute to the increase of the Habitat Conservation Area and percentage of green space	Habitat Conservation Area; Green Space
Limiting the visiting capacity of tourism resources	Brainstorm		

With the implementation of these new actions, the previously mentioned indicators that needed improvement are effectively enhanced, thus improving the overall tourism sustainability index of the region.

5.3 Limitations

The first limitation met when carrying out the methodology was the non-availability of the action plans of the destinations certified by EarthCheck of the action plan necessary for section 5.1, which, supposedly, should be of public knowledge.

Another limitation was also the lack of availability on the part of EarthCheck and the touristic destinations certified by it in making available the Benchmarking Assessment Report necessary for the realization of section 5.2. After several emails were sent, the necessary documents were not made available. Even when action plans were found, they did not always follow the same format.

Regarding the body of the Benchmarking Assessment Report, it was noticed that several indicators at a social and economic level were missing, focusing more on environmental indicators. Even within the environmental indicators, it was observed that specific indicators for the tourism industry were missing, making the analysis not as complete and realistic as it should be.

Regarding these indicators presented in the report, it was observed that for the comparison of the various destinations through the general index of sustainability of tourism in the second analysis, some indicators had to be removed. These indicators were removed as they were optional and therefore not uniform to all destinations. For this reason, it was decided to remove some of the indicators previously used in the first analysis so that the various destinations would be comparable and all share the same criteria. However, it makes the analysis less complex and less realistic, which can be a problem.

5.4 Chapter Conclusion

In this chapter, a Benchmarking of five touristic destinations certified by EarthCheck was carried out: Baião, Melgaço, Nuuk, Rottneest Island and Azores. For this, the sustainability action plan of each destination was used to understand which actions each destination implemented and then, the various actions of each key performance area presented in each of the action plans that were compared.

The second part of this chapter focuses on the multicriteria analysis performed through the M-MACBETH program. This analysis was carried out at two levels: analysing the evolution of tourism sustainability in the Azores and the understanding of how the Azores are positioned in relation to other touristic destinations (Baião, Nuuk and Snaefellsnes).

Next, it was observed which indicators did not have a positive evolution in the Azores over the years and therefore needed improvement. With this being said, a number of existing actions regarding these indicators were analyzed and which actions could be added in order to improve tourism sustainability on the island of São Miguel. Finally, the limitations are addressed

6 Conclusions & Future Work

6.1 Final Conclusions

Tourism in Portugal has been increasing intensely over the last nine years, and the Azores has also been associated with this growth, especially on the island of São Miguel. From 2015, a great evolution of the tourist flow was observed. This increase in tourist flow in recent years represents a constant concern on the part of which destination should adopt standards and measures that improve and preserve tourist environments, manage touristic intensification, and prevent massification.

In this dissertation, the evolution of tourism in Portugal and in the Azores was studied. Since 2019, the Azores' sensitivity for tourism sustainability has been very crucial and taken into account in a very serious manner, since the time that the Azores were certified as a sustainable touristic destination by EarthCheck. For this certification to continue to exist, the monitoring measures, the action plans, the evaluation of the progression of sustainability among many more tools are deeply necessary to repeatedly be done. With this, an extensive literature review was conducted. Through this literature review, it was examined that sustainable tourism management tools exist and are deeply needed, but not in the context of a general tourism sustainability index. As a result, this dissertation was based on the construction of exactly that: a general touristic sustainability management instrument applicable to any tourism destination and which serves to make different destinations comparable between them in a simpler and faster way with the same comparison factors.

Regarding the methodology, a benchmarking was carried out in five tourist destinations, Baião - Portugal, Melgaço - Portugal, Nuuk - Greenland, Rottneest Island - Australia and Azores - Portugal.

Following this Benchmarking, the actions presented in the sustainability action plan of each destination were collected and compared with each other. With this, it was possible to note that the Azores was well positioned amongst the other destinations, with similar measures and often extremely innovative ones. Furthermore, a support decision analysis was carried out using M-MACBETH, and a general tourism sustainability index was developed, consisting of a set of sustainability indicators. Using this index, the evolution of tourism sustainability in the Azores from 2016 to 2020 was assessed. It was found that there was an evolution of it until 2019, with the year 2020 being left behind because it was an incomparable year in relation to the previous ones due to COVID-19 and no conclusions could be drawn from it. The position of the Azores in relation to other destinations certified by Earthcheck, Baião, Nuuk and Snaefellsnes was also analysed through this index, and through that it was observed that the Azores clearly stands out and that it is positioned first, followed by Baião, Snaefellsnes and only then, Nuuk.

Finally, it was observed which indicators had not had a positive progress in the Azores over the past years and subsequently needed to be improved. Following on from this, existing actions regarding these indicators were analysed and actions that could be added in order to improve the sustainability of tourism on the island of São Miguel were taken into consideration.

In conclusion, the actions presented in the action plan have a beginning in 2019 and, in this way, it is normal that their effect is not felt yet in the results, which, in turn, are until 2020. For this reason, it is to be recommended the continuation of the existing actions and an addition of other actions from other destinations that would meet the needs of the Azores.

The development of the general sustainability index is an enhanced value both for the Azores and for other tourist destinations since it is an easy and quick tool to use. It facilitates and enables the effortless observation of the evolution of tourism sustainability, its analysis, the simplicity of comparison between destinations and it also facilitates the observation of the strengths and weaknesses of each destination, in this specific case, the Azores. The creation of this index also assists in the monitoring of the indicators to be improved, in order to add actions specifically related to it. The final point that should be added is that it makes it possible to understand at what point the implemented actions and measures actually begin to have an effect.

6.2 Future Work

The current research aimed to identify the development of a supervising tool, a general sustainability index. The analyses were made using this implement, as mentioned above, however, there is still much future work in need to be done, principally due to some existing limitations.

Firstly, specific indicators are vital when it comes to tourism, in which the Benchmarking Assessment Report does not account for and therefore there is no valid information on them. These indicators are for example, the waste that is being produced in the context of tourism, Urban waste generated by tourism, Energy Consumption and CO₂ Emissions in Tourism and the institution of three different indicators: an indicator for waste separation, another for the optimization of the consumption of water and finally an indicator that denotes the consumption of energy (Turismo de Portugal, 2022a). These indicators are essential for there to be an addition to the overall sustainability index in order to allow a more complete and realistic analysis of the reality lived on each destination.

The transparency of information given by the different destinations is crucial and essential so that there can be a broader and more complex comparison between destinations. It is essential to understand how the Azores stand out in relation to other destinations, both in terms of indicators and actions to need to be applied. It is also important to realize which indicators have the best and worst performance, so that they can understand where and how to improve.

It is equally focal that studies about the sustainability of tourist destinations cover not only environmental, but also social and economic indicators. It should be noted that the report produced by EarthCheck, which was used to extract indicator values for each destination, is still a report that lacks a lot of economic and social analysis and, as previously stated, does not cover specific indicators to account for tourism-related consumption in particular.

For this indicator to be taken forward by the Azores, it is suggested the occurrence and realization of a study and analysis held by the Azores Tourism Observatory, in order to continue the work carried out in this thesis.

To conclude, sustainability is an extensive process and therefore requires strong monitoring, planning, and evaluation using various indicators, both more general and more specific when it comes to tourism.

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