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EXTENDED ABSTRACT

SOSTUR DATA SCIENCE PLATFORM: TOOL FOR MEASURING TOURISM SUSTAINABILITY IN ANDALUSIAN DESTINATIONS WITH OPEN DATA

Marta Lozano Domínguez
Instituto Andaluz de Investigación e Innovación en Turismo (IATUR)
Universidad de Málaga
mlozanod@uma.es
https://orcid.org/0009-0009-7986-0698
Antonio Jesús Guevara Plaza
Instituto Andaluz de Investigación e Innovación en Turismo (IATUR).
Universidad de Málaga
guevara@uma.es
https://orcid.org/0000-0002-2400-0668

1. INTRODUCTION

In recent decades, sustainable development has established itself as a key element in the tourism sector, thanks to its ability to address economic, social, and environmental issues. Sustainability has improved both the sector and local communities, and has contributed to reducing the negative impacts associated with mass tourism (UNWTO, 2015). Before the health crisis, its importance in mitigating the overcrowding caused by the uncontrolled growth of tourism was already recognised (Andrades *et al*., 2021; EC, 2022). However, the COVID-19 crisis accelerated the need to transform the tourism model towards a more sustainable one, seeing it as an opportunity to drive this change. This approach favoured the resilience of the sector and aligned with new traveller trends, such as the use of technologies, increased awareness of environmental impact, and a preference for authentic and less crowded destinations (EC, 2022; UNWTO, 2023, 2022, 2020; UNWTO and One Planet, 2020; WTTC, 2021; WTTC, 2020).

Following the recovery, tourism has surpassed the 2019 figures internationally (UNWTO, 2024) and in the Andalusian region (INE, 2024). Despite this growth, sustainability continues to consolidate as a key trend among tourists, who show greater awareness of sustainability, using it as a tool to mitigate the negative effects of the sector (Booking.com, 2025, 2024, 2023; EC, 2022; UNWTO, 2025; Rasoolimanesh et al., 2023).

The success of sustainable tourism requires the active participation of all tourism stakeholders, and sustainability indicators are essential to measure progress and design strategies that ensure responsible and equitable tourism development in the long term (Torres et al., 2023; UNWTO, 2023; REDS & ITR, 2019).

There are currently various systems of indicators to measure tourism sustainability in destinations, designed by both academia and specialised organisations. However, these systems have several disadvantages. First, many indicators are oriented to specific destinations or resources, which makes it difficult to compare between territories (Rivera & Mendoza, 2022; Lozano et al., 2012). Second, many lack a periodic review system, which can make them obsolete in the face of changes in the sector (UNWTO, 2005).

In addition, some systems include a large number of indicators, making their practical implementation difficult, such as the system of Junta de Andalucía (s.f.a) with 347 indicators, or that of UNWTO (2005) with 671. Another important limitation is that some indicators do not have an exact calculation or address aspects that are difficult to measure, such as the consumption of fossil fuels by tourist transport (GSTC, 2019; UNWTO, 2005). There is also a lack of a scale for interpreting the results obtained (EC, 2016; OTB, n.d.).

In addition, the lack of access to adequate data or the need to conduct specific surveys or acquire external data represents a significant economic barrier (Torres & Lopez, 2024). Many systems do not have automated platforms to apply indicators in a standardised way, which makes their use difficult (UNWTO, 2005). In Andalusia, no tourism sustainability indicators meet these needs, and there are no automated platforms for their analysis, which prevents comparison between destinations and complicates the transition towards sustainable tourism.

2. OBJECTIVES

The main objective is to provide tourist destinations with a technological tool that automatically applies a system of indicators to measure tourism sustainability and thus achieve advanced monitoring and analysis of progress by the 17 SDGs. The platform's system of synthetic indicators is aimed at responding to current needs in terms of its applicability to all destinations in Andalusia and adaptation to the current needs, as well as the use of open data and the provision of the exact calculation and the scale of each indicator. All this is done to facilitate and encourage the transition of Andalusian destinations to a sustainable tourism model through appropriate measurement indicators based on open data, with a technological support tool.

3. METHODOLOGY

The methodology of SOSTUR combines qualitative and quantitative approaches for the development of a system of tourism sustainability indicators. Firstly, an exploratory qualitative methodology was employed, analysing an exhaustive bibliography of tourism sustainability measurement systems, including indicators from the UN (2015), UNWTO (2005), European Commission (2016), RTI (2019), and Junta de Andalucía (n.d.a). The detailed analysis of 1,425 indicators from these systems allowed identifying the current needs of the tourism sector and the strengths and weaknesses of the existing indicators.

This analysis facilitated the design of the initial proposal of indicators for the SOSTUR system, structured around the 17 Sustainable Development Goals (SDGs). The proposal included 207 indicators: 187 were designed specifically for the Andalusian context,

while 20 were taken from existing systems. The indicators were evaluated considering their appropriateness for the current tourism sector, the availability of public information sources, the possibility of calculating them accurately, and the existence of a scale to interpret the results. The aim was to facilitate the practical application of the indicators without creating difficulties in their implementation.

The indicators were then validated with actors in the sector to verify their feasibility. This process resulted in three categories of indicators: unchanged, those that did not require changes; adapted, those that needed minor adjustments (changes in the territorial level or the elimination of some sociodemographic variables); and eliminated, those for lack of adequate sources or for not having a strictly tourism focus (GSTC, 2019). This made it possible to reduce the number of indicators to make them easier to understand and use.

Finally, the system was structured into 102 achievable indicators according to the 17 SDGs. The indicators were classified into three types: directly related to tourism, such as the number of visitors; indirectly related, addressing aspects of residents' quality of life, such as access to health services; and mixed, linking the positive effects of tourism on the territory, such as local investment in sustainability regarding the tourism revenues generated.

To ensure the reliability of the indicators, several open data sources were used, and a standardisation system was designed to calculate the indicators, with a scale of interpretation of results on a scale from 0 to 100, facilitating their analysis and monitoring. The indicators were validated by technical experts to ensure their appropriateness and feasibility in the Andalusian context (UNWTO, 2005; REDS and ITR, 2019).

4. SOSTUR DATA SCIENCE PLATFORM

The SOSTUR tool has been developed using Superset, an open-source business intelligence software with an intuitive interface that allows it to be used by both experts and average users. The platform consists of 18 dashboards: a general one on the state of play and 17 specific ones for each Sustainable Development Goal (SDG) of the 2030 Agenda. The dashboards include filters that allow information to be displayed according to different criteria, such as provinces, municipalities, and types of expenditure.

The general dashboard summarizes all the specific dashboards of the platform, including the number of graphs, the sources of information used, and the ranking of the indicators, classified as 'Excellent', 'Fair', and 'Unfavourable'. According to the average score of all available data, Andalusia has an overall score of 45.92 out of 100, classified as 'Acceptable'. Also, this dashboard includes graphs showing the average score by province, identifying differences between destinations, and a map of the municipal distribution. Another relevant aspect is the measurement that interrelates tourism revenues and municipalities' investment in sustainable development. In 2023, for every 562€ spent by tourists in Andalusia, municipalities invested 1€ in sustainability, with greater investment in areas such as energy and heritage management.

The SDG-specific dashboards include 102 indicators distributed across 143 graphs. For example, the SDG 11 dashboard shows indicators such as the proportion of accommoda-

tion places per resident, highlighting that in Malaga in 2022, there was an average of 7.44 short-term rental places per resident. The platform is currently undergoing a second phase of evaluation by tourism managers to improve its operation and effectiveness.

5. CONCLUSIONS

The result of this research is the successful development of the digital tool SOSTUR, which includes a set of indicators to measure the sustainability of tourism in Andalusian destinations. The main advantages of SOSTUR are its ability to make intelligent decisions based on data, its applicability to any destination in Andalusia, and its use of open data. In addition, it provides synthetic indicators that are validated and adapted to the current context, along with their specific calculations and scales.

The study highlights the growing importance of sustainability in tourism, especially in the face of the overcrowding of destinations. The SOSTUR system responds to this demand for sustainability by providing key information for equitable and resilient tourism development. The analysis of current measurement systems has identified their shortcomings, justifying the creation of SOSTUR as a valuable and replicable tool in other territories.

It has been proven that advanced and intuitive digital tools are essential to support the transition towards sustainability, allowing destination managers to design strategies that respect the social, economic, and natural environment. The platform also facilitates comparisons between territories and ensures transparency by using public data.

A limitation detected was the lack of open-access information sources with sufficient sociodemographic and territorial variables at the municipal level. It is recommended that these sources be improved to facilitate the analysis of tourism and its sustainability.

Future lines of work include the validation of the platform by tourism managers and the creation of a digital twin of Andalusian destinations for simulations and predictions.