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Smart Management of Tourist Coastal Areas in a Reborn Tourism Era: Transitioning from Safe to Sustainable Beaches within the Spanish Sun and Sand Model

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ABSTRACT

The aim of this work is the reconceptualisation of beaches as internal objects of smart tourist destinations and to offer a means to capitalize pandemic distintictives such as the Safe Tourism Certification (STC) on the physical pressure of the coastal tourist space to contribute to the natural recovery of these settings. The methodology of this work consisted of analyzing the spatial management of tourist coastal areas according to their congestion level before and after the implementation of the STC. The research technique used for data collection was an online survey with a sample of 64 certified Spanish beaches. One of the main findings of this work is that despite Spanish beaches holding several quality distinctives based on international standards, none of these distinctives guaranteed their decongestion with a minimum surface of 5 m2 per user in the sample, as literature suggests. Thus, the STC implementation and the efforts related to managing physical pressure on coastal resources show the main existing bottlenecks in the sun and sand destinations to transit from safe to physically and ecologically sustainable tourist coastal areas. Also, practical implications to Destination Management Organisations are shared regarding the transition from traditional to smart sun and sand destinations.

KEYWORDS

Tourism Pressure, Physical Carrying Capacity, Smart Touris Coastal Areas Management, Coastal Vulnerability, Sun and Sand Tourism.

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1. Introduction

Since the 1990´s decade, the sun and sand model is not only the most predominant tourism modality in Spain but also one of the main challenges for the sustainability of tourism activity at the national level as well as along the Mediterranean region (Blázquez-Salom et al., 2019).

Overcrowding and saturation on Spanish beaches (Pueyo-Ros et al., 2018; Soto & Clavé, 2018; Nolasco-Cirugeda et al., 2020) seem to be inseparable matter from tourism planning and a priority in the urban political ecology (Perles-Ribes et al., 2021).

Within this framework, beaches become the most seasonally and highly vulnerable spaces (Morales et al., 2018; López-Dóriga et al., 2019; Lukoseviciute & Panagopoulos, 2021) due to the high number of users and services. This discourse has been analysed by the scientific community in a large number of studies (Zacarías et al. 2011; Rodella et al., 2017; Botero et al., 2018; De Sousa, et al., 2018; Wang et al., 2020) that have emphasized the need to assess the physical carrying capacity and control the existing tourism pressure on these spaces. This implies the need for optimal management processes and tools that offer guarantees for contributing to the protection, adaptation, changes of use, mitigation, prevention, control, and/or recovery of the existing natural ecosystems in the touristic coast space.

The outbreak of COVID-19 has drawn scenarios of great diversity that emphasize the need to establish mechanisms that guarantee the safety of users in the process of consuming products or services but also the safety of the coastal tourism space (Kane et al., 2021; Merino et al., 2021). Anthropogenic stressors such as the reduction of noise, odor, litter, user density, and recreational activities during COVID-19 lockdown have been proved to restore natural settings quickly (Soto et al., 2021). This fact put governments on alert to seek mechanisms that would guarantee the safe use of beaches. Thus, the arrival of certificates such as Safe Tourism Certified (STC) in the case of Spain contributed to guarantee the development of safe tourism in the different tourism subsectors (Amaro, 2021; Sanabria-Díaz et al., 2021; Vargas-Sánchez et al., 2021; Villacé-Molinero et al., 2021), including beaches. This document helped town councils by providing them with a roadmap of actions to guarantee social distancing and limitation of physical capacity.

The empirical evidence obtained from the use of management tools such as the STC becomes an opportunity for coastal destinations to transit from safe to sustainable beaches.

The results of this work offer empirical evidence based on the use of STC as a tool to control physical tourism pressure on beaches, in the context of ecological transition and digitalisation. To this end, the aim of this work is the reconceptualisation of beaches as internal objects of smart tourist destinations and to offer a means to capitalize pandemic distintictives such as the STC on the physical pressure of the coastal tourist space to contribute to the natural recovery of these settings. This work also brings some practical tools used on the Spanish coast to combine sustainability and digitalisation as a way of guaranteeing an optimal carrying capacity that assures both a proper coastal sensitivity/vulnerability adaptation strategy, as well as offers a better experience for sun and sand tourists. Thus, a technology-based management of beaches is discussed at the end of the work, based on the results of the analysis.

2. Beaches: The Key Tourism Resource for Sun and Sand Destinations

In the context of the sun and sand tourism model, beaches are not just idyllic landscapes but essential and multifaceted tourism resources (Lukoseviciute & Panagopoulos, 2021).

The relevance of beaches in the sun and sand model is underscored by their pivotal role in attracting tourists. The literature substantiates the significance of beaches as prime destinations (Enríquez & Bujosa, 2020), forming the bedrock of tourism in coastal regions. Their natural beauty, recreational opportunities, and cultural resonance make them key drivers for destination choice. However, the escalating popularity of these coastal havens has precipitated a myriad of physical and social impacts, necessitating an in-depth exploration (de Andrade et al., 2019).

Physically, the unregulated influx of tourists places immense pressure on beach ecosystems. Erosion, a tangible consequence, results from trampling on fragile dune systems and the removal of essential vegetation (Defeo et al., 2021; Pinna et al., 2022). Simultaneously, pollution emerges as a critical issue, with elevated levels of litter, sewage, and chemical pollutants degrading marine ecosystems and compromis-

ing water quality (Lukoseviciute & Panagopoulos, 2021). These physical transformations not only threaten the environmental integrity of beaches but also diminish the quality of the tourist experience.

Socially, the impacts of burgeoning tourism on beaches are equally profound. Overcrowding becomes prevalent, transforming serene landscapes into congested spaces, thereby altering the character of the visitor experience (Murillo et al., 2023). Cultural displacement also becomes a poignant concern, as local communities contend with the erosion of their traditional lifestyles and the commodification of their cultural heritage (Macleod, 2023). The amalgamation of physical and social impacts signals the urgent need for interventions such as STC.

The rationale for STC intervention lies in the imperative to reconcile the economic benefits of tourism with the physical preservation of beach ecosystems and the well-being of local communities, thus, becoming a "sustainable beach". This could be conceptualized as a coastal area where tourism is managed judiciously to preserve ecological integrity, respect local cultures, and foster mutual benefits for both visitors and host communities. The interventions are multifaceted and extend across ecological conservation, community involvement, and the promotion of economically viable, responsible tourism practices (Mestanza et al., 2019; da Costa et al., 2020).

In conclusion, the complex interplay between the allure of beaches, the adverse impacts of tourism, and the exigency for sustainability through STC become the common factores that need further analysed so that sustainable beach management strategies are provided based on technological solutions.

3. Materials and Methods

The methodology of this work consisted of analyzing the spatial management of tourist coastal areas according to their congestion level before and after the implementation of the STC to assuring safe beaches in Spain. The research technique used for data collection was an online survey with a sample of 64 beaches with an STC distinctive.

3.1 Questionnaire Design

This questionnaire contained a total of 33 items combining multiple-choice, 5-point Likert scale, and open questions.

The survey was divided into two sections: the first one focuses on general information (number of STC certified beaches, dates of certification, beach extension and maximum capacity established before the STC implementation, other distinctives, and reasons why they implemented STC, among others).

The second section deepens on the factors related to the implementation of the STC distinctive regarding some of the main difficulties to implementing the social distance measures in highly congested and ecologically vulnerable spaces like beaches.

3.2 Sampling and Data Collection

The survey was addressed to the Destination Management Organisations (DMO) responsible for tourist coast areas management. The sample of this work contains a total of 160 Spanish beaches holding an STC distinctive. A 40% of obtained responses were validated.

The collected data was analyzed at an aggregate level for DMOs that did not give their consent to be de-anonymised (79%) and a disaggregation has been made for the consenting ones (21%).

The questionnaires were applied between January and June 2021, with the pre-test being sent for validation to experts

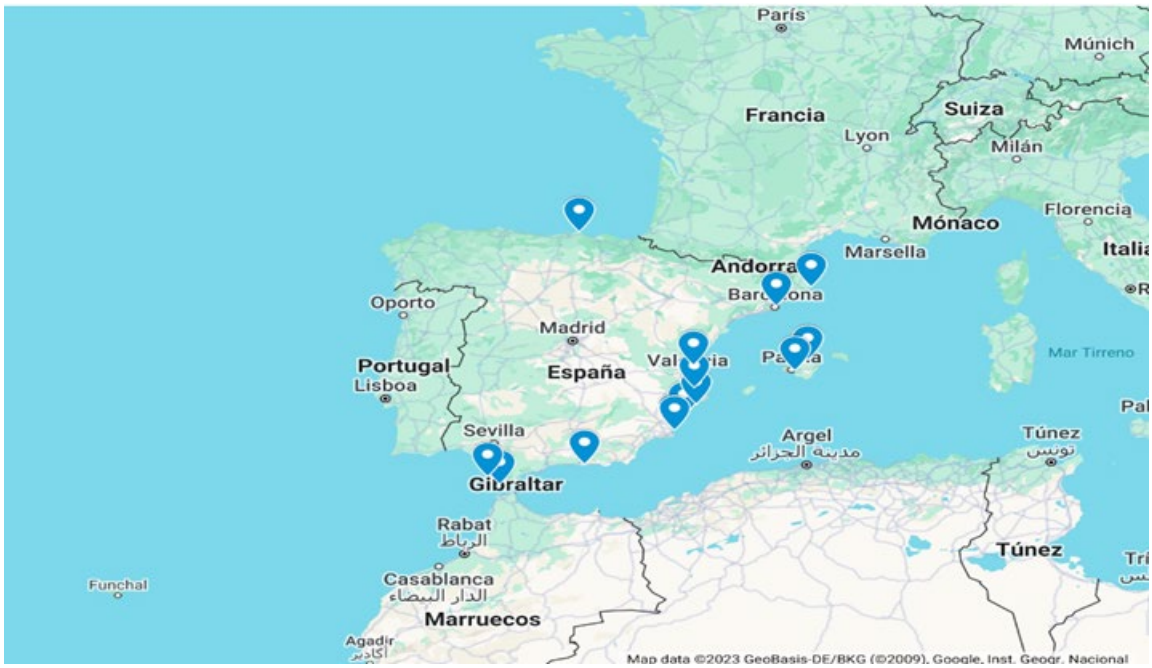
Descriptive analysis was carried out for all the variables. Frequencies and percentages were calculated for categorical variables.

For qualitative variables, minimum and maximum values, median, mean and standard deviation were calculated. For the analysis of the comparison of the different sectors in the common variables, non-parametric tests were carried out due to the small sample size in the beach and museum sectors. Kruskal-Wallis OVAs were performed for the comparison of the beaches in quantitative variables and Chi-Square tests for the comparison of categorical variables.

3.3 A Brief Framework of the Area of Study

Sun and sand tourism contributes to a substantial portion of the country's Gross Domestic Product (GDP). In recent years, the tourism sector has accounted for around 12-14% of Spain's GDP, with beach tourism playing a predominant role. Spain consistently ranks among the top three most-visited countries globally (Nurmatov et al., 2021). The change of the Spanish tourist model: From the Sun and Sand to the Security and Sand. Tourism Economics, 27(8), 1650-1668. Welcoming over 80 million international tourists annually, and a significant portion of these visitors are drawn to its extensive coastline and pristine beaches. This robust influx of tourists has translated into a substantial economic impact, with tourism-related activities contributing over €150 billion annually to the Spanish economy (INE, 2023). Also, Spain boasts over 8,000 kilometers of coastline (IGN, 2023), and this geographical advantage has led to substantial investments in tourism infrastructure.

Figure 1. Spanish Beaches Included in the Study



Source: Own Elaboration

This is some of the intrinsic factors that are common to the beaches included in the sample (Figure 1).

4. Results

Rodella et al. (2017) carried out a comparison of the carrying capacity for seven beaches in the Emilia-Romagna region (Italy), assessing their geomorphological characteristics in relation to the maximum user threshold, to ensure that the sun and sand model in the region offers a competitive and responsible model in terms of physical-environmental degradation and user satisfaction. Based on the results of this study, it was ruled that the carrying capacity of the beaches of Emilia-Romagna must guarantee, as a minimum, a surface area of 7m^2/user.

On the other hand, Zacarías et al. (2011) propose that the usable area per user should be between 5-10 m^2/user for the case of the beaches of Faro (Portugal). Based on the assumption that Spanish beaches share similar geomorphology to the beaches of Emilia-Romagna and Faro (Portugal), Table 1 shows the immediate effect that the implementation of the STC had on the maximum permitted capacity on the beaches in the sample that consent to be de-anonymised, based on their respective usable areas:

Table 1. Status of Spanish Beaches Before and After the STC Implementation

Beach	Location	Capacity previous to STC	Capacity after STC	User/m² Previous to STC	Status previous to STC	User/m² Post STC	Status after STC
Ensenada del Esparto	San Javier (Region of Murcia)	15,000	13,725	11.20	Decongested	12.24	Decongested
Sotillo-Castell	Gualchos (Andalusia)	12,240	4,153	4.25	Congested	12.52	Decongested
Canet D'En Berenguer	Canet de Berenguer (Valencia)	25,000	5,000	4.00	Congested	20.00	Decongested
Nord	Gandía (Valencia)	140,000	70,009	3.31	Congested	6.63	Decongested
L'Arenal	El Arenal (Balearic Islands)	10,000	4,500	3.20	Congested	7.11	Decongested
Platja Gran	Benidorm (Valencian Community)	7,500	7,000	11.22	Decongested	12.03	Decongested
La Barrosa	Chiclana (Andalusia)	64,200	35,696	4.00	Congested	8.99	Decongested
La Playita	Zahara de los Atunes (Andalusia)	2,500	1,800	1.73	Congested	2.41	Congested
Garbí	Calella (Barcelona)	30,000	14,730	2.14	Congested	4.37	Congested
Trengandín	Trengandín (Cantabria)	70,541	35,270	1.89	Congested	3.79	Congested
Levante	Benidorm (Valencian Community)	30,000	11,300	12.23	Congested	32.46	Decongested
Aiguablava	Begur (Catalonia)	726	182	3.02	Congested	12.03	Decongested
Villananitos	San Pedro del Pinatar (Region of Murcia)	13,104	4,675	1.92	Congested	5.39	Decongested

Source: Own Elaboration

The results show that, in an initial scenario prior to the implementation of the STC, 85.7% of the beaches were in a state of congestion, as they could not guarantee a minimum surface area of 5 m^2/user. However, the STC implementation process meant that all the beaches included in the sample were able to optimise and increase the minimum surface area per user: 57.1% of them passed from "congested" to "decongested" status (Sotillo-Castell; Canet D'En Berenguer; Nord; L'Arenal; La Barrosa; Aiguablava; Alcudia; Villananitos beaches). Additionally, 21.4% of the beaches contained in the sample, despite being in a "decongested" situation, achieved better physical capacity management to increase their surface area (Ensenada del Esparto, Platja Gran, and beaches), in some cases even tripling it (Levante beach). Finally, 21.4% of the beaches, despite implementing the STC, were unable to guarantee a minimum threshold of 5m2, although the m2 /user surface was doubled (La Playita, Platja de Garbí, and Trengandín beaches).

This transition from unhealthy to healthy beaches also made these beaches become more sustainable, as 100% of the beaches decreased their physical pressure, as well as 85.7% transited from congested to descongested status. In the following sections, the findings obtained from the questionnaire are analyzed to identify the main barriers and implications regarding this transition process to environmental sustainability.

4.1 The Implication of the Services Offered on Beaches on Physical Carrying Capacity

The services offered on beaches consist of the provision of facilities or services to beach users, which may be provided by public or private entities and with a variable availability and cost depending on the season. These services may include recreational activities, bars and restaurants, or the use of certain infrastructures such as toilets or showers, among others.

These factors should be analyzed depending on their typology, as this implies the spatial distribution being conditioned by the useful surface area for the joy of users, as well as conditioning the distribution of uses of these beaches per area (Valdemoro & Jiménez, 2006).

Table 2. Elimination or Reduction of Services on Beaches

Services reduced or abolished	%
Recreational áreas	71.4
Sports áreas	57.1
Toilets and/or changing rooms	50.0
Sun lounger/parasol service	50.0
Food and beverage service	35.7
Assistance to people with disabilities	28.6
Showers	14.3
None	7.1

Source: Own Elaboration

According to the data in Table 2, temporary closures and service limitations have been one of the aspects that have considerably conditioned the availability of usable surface area for users to guarantee their safety. In this sense, to optimise the distribution of tourist flows as shown in Table 1, most of the beaches must reduce or remove a large part of the services offered, regarding the level of "spatial dispersion" they currently generate. Specifically, to achieve better physical management of space. This meant a reduction or elimination of sports areas for 57.1% of the beaches, followed by 50% for toilets and changing rooms, as well as for the sun lounger and parasol service. On the other hand, 35.7% of the beaches were forced to eliminate or reduce the food and beverage service, 28.6% the assistance to people with special needs, and 14.3% the shower service. This finding proves one of the main weaknesses regarding the existing management strategies on the studied beaches until the existence of tools such as the STC, as no corrective factors were integrated to meet spatial dispersion generated in terms of tourist pressure with the expected physical carrying capacity to guarantee a minimum of 5m^2/user. Thus, fostering a massive sun and sand model within the Spanish beaches.

4.2 The Use of Quality and Sustainability Labels as a Route to Requalification

Spain is one of the countries with the highest number of management system certifications (ISO, 2020), as a means of sustainability and requalification of the sun and sand model. Thus, the majority of managing bodies stated that they hold quality or environmental certificates, or some other recognition prior to the implementation of the STC, as shown in Table 3.

Table 3. Previously Implemented Protocols and Certificates at Beaches

Previous certificates	%
Q for Tourist Quality (based on ISO 13009)	85.7
UNE-ISO 9001 Certificate	42.9
Tourism Quality Commitment (SICTED)	28.6
Blue Flag	21.4
European Environmental Management Association Certificate (EMAS)	14.3
Ecobeaches Flag	7.1

Source: Own Elaboration

The most frequently reported certificate was the Q for Tourism Quality awarded by the Spanish Institute for Tourism Quality (ICTE) and property of the Secretary of State for Tourism (ICTE, 2020), with representativeness of 85.7%. This certificate is obtained after demonstrating compliance with the international standard ISO 13009 Requirements and recommendations for beach management. This is followed by the ISO 9001 Quality Management Systems certificate and then the Tourist Quality Commitment in Destinations (SICTED), which was awarded to 42.9% of the beaches in the sample, prior to the STC label. This was followed by other distinctions such as the Blue Flag, obtained by 21.4% of the beaches, the European Environmental Management Certificate (EMAS), awarded by 14.3%, and the Ecobeaches Flag, awarded by 7.1% of the beaches.

However, none of the certificates included in Table 3 require the definition of a specific beach capacity, although some of these standards, such as the ISO 13009 and ISO 9001 establish a management framework on which to define appropriate measures when, either because of the coronavirus or for other reasons (such as tourist pressure), it becomes appropriate to limit capacity. The STC distinctive, thus, offers a means to fill this gap.

Table 4. Assessment of Motives and Criteria for Implementing a Protocol

Motives	**Mean**
Ensuring the user's perception of safety	4.43
Preserving the image of the destination	4.39
Caring for the health of workers and users	4.39
Avoiding a source of contagion at the destination	4.35
As a matter of city council policy	4.03
Criteria	
Prestige	4.35
Effectiveness	4.35
Ease of implementation	3.71
Because they are promoted by the Ministry of Industry, Trade and Tourism.	3.57
Cost	3.43
Support from the Autonomous Community	3.00

Source: Own Elaboration

Regarding the reasons for choosing the STC label, based on the certification of the ISO/PAS 5643 specification (Table 4), the most highly valued aspects were the prestige of the brand and the effectiveness of the standard (4.35 out of 5 points), followed by the ease of implementation (3.71 out of 5 points) and the support and promotion at the national level from the Ministry of Industry, Trade and Tourism (3.57 out of 5 points). The aspects least valued when opting for the STC were the support received by the Autonomous Community (3 out of 5 points) and the costs associated with obtaining this certificate (3.4 out of 5 points).

Thus, these results show that a previously recognised brand provides the protocols with the necessary recognition when they are required by the managing bodies to solve the corresponding issues to be solved in tourism destination management, and specifically, control of physical tourism pressure on vulnerable ecosystems.

On the other hand, Table 4 also confirms the need for a tool such as the STC to preserve the image of the destination, as well as to guarantee the safety of users and workers in the sector.

The main criteria that motivated the beach management bodies to implement a protocol focused on COVID-19 safety were, on the one hand, to guarantee the beach user's perception of safety (4.43 out of 5 points), while at the same time preserving the image of the destination (4.39 out of 5 points), protecting the health of workers and users (4.39 out of 5 points) and, lastly, avoiding sources of contagion (4.35 out of 5 points). These criteria obtained average scores above 4.

The results show the importance given by the managing body to regaining the confidence of beach users (whether tourists or residents) through the establishment of biosafety measures appropriate to the context of the pandemic, and as a continuation, therefore, of preserving the image of the destination, a key element for the ecological transition and sustainability of the Spanish sun and sand model. Particularly noteworthy examples include the Balearic Islands and Benidorm, whose level of tourist congestion places these beaches in a situation of overcrowding that requires intervention by the managing bodies, and whose tourism policies in many cases are not adapted to the real need to control this tourist pressure.

4.3 The Delimitation and Management of Capacity: A Pending Issue for the Spanish Sun and Sand Model?

The implementation of the STC on the beaches under study reveals that the delimitation and management of capacity continue to be a pending matter for the management bodies in sun and sand destinations.

Table 5 shows that among the most difficult aspects of implementation and consensus for the STC are the delimitation of the capacity for each space (64.3%) linked to the investment linked to the redistribution of uses and spaces of the beaches (50%), followed by the lack of staff training (14.3%), access control (7.1%), or the difficulty of controlling areas of greater recreation such as those destined for bathing (7.1%).

Table 5. Aspects of the Protocol that are most Difficult to Implement and Reach Consensus on

Aspects that are more difficult to implement	%
Capacities established in each space	64.3
Investment required	50.0
Lack of staff training	14.3
Access control	7.1
Distancing in the bathing area	7.1

Source: Own Elaboration

In short, the Spanish model of sun and sand is going through a challenging stage of congestion that leads to overcrowding of beaches with an aggravated seasonality that exerts serious tourist pressure on coastal resources, endangering the sustainability of the model.

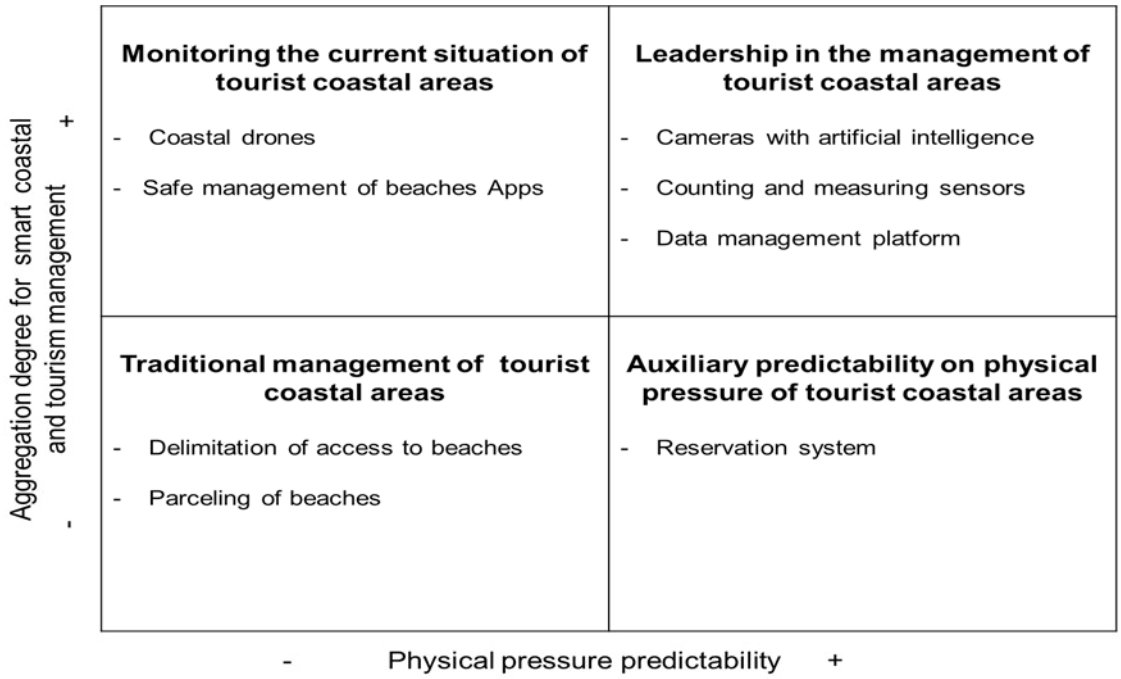
The results of this work prove the relevance of providing local authorities with tools that allow them to define and manage capacity in accordance with optimising tourist pressure on beaches, while offering a user experience that provides sustainability and competitiveness to the destinations, based on tools such as the STC.

5. Discussion

Within the framework of the current process of smart transformation of tourism in Spain, one of the priorities for sun and sand destinations (Dorcic et al., 2019) should be the identification of technological solutions to respond to the challenges posed by the current surpassing of the physical carrying capacity in destinations such as those included in the sample (Femenia-Serra & Ivars-Baidal, 2021). The reconceptualisation of beaches as internal objects of smart tourist destinations together with technology enables not only to better respond to sustainability and ecological challenges but also to build tourism experiences and loyalty (Azis et al., 2020).

Regarding the STC implementation on the Spanish beaches, several methods have been identified combining technology and spatial management of coastal resources. Thus, contributing to the existing body of knowledge on managing sun and sand destinations.

Figure 2. Matrix of Carrying Capacity Management Implemented in Spanish Sun and Sand Destinations



Source: Own Elaboration

Figure 2 shows the main technological tools used in Spanish beaches for better spatial management regarding the carrying capacity required to transition from unhealthy to healthy beaches after STC implementation. This matrix divides the corresponding tools according to their potentiality for predicting tourism physical pressure of tourist coastal resources as well as their level of aggregation and interrelationships within smart coastal tourism management.

5.1 Technological Tools for Monitoring of the Current Situation of Tourist Coastal Areas

According to the upper left quadrant of the matrix (Figure 2), these tools are characterized by a high level of aggregation for smart management of tourist coastal areas and a low level of predictability. Their main function is to monitor and evaluate the current situation regarding the physical pressure of coastal resources. Two different tools are included in this quadrant:

On the one hand, coastal drones are used to face the need to control the capacity and behaviour of beach users, such as Conil de la Frontera (Cádiz) and Sagunto (Valencia) have opted for a combination of drones and artificial intelligence, capable of facilitating both the management and the collection of information to determine the state of the beaches (SEGITTUR, 2021). In terms of natural accidents, drones can even transmit information to competent authorities involved in that casual event.

On the other hand, in line with Chen & Teng (2016), physical hazards occurred on beaches can be controlled by mobile apps and websites. According to Fuengirola (Andalusia) and Palma (Balearic Islands) beaches, these apps are based on the Internet of Things (IoT), Artificial Intelligence, and Deep Learning to determine in real-time the occupancy level of a tourist coastal area including 3D optical sensors capable of real-time analysis and differentiation of the different objects as well as monitoring variables such as temperature, humidity, wind speed, air quality or noise levels (Esmartcity, 2020).

5.2 Technological Tools for Leadership in the Management of Tourist Coastal Areas

According to the upper right quadrant of the matrix (Figure 2), these kinds of tools have a high degree of usability to predict physical pressure on tourist coastal areas and also share a high degree of aggregation to feed with the existing smart management systems in destination and contribute to data collection and decision making. In this section, three solutions have been identified:

Firstly, cameras with artificial intelligence are used to establish control over capacity is the installation of sensorised cameras with artificial intelligence. This technology is being already implemented in other governance areas (Sharma et al., 2020) such as civil security or traffic (Sukhadia et al., 2020). In the case of tourism, the information collected by cameras is distributed through a mobile application, which allows the bather to know which beaches are open (green), are beginning to reach the capacity limit (orange), or even are already closed (red).

At Salou beach (Catalonia), a total of 22 smart cameras with Deep Learning technology were installed in bathing areas with Deep Learning technology for the purpose of counting people and offering information about the status of the beach (SEGITTUR, 2021).

Regarding the counting and measuring systems, this is an increasing technology for tourism planning and management (Lisi & Esposito, 2015). In the case of tourist coastal areas, these systems can register the temperature, quality, and cleanliness of the sand, bathymetry, as well as water quality and temperature, and UVA sensors (to measure radiation levels and their variation) based on the pilot initiative of Ciutat Jardín beach (Balearic Islands). it has been determined that if the beach is occupied with a density of less than 8 m^2/user, the state of occupation is considered low (green). If the density is between 4-7 m^2/user, it is considered medium (orange), and if the density is higher than 4 m^2/user, it is considered highly congested (Diario de Ibiza, 2020).

Finally, the data management platform is where the different sources that the destination deploys for subsystems management within a tourism smart transformation process (Buhalis & Amaranggana, 2015). For the case of beach monitoring, this includes indicators such as the inflow data from sensors, the characteristics of the beaches, areas of stay, available services, the state of the sea, the weather, etc.

Santander municipality has installed devices on its beaches based on the use of APIs that are provided by the Smart City platform to send data on people entering and leaving through each one of the regulated accesses. Considering the parameters of each beach, the capacity of the maximum capacity is calculated in real-time, and based on this, the degree of occupancy of the beaches is determined. In addition, the platform integrates information on the services available at the beaches, beach flags, etc. services available on the beaches, lifeguard and lifeguard service flags, jellyfish alerts, weather forecasts, etc. of jellyfish, weather forecasts and the state of the sea, among other information (SEGITTUR, 2021).

In short, these kinds of tools need to be fostered in sun and sand destinations in order to gain smart management leadership and monitor present and future physical pressure on coastal resources.

5.3 Traditional Tools for Management and Auxiliary Predictability Tools for Tourist Coastal Areas

In the lower quadrants of the matrix (Figure 2), three technological tools have been identified to manage physical pressure on beaches.

On the left-hand side, it is contained traditional means to control carrying capacity and widely used until the COVID-19 pandemic:

On the one hand, the control of access to beaches as well as shuttle bus routes from park-and-ride car parks. This system is still used by several beaches such as San Javier (Murcia) and San Sebastian beaches (Basque Country) to assure a limited number of entrance points as well as authorized vehicles (Murcia Government, 2022).

On the other hand, the parceling of beaches consists of delimiting a useful space on the sand per user in areas of 4 by 4 meters. One of the first destinations to apply this technique was Benidorm, which carried out the action on the Levante and Poniente beaches, dividing them into 20 free access sectors with 1,554 plots in Levante and 5,661 plots in Poniente, all of them 16 square meters in size (4x4 meters) in which up to 4 people could be accommodated (SEGITTUR, 2021).

In line with the right-hand side quadrant (Figure 2), the parceling was accompanied by a platform that supported a system of reservations for these plots. The reservation is made 24 hours in advance and implies choosing a date and time with availability on the chosen beach, selection of sectors, filling in the details of the reservation holder and attendees, and finally validating the reservation on the beach access point (Diario La Información, 2021).

Finally, the tools contained in these two quadrants follow a basic strategy that could be useful for Des-

tination Management Organisations in the short term while transitioning to a smarter complex system for monitoring physical pressure.

6. Conclusion

This work brings a rethinking to the management of tourist coastal areas according to their physical vulnerability due to users´ pressure within a post-pandemic scenario from a smart paradigm. To do this, the STC implementation process has been analyzed in the Spanish sun and sand model according to their management of the physical carrying capacity.

A key revelation from our study is that, despite Spanish beaches boasting various quality distinctives aligned with international standards, none of these assurances guarantee the decongestion of beaches or the provision of a minimum surface area of 5 square meters per user, as revealed in our sample. Consequently, STC implementation and efforts directed at managing physical pressure on coastal resources emerge as significant challenges within sun and sand destinations, highlighting existing bottlenecks in addressing these issues. Confronted with these barriers, our empirical evidence underscores how a distinctive certification like STC, or a similar framework, ensuring safe spaces, could serve as a catalyst for transitioning from mere safety to the establishment of physically and ecologically sustainable tourist coastal areas.

The practical implications derived from our findings extend to Destination Management Organisations (DMOs), offering insights into the imperative shift from traditional to smart sun and sand destinations. Furthermore, we highlight the emergence of relevant technological solutions in Spain for managing tourist spatial dynamics. This marks a pivotal contribution of our work, as it emphasizes the possibility of a smart transition for beaches, leveraging the analytical prowess of various technological tools. This is one of the main novelties of the work, as smart transition of beaches can be reached based on the analysed technological tools.

Firstly, DMOs are urged to embrace a smart paradigm for coastal destination management, leveraging technology to enhance the visitor experience, optimize resource allocation, and address challenges such as overcrowding. Real-time monitoring, data analytics, and dynamic decision-making can be facilitated through smart solutions to ensure sustainable development.

Additionally, the study emphasizes the relevance of specific technological tools for managing tourist spatial dynamics. DMOs can consider adopting geospatial mapping, crowd monitoring systems, and mobile applications to provide real-time information on beach occupancy and conditions. These tools empower authorities to implement effective crowd control measures, ensuring visitor well-being and sustainable use of coastal resources.

Furthermore, the integration of certification frameworks, such as the Safe Tourism Certification (STC), emerges as a transformative tool for ensuring safe and sustainable coastal tourism. DMOs can proactively collaborate with stakeholders to implement safety protocols, enforce carrying capacities, and leverage certification frameworks to enhance the overall quality and sustainability of sun and sand destinations.

Crucially, stakeholder collaboration and community engagement are highlighted as essential. DMOs should actively involve local communities, businesses, and residents in the decision-making process to foster a sense of shared responsibility for sustainable tourism practices.

Lastly, DMOs are encouraged to advocate for investments in infrastructure and innovation to support the transition to smart destinations. This includes the development of smart infrastructure, such as sensor networks and communication systems, to enhance real-time data collection and analysis. Encouraging innovation in tourism services and experiences contributes to the overall competitiveness and resilience of sun and sand destinations.

As a future research line, factors associated with tourism performance and smart transformation should be analyzed regarding the effects that beach decongestion could have on the quality of life of residents in coastal life as well as both on local and external beach users´ perceptions.

Declaration of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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