Assessing the Tourist Carrying Capacity of a UNESCO World Heritage proposed site

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Abstract. In destinations where tourism represents a significant economic and cultural development source, it is crucial to address and mitigate the associated threats and challenges. In this regard, the present study aims to analyze the concept of sustainable tourism. This concept promotes tourism development while protecting environmental resources and preserving local cultural identities. The tool employed for this analysis is the Tourism Carrying Capacity (TCC), a methodology that was initially developed to define the maximum number of visitors a destination can handle without compromising its sustainability. The paper explores the evolution of this concept from both a theoretical and practical point of view, applying the most recent approach. The integrated methodology employed in this study aims to evaluate this concept to propose management guidelines for the management of cultural heritage sites. This paper will apply the methodology to the real-case study of the Sacra di San Michele. This abbey is a site of significant cultural, historical and spiritual value to the region of Piedmont and is currently listed as a tentative World Heritage Site. The results highlight the need to redesign the direct access to Sacra, with a better management of public transport and interchanges between public and private transport. In addition to setting the basis for a balanced management of the site while preserving the environmental and cultural values, this paper aims to demonstrate the importance of adopting integrated methodologies for decision support in complex contexts such as the cultural heritage sites.

Keywords: Tourist Carrying Capacity · Sustainable Tourism · Indicator system · UNESCO · Management Plan

1 Sustainable Tourism

In the contemporary context, tourism has emerged as a significant catalyst for economic and cultural development. Nevertheless, it is imperative to address and mitigate the challenges associated with this phenomenon [1]. Tourism exerts a considerable influence on various components of the territory, including the environment, the local economy, and

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the social dimension [2, 3]. The World Tourism Organization (WTO) asserts that ensuring the long-term sustainability of tourism requires a balance between the environmental, economic, and socio-cultural dimensions that are inextricably linked to the tourism sector. In accordance with this perspective, sustainable tourism should (a) make optimal use of environmental resources; (b) respect the socio-cultural authenticity of host communities; and (c) ensure profitable and long-term economic operations that distribute benefits equally. Moreover, the development of sustainable tourism needs informed engagement of all relevant stakeholders [4–6]. This is true for all tourist locations, but it is especially important for UNESCO sites and places of cultural significance. These sites have to combine the socioeconomic development of the territory with resource protection and enhancement [5, 7]. In particular, the inscription of a site in the World Heritage List (WHL) generally produces certain benefits in terms of safeguarding cultural assets, but it can also exert negative repercussions on the territory if management practices are not balanced with the principles of sustainability. One of the most evident impacts is overtourism. For WHS, the risk associated with this phenomenon is even more relevant, as they are globally recognized and subject to significant tourist flows, especially at certain times of the year. This phenomenon has been widely studied in the literature, taking into account different types of tourism and different contexts around the world [8–11].

Within this context, the necessity of tools to support tourism management decisions is becoming increasingly evident. To manage tourism in a sustainable manner, national and local governments have increasingly available technics that support decision-making processes, often in conjunction with one another [12, 13]. In particular, decision-making approaches have evolved to encompass systemic, nonlinear, and integrated perspectives to support a development that has become increasingly complex [14]. This approach consists of the synergistic use of aspects from different disciplines and proves to be fundamental in contexts such as tourism, in which the problems to be addressed are complex in nature, characterized by uncertainties and interdependencies [15]. Among the various decision-support approaches, Tourism Carrying Capacity (TCC) is particularly useful for quantifying the optimal number of tourists that a given destination can accommodate. Generally, the concept of carrying capacity is predicated on the measurement of the sustainable utilization of a given resource [7, 16]. When applied to the evaluation of tourism phenomena, the application of this approach becomes complex due to the numerous environmental and socioeconomic factors that interact with the tourist destination [7, 17]. Many of these factors also depend on the subjective perception of tourists and the host community [7]. According to the official definition proposed by the WTO, the carrying capacity of a tourist location consists of the maximum number of people who visit that place in the same period, without compromising its environmental, physical, economic and sociocultural characteristics and without reducing tourist satisfaction [18]. However, various definitions of TCC and supporting methodologies exist. The paper will explore them in detail in Sect. 2. This intense debate about TCC highlights the pivotal role in pursuing sustainable tourism. Indeed, the calculation of TCC facilitates the establishment of practical and feasible limits, thereby contributing to the development of sustainable tourism practices.

In this paper, the TCC is considered both as a statical indicator of sustainability and dynamic and informative tool, as the recent definition proposed by the SITi research institute (now named LINKS Foundation and hereafter simply mentioned as LINKS) of Politecnico di Torino in 2017 [19]. Specifically, the calculation method proposed by LINKS is applied in this work to a WHL proposed, namely an abbey in the municipality of Turin (Italy) called the Sacra di San Michele. The site is a relevant and prestigious example of cultural, historical, and spiritual value, considered as the symbol of the Piedmont region. The calculation of the TCC provides the foundation for the formulation of guidelines for this site to enhance the future management of the UNESCO property, with the objective of safeguarding its natural and cultural values in accordance with the principles of conservation and protection.

After this introduction, the paper is structured as follows. Section 2.1 presents the different definitions of TCC and methodologies for its calculation. Based on this, the methodology chosen is presented in Sect. 2.2. Section 3 describes the case study of the Sacra di San Michele with an in-depth on the main strengths, weaknesses, opportunities and threats, useful for the TCC calculation. Section 4 details the application of TCC to the case study, while the results are highlighted in Sect. 5. Conclusive remarks are finally provided in Sect. 6.

2 Tourist Carrying Capacity

2.1 Definitions of TCC

The concept of carrying capacity is derived from civil engineering, where it indicates the maximum load a structure can support before failure. Subsequently, this concept was integrated into the tourism sector. However, various definitions of tourist carrying capacity can be found in literature. The term has evolved over time and across different disciplines, emerging as a multidisciplinary concept that supports decision-making processes.

Initially, the TCC was associated with environmental sustainability, specifically as the physical limit an area could withstand without compromising the integrity of the local ecosystem. This initial concept is elucidated by the definitions proposed by Mathieson & Wall (1982) and Canestrelli & Costa (1991) [21, 22]. Mathieson & Wall (1982) [22] defined TCC as the unacceptable alteration of the physical environment resulting from unsustainable tourism, while Canestrelli & Costa (1991) emphasized the ecological dimension of tourist destinations, identifying the maximum level of environmental stress beyond which tourism causes substantial damage [21].

Subsequently, the growing recognition of the links between the environment, culture and economy expanded the idea of TCC to include a wider range of factors, such as social, economic and cultural aspects. This is evidenced by the definition of the World Tourism Organization (WTO) in 2000, which defined TCC as " the maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic and socio-cultural environment and an unacceptable decrease in the quality of the visitors" [18].

A more recent conceptualization of TCC was proposed between 2010 and 2020 by LINKS. The latter institute proposed a definition of TCC that not only considers the maximum number of tourists as a location can accommodate without suffering damage, but also as a dynamic tool, updatable over time and oriented to an analysis of the current situation of the site under study, its state of conservation and possible management problems [23]. Therefore, the TCC becomes an instrument to direct tourism strategies according to the specific location under analysis and by facilitating its decision-making processes related to tourism management.

As was the case with the definition of TCC, the scientific community does not hold a consensus on the identification of the dimensions affected by over tourism. Fisher & Krutilla (1972) [24] adopts the ecological and economic dimension of TCC. In 2004, WTO introduced other three dimensions, i.e. cultural, social and psychological, and infrastructural. LINKS in 2017, identified six components of the TCC:

- TCC Theoretical: maximum number of tourists based on the surface of the good;
- TCC Physical/Functional: equal to the TCC Theoretical to which (qualitative or quantitative) adjustments are applied according to physical limits (such as safety conditions of the property, the presence of any architectural barriers, etc.);
- TCC Social: residents' perception of the tourism phenomenon, both in terms of quantity and quality. This assessment includes for example the level of seasonalization of flows, the attitude of tourists, and the number of visitors;
- TCC Psychological: tourists' perceptions of the property they are visiting and the level of satisfaction at the end of the visit; it derives mainly from evaluations related to the presence of tourist services, the efficiency of reception policies, the existence of adequate signage etc.;
- TCC Infrastructural/Territorial: consider aspects related to a broader scale, including infrastructure conditions and adequacy of mobility policies, the number of available parking spaces (compared to a surrounding area), and factors related to the specific conditions of the area, such as its ability to accommodate, absorb and manage the flow of tourists;
- TCC Management: cross-cutting and concluding element that guides all other indicators, to respond to the system′s weaknesses.

Given the plurality of definitions and the variety of dimensions associated with the concept of TCC, as evidenced by the extant literature, it is evident that the methodologies employed for its calculation also vary. For a complete review of the existing methodologies, it is possible to refer to Cimnaghi et al. (2017) [19]. Among them, the present work adopts the integrated method proposed by Cimnaghi et al. (2017) [19], detailed in Sect. 2.2.

2.2 Links Foundation Methodology

The methodology proposed by LINKS derives from a research project developed in collaboration with the Italian Ministry of Cultural Heritage, Activities and Tourism in 2007. The objective of the work of Cimnaghi et al. (2017) [19] was to define a framework capable of taking into account the critical aspects that characterize cultural heritage in the tourism phenomenon. To this end, the evolution of the TCC concept and the application

purposes proposed by different authors have been examined in the literature. The main issues included are the accessibility of the site, the ability to communicate its value to the population, the existence of infrastructural limitations, but especially the preservation of the exceptional value of these sites. In this sense, the TCC aims to be a dynamic tool capable of reconciling the conservation of the property with the maximization of the quality of the tourist experience. The original method, tested on simple case studies (such as museums and enclosed sites), was subsequently updated by the LINKS itself, which applied it to the World Heritage sites of the Lombardy region in Italy, experimenting with more complex and wider contexts.

The method consists of three main phases (Fig. 1): (1) the phase of recognition and identification of the dynamics affecting the site, along with the compilation of the preliminary Carrying Capacity form; (2) the core phase of the methodology, in which the Table of Indicators is developed; and (3) the compilation of the results sheet with the consequent drafting of management guidelines.

The first stage is to complete the preliminary carrying capacity form, which collects the main information on the intrinsic characteristics of the property. This is followed by information on the management and conservation of the site in terms of its degree of usability. Finally, it is possible to implement the required information, giving space to the state of conservation of the property in order to highlight possible criticalities.

The second phase is to define the indicators that can be used to describe the current state of the site from different perspectives. In particular, the table of indicators can be divided into the 5 themes previously analyzed, giving for each indicator the name, a brief description, the level of comparison used (insert explanatory note) and the value measured in relation to the data collected or found *in situ*. For the value of the theoretical TCC, the calculation used is taken directly from the formula of Cifuentes (1992) [25]. A comparison level is defined for each indicator. This level indicates whether (a) the target value is provided by law or if it is a quantifiable factor; (b) the target value is derived from a reference in the literature or from a best practice; (c) the target value needs to be defined *in situ* with the site managers; (d) no target value is defined, so the qualitative indication needs to be defined by experts and site managers [19].

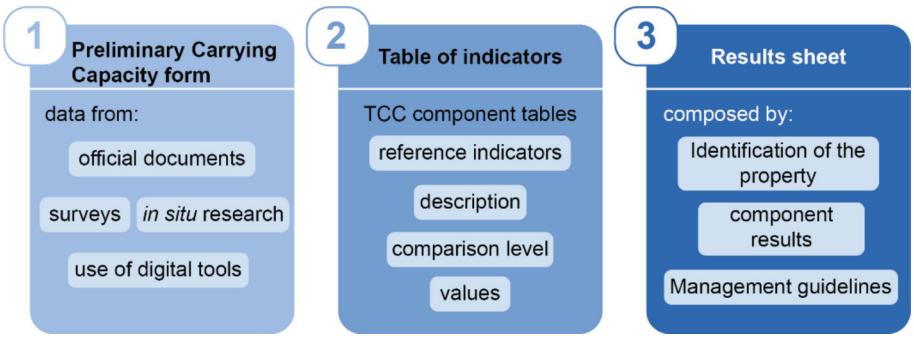

Fig. 1. Methodological diagram and results

In the final stage, the findings obtained are collected and summarized in the 'results sheet'. This includes a first section summarizing information about the site, including maps and figures where appropriate. This is followed by considerations for each of the components of the TCC. Firstly, the theoretical TCC is calculated, which should be compared with flows observed in previous periods to highlight any conditions of overuse and overtourism. After an evaluation of the other components, the form ends with a section dedicated to management guidelines, in which strategic indications are given for the cultural property analyzed.

3 Case Study

The case study investigates a historical and religious building called the Sacra di San Michele located in the Northwest Italy, and more precisely close to the city of Turin, in the municipality of Sant′Ambrogio di Torino (TO) in the Piedmont Region (Fig. 2).

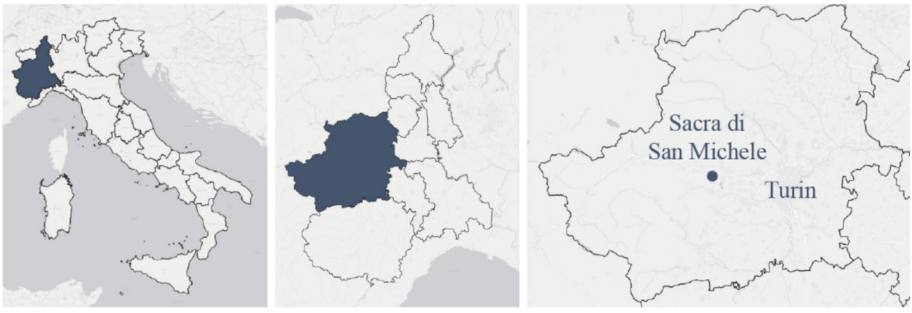

Fig. 2. Location of Piedmont Region (left), Metropolitan City of Turin (center) and Sacra di San Michele (right).

The building is an abbey on the top of a rocky promontory called Mount Pirchiriano at an altitude of 962 m [26]. The founding year of the abbey remains undocumented and unconfirmed. However, recent historical studies suggest that its construction occurred between 983 and 987, marking an expansion of an earlier chapel dedicated to the Archangel St. Michael [27]. The Sacra di San Michele has historically functioned as a prominent landmark in the region, serving as a point of cultural and aesthetic significance for the local community. In recognition of its historical and visual importance, it was designated as a Monument Symbol of Piedmont in 1994. Moreover, from a national perspective, the Sacra di San Michele represents one of the most important centers of Benedictine spirituality. In 2016, the Sacra di San Michele complex has been included in the Italian "Tentative List" as a serial site, with the ambition of entering the UNESCO World Heritage List. The Abbey is also located along the "Via Francigena," and it is the initial stop on Italian territory. Furthermore, it is an integral component of the "St. Michael Line," a geographically aligned succession of seven shrines erected for St. Michael that goes from Ireland to Israel.

The designation of the Abbey as a UNESCO heritage site necessitates a meticulous analysis of all the aspects in play, as required in the formulation of a management

plan [28]. Among the required tools, SWOT analysis [29] was conducted to highlight strengths, weaknesses, opportunities and threats of the site and area where it is located. Several strengths are identified, including good accessibility, guaranteed by efficient infrastructures such as the Turin-Bardonecchia highway and the Turin-Susa railway line, which offers an integrated ticket to facilitate public transport. The landscape and cultural value of the area is high, thanks to the presence of landscape protection laws that preserve the integrity of Mount Pirchiriano and numerous historical elements such as churches, chapels and ancient communication routes. Tourist activity is already well established, both because of the importance of the site and the presence of the Avigliana Lakes, which attract active daily tourism. However, direct access to the Sacra di San Michele is limited to scenic routes with no direct connection to Sant′Ambrogio, the nearest town. Parking lots near the site are also inadequate and expensive, while the shuttle service operates only at weekends with vehicles of limited capacity. In addition, the visual impact of the Turin-Bardonecchia highway and the railway trails reduces the environmental quality. The current touristic pressure highlights some shortcomings in accommodation facilities, especially in Avigliana and Sant′Ambrogio, which may not be sufficient to handle a possible increase in visitors linked to the UNESCO candidature. Development opportunities include the improvement of sustainable mobility, public transport and the introduction of alternative systems such as bike-sharing, as well as the valorization of historic hiking trails. The redevelopment of unused housing could stimulate sustainable tourism without putting pressure on the local fabric. The new Lyon-Turin high speed line is a controversial element: while it could improve international accessibility, it would increase the impact on the landscape and social tensions. In addition, the risk of an excessive influx of tourists linked to the UNESCO candidacy raises concerns about the sustainability of the site.

In this context, the candidacy necessitates an in-depth examination of the potential tourism impact that might result from the inclusion of the site in the UNESCO list. For doing that, the implementation of a TCC is instrumental in identifying the potential tourism scenarios for the Sacra di San Michele in the event of its inclusion on the WHL.

4 Application

4.1 Carrying Capacity Preliminary Form

Information derived from preliminary analyses on the Sacra di San Michele Site was included in the Carrying Capacity Preliminary form (Table 1). According to the methodology, this is the first step with the aim of creating a site profile. It is important to highlight that in the sheet only the information available is reported, but it can be updated as soon as new information related to the site is available.

Table 1. Carrying Capacity preliminary form

CARRYING CAPACITY PRELIMINARY FORM	
TYPE OF SITE: Abbey	ID: 001
	DATE: 30 September 2024
	COMPILER: Sebastiano Barbieri
NAME: Sacra di San Michele della Chiusa	
TYPOLOGY: Monument, place of worship, tomb, bell tower, door, engravings, mosaic, fresco, complex, area intended for worship, settlement.	
ADDRESS: via alla Sacra 14, 10057 Sant'Ambrogio di Torino (TO), Italy	
LOCATION: historic center periphery extra urban	
ENVIRONMENT **Geomorphology:** seaside mountain hill plain **Seismic risk**: Seismic zone 3S (according to the 2019 regional classification) **Hydrogeological risk**: geology of the area: metamorphic, volcanic and plutonic rocks. Area subject to the Hydrogeological Constraint. Area bound ope legis pursuant to art. 142 of the Code of Cultural Heritage and Landscape (Legislative Decree 42/2004). **Rainfall**: average rainfall 782 mm per year	
DISTANCE TO MAIN PUBLIC TRANSPORT: airport: 49 km (Turin) train station: 14 km (Avigliana) bus station: 800 m (Piazzale Croce Nera)	
LEGAL STATUS: Ente religioso Sacra di San Michele, state-owned complex since 1866	
MANAGEMENT BODY: Ente religioso Sacra di San Michele	
PROTECTION MEASURES: Law No. 1089/39, Artt. 10-12 Leg. Decree No. 42/2004, Regional Law No. 68/1994	
TIMEFRAME: X - XI century	
BEGINNING OF ACTIVITY (YEAR): X century	
STATUTE AND PLANNING: Ente religioso Sacra di San Michele's statute	
AREA*: total (parcel): 26,630.82 m^2 total (building): 2,290.60 m^2	
ARCHAEOLOGICAL ACTIVITIES: in progress previous none	
NUMBER OF VISITORS (per year)**:** 1.385.457 (2023)	
DISABLED ACCESSIBILITY: none partial total	
PRESENCE OF A TOURISTIC TERRITORIAL PLAN: Regional Law No. 14/2016	
NUMBER OF OPENING DAYS (per year): 348 days (2024)	
PRICES AND DISCOUNTS: Ticket: 8,00 € - Reduced price ticket: 6,00 €	

* Area calculation made in QGIS with data provided from Piedmont Regional Geoportal

4.2 Review of Indicators for the Case Study

To select the most appropriate indicators for the application of the TCC to the Sacra di San Michele, it is essential to consider past experiences in which the method developed by the LINKS has been successfully applied. In particular, the two case studies of the Cinque Terre (Italy) and the Venetian Fortress of Bergamo (Italy) offer a useful reference framework for understanding which indicators have been used in contexts with different territorial, cultural and management characteristics. Through this analysis, it will be possible to assess the transferability of certain indicators and adapt them to the case of the Sacra di San Michele, identifying the most effective metrics to measure the tourist sustainability of the site with a solid, empirical evidence-based approach.

The application of the methodology to the Fortified City of Bergamo, included in the world heritage site of the "Venetian Works of Defence between the 16th and 17th Centuries" employed a very diversified set of indicators, covering all the thematic components investigated by the TCC [30]. For this site, a tentative calculation of the theoretical TCC has been made, adapting from the formula devised by Cifuentes (1992):

$$TCC = S/Su * V \tag{1}$$

where S is the site's accessible surface, Su is the area required for one visitor (m^2/person), V is the number of shifts or daily changes.

Some of the indicators used to analyze these phenomena include: for the social TCC, the level of satisfaction of tourists and the quality of life of residents; for the psychological TCC, the perception of the tourist experience after the visit and the presence of services to support the visit; for the infrastructural/territorial TCC, the efficiency of public transport (both ordinary and dedicated), the availability of parking, the quality of signs inside and outside the site and the availably for accommodation. The functional TCC analyzed the ratio of tourists to the visitable area, the capacity of the main access infrastructure, specifically the funicular railway, to transport visitors, and the presence of architectural barriers. The indicators identified a number of critical issues, including congestion, low awareness of the reason for the UNESCO candidacy, inefficient distribution of tourist flows and limited synergy with other UNESCO sites in Lombardy.

Similarly, the application of the methodology to the World Heritage Site "Portovenere, Cinque Terre, and the Islands (Palmaria, Tino and Tinetto)" employed a set of indicators similar to that of "The Venetian Fortress of Bergamo", with some differences reported below. In this case, no theoretical TCC was calculated because of the vastness of the Cinque Terre territory. In addition to the indicators already mentioned for the previous case study, the social TCC examines residents' perception of living in a World Heritage Site, employment levels, and the number of commercial activities. The psychological TCC assesses the adequacy of the cultural offer, critical issues reported by visitors, tourists' awareness of being in a World Heritage Site, and the seasonality of tourist flows. The infrastructural/territorial TCC considers the availability of services for tourists near the site, such as accommodation and restaurants. Finally, the functional TCC relies on indicators to evaluate tourism management, including the presence of projects and programs for sustainable flow management, awareness-raising campaigns for tourists and residents, and measures to regulate and distribute visitor numbers throughout the year.

Thanks to these indicators, critical issues concerning the state of tourist use of the site have been highlighted. Some of them are: excessive exploitation and environmental degradation, strong seasonality of flows, especially in villages overlooking the sea, high tourist pressure (30% by 2021 and rising), an explosion of second homes, traffic congestion and lack of parking spaces, a lack of tourist information and suboptimal waste management [31].

5 Results

5.1 Table of Indicators

The analysis of similar cases allowed for the identification of indicators relevant to study the context of the Sacra di San Michele, with particular focus on the tourism aspect. Although the indicators chosen mainly refer to those used in the two LINKS case studies, the table of indicators was further enriched with additional indicators tailored to site-specific characteristics that need to be thoroughly investigated.

For the assignment of value to the indicators, the color rating scale from red (Poor value) to green (Excellent value) was taken into account (Table 2).

Table 2. Values for the assessment

	Excellent
	Good
	Sufficient
	Not sufficient
	Poor

For the quantitative indicators, target values (i.e. the best performing value for the indicator) were established and associated with Excellent value. The other values are assigned proportionally according to target value. The dichotomous indicators, which indicate the existence or absence of a particular element, were classified into the two extreme values of the scale (Excellent and Poor). Finally, the qualitative indicators were evaluated and compared to similar cases analyzed with the support of LINKS experts.

5.2 Management Guidelines

In view of the issues that have emerged from the evaluation of the indicators, the management of the Sacra di San Michele must take into account several fundamental aspects in order to ensure the optimal use of the site, improving accessibility, tourist services and the influx of visitors.

In terms of accessibility, the three lifts leading up to the church provide access for the disabled. Additional assistant devices could further improve this aspect. The narrow

passages in some places could restrict the flow of tourists at peak times, so better management of the paths in and out of the church or access regulation systems are suggested. From a mobility point of view, the distance from the main public transport hubs implies the need for more appropriate solutions, such as the introduction of shuttle services during periods of high tourist activity. The scarcity of parking lots in Piazzale della Croce Nera is another obstacle, which underlines the need to increase the availability of parking lots or to promote the use of public transport and hiking trails to reach the Sacra di San Michele. The implementation of the public transport system could also be a solution to this problem, reducing the number of parking spaces in the close area of the site and proposing alternative means of transport at the Avigliana and Sant′Ambrogio di Torino interchanges.

The Sacra′s opening hours vary according to the season, with planned closures in January and extended opening hours during the summer months. The influx of tourists peaks in April, when the number of visitors is 4 times higher than in February. To compensate for this seasonal variation, more diversification of the tourist offer in the less crowded months could be considered, through cultural events, targeted promotions or exceptional openings of areas normally closed to the public. The Sacra di San Michele offers a range of services to enhance the tourist experience. Guided tours are available on weekends and, in a special form, once a month, with access to areas that are normally closed. To encourage participation in these experiences and maximize access, promotion through digital channels should be increased and the availability of guided tours should be extended. The site′s lighting system and video surveillance are very good, but constant maintenance is required to ensure maximum security and respect for the site.

Finally, effective management of the Sacra di San Michele must be based on a balance between heritage conservation, improved accessibility, optimization of tourist services and sustainable management of visitor influx.

6 Conclusions

The paper explored the concept of TCC both in theoretical and practical terms. Starting from an analysis of the term in the literature, the work proposed the use of the recent approach to the calculation of TCC, proposed by LINKS in 2017. In particular, the paper applied the methodology to the Sacra di San Michele, an abbey in the metropolitan city of Turin, proposed to the WHL. The application of the TCC calculation to a real-world case study highlighted the dynamic ability of the approach that can be updated over time and is aimed at providing information on the current situation of the site under study, its state of conservation and any management issues. In this way, it serves as the basis for developing guidelines for this site that will improve the UNESCO property′s future management with the aim of preserving its natural and cultural values in line with conservation and protection principles.

A future phase of the research will explore the possibility of assigning values to indicators included in Table 3 that currently lack data due to the unavailability of supporting information. This limitation should be addressed in the future steps of the research through on-site visits, to gather information on tangible items in place, but also through interviews and surveys of local population and tourists to gather perceptions and satisfaction.

Table 3. Table of indicators for the TCC components

Theoretical TCC				
Indicator	**Description**	**level**	**Value**	**Notes**
No. of tourists compared to the total area of the site	Tourists are calculated according to the TCC formula (TCC = S/Su * V)	a	TCC = 2.290/4*2= **1.145 persons** (1)	S = site's accessible surface Su = 4 m^2/person V= 2 rounds
Physical/functional TCC				
Maximum crowding	Existence of safety rules	d	Excellent	
Physical accessibility	Presence of architectural barriers, difficult or tiring routes	a	Good	The building is equipped with three elevators. (the construction of a fourth lift is being evaluated)
Opening hours		a	348 days per year (2024)	Winter (November-February) Mon-Sat: 9.30am - 4.30pm, Sun: 10.45am – 4.30pm Summer (March-October) Mon-Sat: 9.30am – 5.30pm, Sun: 10.45am – 5.30pm
Lighting	Degree of illumination of the Site internally and externally	c	Existence of indoor and outdoor lighting system	
Safety of the Site	Existence of a plan for the security of the Site	d	Existence	Presence of surveillance cameras
Visitors' safety	Existence of a risk prevention plan	d	Existence	
Microclimate	Existence of an air conditioning system	d	Existence	
Management guidelines: Improving the accessibility of the Abbey for people with motor disabilities, while respecting the historical architectural structure.				
Psychological TCC				
Indicator	**Description**	**level**	**Value**	**Notes**
Satisfaction levels of tourists (accessibility, comprehension of the value, fruition)	Surveys	c	ND	
Percentage of tourists believing that the site is too crowded	Surveys	c	ND	
Existence of policies to		d	Existence	The basic ticket can also be purchased

(*continued*)

Table 3. (*continued*)

reduce Crowding				online, while the ticket with the guided tour must be purchased online.
Adequacy of the cultural offer	Field observation	c	Excellent	Brochures are available at the ticket office in 12 different languages. Along the path there are QR codes that allow you to access explanatory videos in Italian, English, French on YouTube.
Communication and promotion	Interviews with selected stakeholders	b	Good	High level of use of the official website and social media such as Instagram and Facebook.
Presence of services	Field observation and interviews with selected stakeholders	c	Sufficient	The library, the noble floor and the museum areas of the old monastery are open to the public only on the first Saturday and Sunday of the month. A bar was built in the entrance of the Abbey complex.
Management guidelines: allow access to the library, the main floor and the museum areas of the old monastery, also on Saturdays and Sundays following the beginning of the month, and if possible, even weekly. Expand guided tours even during the week (compatibly with an adequate number of admissions with guided tours)				
Social TCC				
Perception of the touristic flow (in terms of quantity of tourists)	Interviews with selected stakeholders	c	ND	
Perception of the touristic flow (in terms of behavior)	Interviews with selected stakeholders	c	Good	The behavior of tourists is quite respectful since they are in a place of worship.
Seasonality	Number of tourists during the most and the less visited	c	Not sufficient	Seasonality index equal to 4.06 (source: Osservatorio culturale Piemonte, 2023)

(*continued*)

Table 3. (*continued*)

	month of the year ratio			
Resident/tourist ratio	Ratio between the no. of residents and the no. of tourists within a significant area	b	(1,511+4,509)/15,653 = **0.38 residents/tourists (²)**	Considering both residents of Chiusa San Michele and Sant'Ambrogio di Torino
Accidents, vandalism acts, thefts	Number of problems	a	ND	Existing video surveillance cameras help avoid these kinds of problems.
Management guidelines: improve the management of seasonal peaks through better organisation of events and links with the Sacra di San Michele during periods of lower tourist influx. Since the number of tourists is greater than the number of inhabitants in the neighbouring municipalities, a sharing of common spaces and services must be guaranteed, without the population perceiving discomfort or harm.				
Infrastructural/territorial TCC				
Efficiency of public transport	Number of dedicated transport to reach the Abbey	a	Not sufficient	
Efficiency of signs			Good	
Presence of proper accommodation structures		a	Sufficient	The number of structures in close proximity to the site is not high but is compensated by the high presence in the Susa valley.
Efficiency of Ordinary parking lots		a	Poor	
Number of dedicated parking lots	Field observation and interviews with the management body	a	Poor	
Number of trash bins	Field observation		ND	
Management guidelines: increase the availability of parking spaces. In the event that this is not possible due to the morphological characteristics of the area, the request for parking at the base of the mountain could be met and a bus service leading to the square of the Black Cross could be guaranteed with optimized frequency.				

([1]) The indicator value is considered good, as the average daily number of tourists is always below the calculated threshold. In the busiest months (such as April and August), the number of tourists may approach the threshold on weekdays with religious celebrations.
([2]) In this case, the proportion of 1 tourist 1 resident was considered as excellent value, which is why the value of 0.38 is considered not sufficient.

Another exploration could regard the calculation of a synthetic index to express the overall performance of all indicators. This could provide information for comparison of alternative solutions, as well as between different WHSs.

The ultimate purpose of the paper is to demonstrate the ability to support decision makers in the management of the territory, considering the physical component, but also the economic, social and cultural one. In the complex relationship between sustainable tourism and the economic needs of territories characterized by the presence of WHSs, TCC seeks to support the achievement of a balance. Often, the economic fragilities of the area drive local governments to focus exclusively on tourism to improve their situation, without regard to the social and natural dimensions that are being impacted. TCC is configured as a strategic planning tool to make sure that tourism has economic spin-offs in the area, sometimes identifying unexploited potential, but maintaining respect for the limits of social, cultural and environmental sustainability. One approach coherent with these purposes is sustainable marketing [32], which promotes tourism products and services capable of creating economic value while protecting natural and cultural capital. An application of this approach was used by Eiseman (2018) [33] in his study of the Amsterdam canal tour.

The application of the proposed methodology shows the possibility of integrating the opinions of the various stakeholders and it develops shared strategies capable of systemizing the different needs, according to the diverse constituent elements of the TCC as well as the possible weights to be assigned. In this sense, TCC can function as a valuable source of decision-support within the domain of cultural heritage management. Moreover, its integration with other assessment methods could provide a valuable opportunity to study these phenomena holistically. Future perspectives aim to limit this gap by integrating methods such as Multi-Criteria Decision Analysis (MCDA), which enables the simultaneous integration of multiple criteria, even in the presence of conflicts or trade-offs between dimensions, by explicitly assigning weights to each criterion based on management priorities or stakeholder preferences. Finally, a combination among multiple methods would also facilitate the identification of specific actions that should be prioritized when determining the allocation of funds from public and private sources.

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