

Article

Sustainable scenarios for Macao to expand its spatial tourism carrying capacity and to re-use heritage sites

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Abstract: Macao is a small territory with a high-density population, with limited heritage sites often overcrowded by tourists and residents. Casino-oriented development and housing needs for a growing population can be an obstacle to heritage site preservation and green spaces. This study explored the feasible strategies and solutions to expand spatial heritage tourism carrying capacity by identifying the potential new land resources for heritage and for tourism. It was conducted by reviewing the relevant planning and policy documents, site surveys and observations, and data application onto the site map through AutoCad computer software to estimate the potential supply of more land areas and historical venues available to the public and to tourists. Results demonstrated how Macao could expand 189 percent of new land for tourism, almost doubling the existing tourism carrying capacity. Some measures for managing the capacity were also proposed. This study also contributes to the literature by understanding how Tourism Carrying Capacity (TCC) of a destination can be expanded, to increase a city's physical/spatial capacity and make the city more environmentally friendly and sustainable

Keywords: heritage tourism; tourism carrying capacity; dynamic approach; sustainable tourism; Macao

1 Introduction

The global concern towards sustainable development and sustainable tourism has been paralleled with an increasing interest in the impacts of tourism on the environment, society, and culture [1]. To minimize the negative impacts of tourism growth on sustainability, the growth



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limits and carrying capacity of destinations have to be considered. The overcrowding of tourism in historical sites can create the “Venice Syndrome” [2] when tourists overtake the spaces traditionally used in local citizens’ daily lives, leading many citizens to abandon the city. The key question of tourism carrying capacity (TCC) is “How many tourists can be accommodated”? To carefully examine and handle a destination’s TCC is a key factor to improve the living quality of residents in a host community as well as the visitors’ experience, resulting in a win-win situation.

There are many approaches to measure tourism carrying capacity. Tourism researchers often approach it based on the host community’s tolerance for tourists, the tourists’ perception of quality experiences [3, 4] and the destination’s actual physical space limit [5]. Macao, one of the two Special Administrative Regions of China besides Hong Kong, is a world-renowned tourism and gaming destination. The city is divided into four main parts—namely, Macao peninsula, Taipa, Coloane, and COTAI (a space between Taipa and Coloane where most of the larger casino resorts are located). Macao is also one of the most densely populated areas in the world. With 32.9 km² in size, it accommodates a population of 679,600 [6]. The living density is about 20,656 persons per km². Since 2002 Macao has experienced drastic growth in tourism and tourist numbers. Tourist numbers have jumped from 11 million in 2002 to 39.4 million in 2019, primarily from Mainland China (70.8%), Hong Kong (18.7%), and Taiwan (2.7%) [7]. The liberalization of casino licensing in 2002 is one reason for such growth.

The COVID-19 pandemic has brought significant changes to Macao’s tourism. Tourist numbers decreased sharply from nearly 40 million in 2019 to 6.5 million in 2020 and 8.2 million in 2021 (DSEC, 2022). Despite this, the number of tourists visiting Macao is predicted to rebound by 2025 when the pandemic is over [8]. Thus, the COVID-19 pandemic has “provided an important time window for Macao to re-examine its tourism carrying capacity, establish visitor flow monitoring and response measures and improve infrastructure” [9].

Macao is often referred to as “the Las Vegas of Asia,” and it is the only place in China where gambling is legal [10]. Since the liberalization of casino licenses from one concessionary to three in 2002, famous and Western-style hotels, casinos and integrated resorts have been built in Macao. Examples include Four Seasons Hotel, Grand Hyatt hotel, Venetian, Sands, City of Dreams, Wynn resort, and Galaxy Resort and Entertainment. All these resorts eat up urban places in COTAI area (approximately 6 square kilometers) previously planned for a new multipurpose new town with a capacity of 225,000 persons [11]. This area was reassigned after 2000 for a casino resort strip, therefore reducing space for housing and contributing to increasing the high population density in the city’s open spaces, which includes several historical sites, like public squares with their buildings.

Macao’s tourism boom has also benefited from the introduction of the Individual Visit Scheme by the Chinese government in 2002, which allows many mainlanders to travel to Hong Kong and Macao individually without the need to join group tours as before. In 2005 Macao was

recognized by UNESCO as a World Heritage site, a unique place where East and West blend in a harmonious way—apparent in the city architecture, public spaces, and landscape [12]. Since 2002 these two factors have brought about a substantial increase in tourists, which has caused increasing pressure on the city, most notably its infrastructure [13]. Furthermore, Macao is designated as a tourism and leisure hub by the Chinese government. The development of Greater Bay Area and subsequently the completion of the Hong Kong–Zhuhai–Macao bridge, along with a high-speed train linking several large cities all the way from Canton to Beijing, have also facilitated tourists visiting Macao [14].

The tourism boom has brought many positive impacts to the community, such as an increase in local employment opportunities, helping to make Macao a world gaming and tourism destination surpassing Las Vegas in terms of generated profit. Yet, the tourism boom has also led to many negative impacts—a real estate boom, high housing prices, environmental pollution, traffic jams, and overcrowding—as well as threatening other development interests such as heritage conservation and urban development [15].

To understand the impacts of tourism growth on the local residents, since 2003 the Macao Institute for Tourism Studies has been commissioned by the Secretariat for Social Affairs and Culture to carry out a TCC study for Macao. The study obtains Macao residents' and visitors' opinions regarding important experience factors affected by tourism. It also collects tourism service providers (i.e., border entry points, restaurants and dining establishments, and taxis) opinions on how well the capacity of hard and soft infrastructure is coping with tourism demand [16]. The 2007 TCC report indicates that both residents and tourists are becoming more sensitive to overcrowding, especially at border gates and restaurants, and they are not satisfied with the increasing number of visitors [13].

The most recent 2019 report estimates that the optimal TCC of Macao is less than 110,000 person-times per day, or less than 40.1 million person-times per year [16], indicating that the 29.4 million visitors handled in 2019 is very close to the upper limit. The report also identifies the major issues of Macao's TCC, including: (1) the surge in passenger numbers during peak travel periods and (2) the excessive concentration of visitors at particular attractions [16]. Apart from extensive promotions of certain popular attractions, lack of attractions and poor transportation and network connecting the attractions perhaps are the key reasons for the high concentration of visitors at particular attractions. Yet, a representative from the Government Tourist Office (MGTO) said in a press conference that there was still an opportunity for Macao to receive more visitors by diverting the flow of tourists from the city center and the famous tourist spots to the less well-known locations if appropriate management measures are put in place [17].

Although the COVID-19 outbreak has dragged the city's visitor numbers down significantly (16,133 visitors in June 2010 compared to 3,396,835 received in June 2019) [7], it is generally believed that once the pandemic is over and the local tourism industry has recovered,

tourism carrying capacity will still be a major challenge to the city (Figure 1–4).



Figure 1. Overcrowding of tourists
(Source: By authors)



Figure 2. Real estate boom (Source:
By authors)



Figure 3. Heavy traffic (Source by
authors)



Figure 4. Threatening to heritage
(Source by authors)

While a majority of the TCC literature and studies examine TCC through collecting residents' and visitors' opinions on their experience affected by tourism and the physical limit of tourism service providers [5, 18], the literature on TCC of open and large spaces such as cities is scant. Destination planners often have little idea of how much extra space is needed, and where it might be utilized to accommodate more tourists. This study, therefore, seeks to contribute to the TCC literature by understanding how TCC of a destination can be expanded by increasing the city's physical/spatial capacity. Potential new land resources for tourism purposes are identified. Some management measures for managing the capacity are also proposed.

2 Literature Review

2.1 *Origin and definition of TCC*

The notion of carrying capacity was initially introduced in biological science to examine the limit, or the level a species population size attains given the environmental resistance indigenous to its location [19]. In tourism, this concept initially appeared in recreation studies in the early 1960s when people were concerned about the growth of recreational use and activity in the United States [20]. The notion of carrying capacity emerged as a potent concept in tourism during the '70s and '80s and led to the development of various definitions on TCC [21].

In general, scholars define TCC from physical, ecological, infrastructural, economic, and social perspectives. First, the earlier TCC strategy focused on numbers and physical dimensions. It determined the optimum number of tourists a destination can hold at a certain period of time without negative effects, establishing an average individual standard for the site itself. Shelby and Haberlein [22], for instance, define TCC as the level of use which exceeds specified evaluative standards. Second, the ecological definition stresses the importance of the balance between tourists and the physical environment. This approach upholds that the number of visitors should not cause any destruction or irreversible ecological change for an ecosystem within a destination [23], cause any harm to the natural environment [20], or lead to available facilities and infrastructure becoming overcrowded [24]. Third, the infrastructural approach estimates the number of tourists that a destination can accommodate with a destination's prevailing infrastructure (i.e., transportation, public utilities, and hotel capacities) [25]. Fourth, the economic approach considers TCC as the number of tourists visiting a destination which do not cause negative impacts on the economy [26]. Fifth, the social approach to TCC stresses the importance of the quality of tourists' experiences and residents' impact perceptions, while tolerance defines TCC as the maximum number of tourists or activities that can be absorbed without diminishing the quality of the tourists' experience and causing negative impacts to the host destination [18,27].

TCC is a complicated issue which relates to physical, economic, social, perceptual, and ecological components [26, 28]. Therefore, multidisciplinary components have to be considered. The World Tourism Organization (2006) therefore defines TCC as "the maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic, socio-cultural environment and an unacceptable decrease in the quality of visitors' satisfaction."

2.2 *Methods to measure TCC*

The existing literature adopts five main approaches to measure a destination's TCC. First, TCC is calculated by estimating the physical capacity of a site, referring to the maximum number

of tourists that a site can accommodate in a given period of time by applying some pre-set indicators and formulas. For instance, Khurade [5] inserted data of the existing usable area, required space per tourist, and the rotation factor (number of visits per day) to the number of permissible visits in a given period of time. Kyriakou, Hatiris, Kapsimalis, Sourianos and Vandarakis [29] applied GIS to assess the physical TCC for the Island of Rhodes, Greece. Indexes of population density, seasonal population density, tourism density, beach impact, and tourism operation index (i.e., tourism service capacity) were input to the estimation.

Second, surveys with local residents to understand their perceptions of tourism impacts and degree of tolerance to the tourism numbers have been conducted by some TCC studies [27, 24]. Earlier works examined the residents' perceptions of crowding as the visitor numbers grow [21, 30]. Shelby and Haberlein [21], for example, adopted crowding perception to determine optimum carrying capacity and suggested that "if more than two-thirds of the visitors say that they are crowded it is likely that the capacity has been exceeded. If less than one-third senses the overcrowding, the area is probably below the load capacity" [21, 30]. A more recent study by Namberger and his colleagues [24] adopted other scales by asking the residents' perceptions on different tourist phenomena in the city of Munich, Germany, such as football fans on the match days of the Munich football clubs, crowds of people in the main shopping streets, and tourist groups from Asia (e.g., from Japan, China) to understand the city's TCC.

Third, obtaining reports of tourists' experiences at a destination is another common method to determine the optimum level of TCC. Wei and Wang [31] used quantitative surveys to examine tourists' perceptions of the Lüshunkou National Forest Park in northeastern China. The results revealed that visitors were very sensitive to the degree of crowding, less sensitive to cultural resource protection, and the least sensitive to vegetation coverage.

Fourth, a mixed research approach has been adopted by some previous TCC literature. To estimate the TCC of the Gangotri tourists/pilgrims circuit in the Himalayas, Vishwambhar [32] first collected the primary and secondary data on the existing infrastructure facilities. In addition, 160 respondents (in business and local government as well as local people who offer services to tourists) were interviewed. Also, the participatory observation method was employed to observe the existing TCC in the tourists/pilgrims' centers. Further, a correlation method was adopted to assess the impact of road connectivity on the quality of major infrastructural facilities in those centers. By combining all these data, a destination TCC development model was developed. Rudsari and Gharibi [33] examined the TCC by surveying 344 tourists and 386 local residents in Chalus, Mazandaran, and found that growth in tourist numbers had caused the quality of tourists' experience and the living quality of local residents to decline.

Finally, TCC is assessed through an economic approach [34]. An endogenous growth model is developed in which the number of tourists is optimally determined by social planners who consider the implied effects on both the economy and the environment. This approach seeks to

determine an equilibrium of the economy along with the optimal number of tourists and the economic and environmental growth rates.

2.3 A dynamic approach to TCC

The above discussion illustrates the different definitions and approaches to TCC. They are developed based on the unique characteristics and local policy agenda of destinations. However, one observation of the existing approaches is that they evaluate the most adaptive level of tourism growth or tourists' perceptions by using historical data or current statistics of the physical limits in a static approach. They do not consider much of the changes in the environment. Lobo [35] is one of the few researchers who adopted a dynamic method to assessing the optimum level of TCC, of Santana cave (PETAR-SP, Brazil). He considered the dynamics of the tourism activities and tourist path inside the cave, changes in air temperature level and humidity inside the cave, as well as the tourism dynamics (i.e., tourist season) in estimating the maximum TCC. Wang et al. [36] assessed the TCC in urban tourism destinations in China. They examined how government investments in tourism economy, environmental protection and infrastructure might affect the city's potential tourism growth. Despite this example, there are few studies on how TCC can be expanded by considering transforming the supply-side environment (such as new land resources) from the macro perspective. Wang and her colleagues [36] suggest: "The previous limits of growth should thus be extended to a higher level through changing environment, such as constructing new tourist products or transforming the supply-side environment. TCC is not just a limit of tourists, but a dynamic management tool that can be used to improve tourist visitation, or a positive and dynamic prism for the implementation." Therefore, a more dynamic approach is needed which takes into account the changing factors, including the future supply of new land in the limits of growth.

This study, therefore, hopes to add to the TCC literature by adopting a dynamic approach to assess the optimal level of TCC in Macao. In particular, it explores the potential new land supply for tourism activities for other tourism destinations as a reference. This approach allows destination planners to comprehend what are the potential sources of new tourism land supply, and how these lands can be utilized to expand the existing TCC before they can design, present and consult with the local residents.

3 Methodology

This study examined new physical solutions for expanding the TCC of Macao. Mrda, Caric, and Scitaroci [37] suggest that adopting TCC into a spatial planning tool should include three steps. First, it needs to identify various location-specific spatial factors such as the sites' constraints, opportunities, and suitability for tourism purposes. It is noted that Macao has 450 years of East-West legacy that was recognized by UNESCO as part of the World Heritage, so a

balance between historical preservation and tourism carrying capacity needs to be considered. In addition, accessibility (such as the provision of transportation and infrastructure, ease of visitors to reach the sites, and connectivity amongst sites) is also taken into account. In this research, the authors conducted regular site visits to different areas in Macao. An ethnographic methodology was adopted [38]. The two authors have lived in Macao for close to and more than 20 years, respectively, gaining firsthand and onsite experience of the place. Macao is a small city, so many places are within walking distance. If driving, it takes less than a day to finish exploring all the major sites in Macao. The author's familiarity with the city of Macao, especially its resources and assets, including the underutilized or abandoned sites/buildings and their conditions and characteristics, allowed them to identify potential areas/buildings that could be used for tourism purposes. Furthermore, site connectedness and accessibility as well as the ownership of sites and buildings were considered. To determine if these underutilized or abandoned sites/buildings were suitable for tourism, government documents and policies on urban planning, ownership of the sites/buildings were verified, and tourism planning and heritage protection principles and guidelines were also reviewed. Photos were taken during the site visits, and the potential sites and buildings were marked on a survey map of Macao.

The second TCC spatial planning step is to develop certain relationships or models to determine the TCC. In this study, the collected data was applied onto the site map through the assistance of AutoCad computer software. It helped to calculate the area and capacity (evaluation of approximate surface in square meters) to provide a threefold increase in the area.

The third essential TCC spatial planning step is to prepare strategies to manage spatial development of tourism. Through policy and document review, the roles and responsibilities of the government bureaus/department responsible for tourism development in Macao were examined. Coordination amongst the government institutions was explored.

4 Findings

There are eight possible solutions for Macao to expand its TCC. Solutions 1–5 are some physical solutions and 6–8 are some management solutions.

Solution 1: Pedestrianization: If we want to increase the capacity of the city to receive more visitors, there is a need to create new places and adapt old ones for pedestrian use, increasing in this way the existing small dimensions of the pedestrian network (DPN) of Macao. There is research demonstrating that regular walking provides a 20 percent reduction of risk and causes approximately 30% reduction in mortality [39] and the reduction of risk of cardiovascular disease, as well as saving millions in costs of fuel and vehicles, and bringing economic benefits for local shops, often run by local families constituting small and medium-sized enterprises. Streets with trees are the best solution for purifying polluted areas. Tree leaves can absorb a large proportion of dust particles, reducing them by 85–95 percent [40]. Trees also help to reduce the

Urban Heat Island effects. Besides, pedestrianization makes it possible to increase considerably the number of visitors, which naturally would include visitors more eager to see something more than the interiors of windowless casinos. The more places to visit, the more time is needed to stay in Macao. The actual average of tourist stay is 1.2 days [7], which is more than enough for seeing all the traditional sites in the city's historical center, classified by UNESCO as part of World Heritage.

Since 1993, pedestrianization was adopted by the formal colonial Portuguese government, and many successful projects were reported as precedents. They include several squares like the Senate, Ama Temple, Cathedral, Carmo Fair, Tap Seac, Lotus, Lilau and Camoes Square, as well as part of the historical centers of Taipa and Coloane Villages. Most of these squares are small in size, with limited capacity for the number of visitors (Table 1). In the study by Wan and Pinheiro [41], there is a confirmation of the great benefit to businesses in pedestrian areas of high flow intensity, as well as the positive impact on the rehabilitation of historical sites, streets and buildings that become part of the city's cultural streetscape, helping like a kind of DNA to preserve its cultural and historical identity.



Figure 5. San Ma Lou avenue could be converted to pedestrian use, helping increase the TCC in the historical center of Macao. (Source by authors)



Figure 6. October 5th Street is a tourist attraction that can be adapted for pedestrian use. (Source by authors)

In the Macao peninsula, a great opportunity for pedestrianization is to link the scattered pedestrian networks along Almeida Ribeiro Avenue (also called San Ma Lou in Chinese), which is the main street in the central area of Macao (Figure 5). San Ma Lou connects the ferry station from Wan Chai in Zhuhai to Macao, with the landing pier near San Ma Lou, an important connection to the northern part of the city towards the Border Gate. San Ma Lou is one of the oldest streets in Macao and was classified as a World Heritage site by UNESCO. The overflow of cars in almost every small street of Macao, from historic Chinatown in the Inner Harbour to the northern half of Almeida Ribeiro Avenue, is one of the reasons why traditional businesses are collapsing and many buildings are becoming dilapidated. The adaptation to pedestrian use of these places can boost businesses, particularly on the small and middle scale. Pinheiro and Wan (2008) demonstrated the heritage preservation benefit of the conversion of San Ma Lou from

traffic to pedestrian use, which also would help the fluidity of the already large and congested sidewalk traffic of people moving between the historical center and the CBD. The pedestrian conversion will bring economic benefits to local shops and improve tourism carrying capacity, without the need for public or private buses that create pollution, traffic congestion, and reduced space for visitors. Along the San Ma Lou there are rows of old shophouses to contemplate, with a variety of styles dominant in the region over the last 100 years, and the many narrow lanes parallel to San Ma Lou provide a wealth of tourist experience of traditional houses and shops.

The existing public transportation can be replaced by an electric tram—so common in Lisbon, which for centuries has been the mother city reference for Macao. In this way it is possible to landscape part of the avenue as well, to cover it with a metal and glass structure, which will protect it from local acid rain. The covered areas allow the trees to clean the air inside, as in London [40] where studies showed they were able to remove 90 percent of dust particles while freshening toxic air. The heavy bus traffic can be transferred to peripheral circular lines through Nam Van and Inner Harbour, a circuit detour that takes less than 10 minutes. The adaptation of San Ma Lou to pedestrian use will bring similar benefits to the ones of Senado Square in 1993. Many other streets have heritage-value buildings—like the colonial houses and Chinese shophouses, for example, at and near October 5th Avenue (Figure 6)—that can be converted for pedestrian tourist use, removing the toxic buses from the city's historical center. Calculation of the areas was done through the maps annexed.

Solution 2: Utilize the existing historical buildings: Many historical buildings now used as government offices could be freed and adapted for heritage and tourist use. For example, the St. Francisco Barracks building and parking areas (Figure 8) (a total of 12,000 sqm) are used actually as a crowded and old Police headquarters, and the Senate Municipal Building (2,100 sqm), used as a municipal office can follow the example of Taipa island city hall headquarters and be adapted as a museum or other facility to be open to the public. In Hong Kong the Central Police Station was converted from government department to heritage tourism, cultural and commercial venue called Tai Kwun (大館) that open to the public in 2018. The Police and other government venues moved to modern buildings. Macao can follow this example with its Police headquarters as well the old building of the Traffic Police headquarters.

There are many possibilities to rehabilitate historical sites, making them capable of receiving tourists. For example, in one old street of the area of Mong Ha, several old colonial government-owned mansions (Figure 7) of historical significance could be opened for the benefit of visitors and citizens, with an approximate area of 10,000 sqm. Pier N.8 is a large old building, with attractive industrial heritage architecture features, which has been abandoned for several years, and become dilapidated year by year. Several historical buildings that are now used by the Cultural Institute could be made available to the public—for example, the Music Conservatory, the Music Academy, the Mansion at the top of St. Lazarus staircase, the old Court House, and

the old Liceu (now headquarters of the Cultural Institute). Government departments in these buildings could move to new facilities, allowing to convert them into venues for tourism and local public use, therefore increasing the accessibility and use of heritage places by local people and tourists.



Figure 7. Empty Portuguese style mansions, and the Coronel Mezquita Avenue. Several of these buildings are now empty. (Source by authors)



Figure 8. Old S. Francisco Barracks, at the city center between casinos and World Heritage sites. This government building could be used for tourism purposes. (Source by authors)

Solution 3: Utilize the underutilized or abandoned sites : As mentioned above, there are some abandoned houses, like Pier N.8 or the old Jesuit retreat facilities in Green Island, but also large sites like the very large old Iec Long Fireworks factory (33,000 sqm), the Lai Chi Vun Shipyards, the small fort at Coloane Village Bay, and several courtyard houses located at the Inner Harbour in Macao, that can be better utilized. All these facilities are abandoned, closed, and/or decaying. In the CBD area, the Ferreira do Amaral shopping center is abandoned, and only the car park area is in use. The Green Island monastery and surrounding hill could be adapted for a tourism or local center for retreats. The now-closed and abandoned Armenian Cemetery could be open to the public as a historical site, in the same way as the old Protestant Cemetery. The Hill surrounding Penha Road (Estrada da Penha) could be used as a small urban park. Several empty slots of land in Taipa near Kwong Tung Avenue by the Pou Tai Buddish temple could attract more visitors to the temple. A similar formula can be applied in Caminho das Hortas in Taipa, a dilapidated area of an old village near the Tin Hau Temple.

Solution 4: Utilize public spaces, sidewalks, and corridors: The old Macao Taipa bridge (16,000 sqm), too narrow for helping the traffic flow, can be covered and converted for exclusive pedestrian and bicycle use, linking the cycling areas of Taipa with Macao. There is a large stretch of riverside shore, encompassing the jetfoil terminal, the adjacent Fisherman's Wharf, and the Science Museum, all the way to Macao Tower, that is not landscaped and connected. This

riverside area could be connected, improved, landscaped and opened to the public as a space for pedestrians and bicycles, with a total of 3,670 meters. The Inner Harbour shore (2,390 meters) could also be improved in many areas, such as by opening them for pedestrians who could enjoy the view of the harbor and the landscape of the hills in mainland China. In the 2020 Policy Address, the new Chief Executive (Macao's Governor) announced the improvement of public spaces. Some of these improvements have been started already by the Municipal Affairs Institute (IAM), with an area of 2,700 sqm at the riverside area near the Science Museum and Kun Ian statue, and all the area up to the Barra [42] at the entrance of the Inner Harbour. From the same source, it is announced that at the Hac Sa beach inland area there are plans to enlarge the entertainment area, to promote some cycling lanes as well as some pedestrian areas throughout the city.

Solution 5: Utilize the sea and waterfront areas: On December 20, 2015, the Chinese Central Government gave Macao 85 square kilometers of sea area. This large area can be used to promote tourism activities such as water tours, as well as to develop land reclamation for tourism (e.g., beaches, water resorts, hotels, theme parks, etc.). This large area has a great potential for diversification of the tourism product. At Hac Sa beach, the waters are highly polluted (Map 3), but it is possible to make an artificial lake and create a beach resort of clean water and sand. Coloane Island could be a cycling paradise if cycle lanes are added to the main street that circumnavigates the island (see maps).

In April 2021, 15,000 square meters of previously unused waterfrontⁱ land located between the Science Center and the Kun Ian Statue were open. SA (2021).

The dilapidated (and in need of improvement) or closed areas could also be used for catering to more visitors. The Nam Van and Sai Wan lakes have approximately 100,000 sqm of shore area that can be improved, with F&B areas as well as more public entertainment facilities. There is a lack of space for the storage and parking of public and tourist buses. The area below the (artificial) lakes of Nam Van could be used as underground parking storage, freeing in this way several thousands of square meters for bus parking.

To increase areas for tourists requires more planning work and better management and coordination with the private sector (casinos and hotel industry) in order to improve the quality and usefulness of open spaces, and to resolve long-standing conflicts like the case of Fisherman's Wharf. It is now half empty and has a poor connection with important neighboring government venues like the jetfoil terminal and the Science Center. Both Fisherman's Wharf and the Science Center could benefit in carrying capacity and business by creating a seaside promenade through wooden wallboards, well landscaped and comforting with the refreshing shade of trees, as happens in many seaside resorts, popular for tourists and residents.

4.1 Mapping the spaces for increasing TCC

Based on the above methods to identify new land sources for tourism, the following tables and Figure provide the details of potential future supply of new land for tourism activities in Macao peninsula, Taipa island and Coloane island. The size to accommodate tourists is estimated by applying the AutoCAD computer software (see Tables 1–4, and Maps 1–3).

Table 1. Macao peninsula.

Solution 1. Pedestrianization

Almeida Ribeiro Avenue (San Ma Lou) from Post Office to the old International Hotel, 4,800 sqm

Coronel Mesquita Avenue. East sidewalk improvement area 3, 200 sqm

October 5th Street, 6,400 sqm

Solution 2. Utilize existing historical buildings

Green Island Monastery. 8, 800 sqm

St Francisco Barracks area 12,000 sqm, plus nearby mansion 550 sqm

Old Military barracks opposite to Sun Iat Sen Memorial Hall; 5, 500 sqm, and behind old mansion (actual tuberculosis center); 2,900 sqm

Government old colonial facilities at Coronel Mesquita Avenue, Ox House and dog's nursery and cemetery (4,7000 sqm) three clusters of colonial houses (570, 2,400 and 2,300) making a total of 9,970 sqm of the ground floor area of facilities.

Solution 3. Utilize the underutilized or abandoned sites

Lisboa Rotunda (Ferreira do Amaral Square) Facility for Bars and Shopping 4,500 sqm

Solution 4. Utilize public spaces, sidewalks and corridors

Connection, improvement, and opening to the public the complex of Dona Maria Forts, and Communication Museum, 4,700 sqm, and the old Ama Temple near the northern part of the reservoir, 975 sqm.

St. Paul Street and Camoes Square: 6, 600 sqm

Solution 5. Utilize the sea and waterfront areas

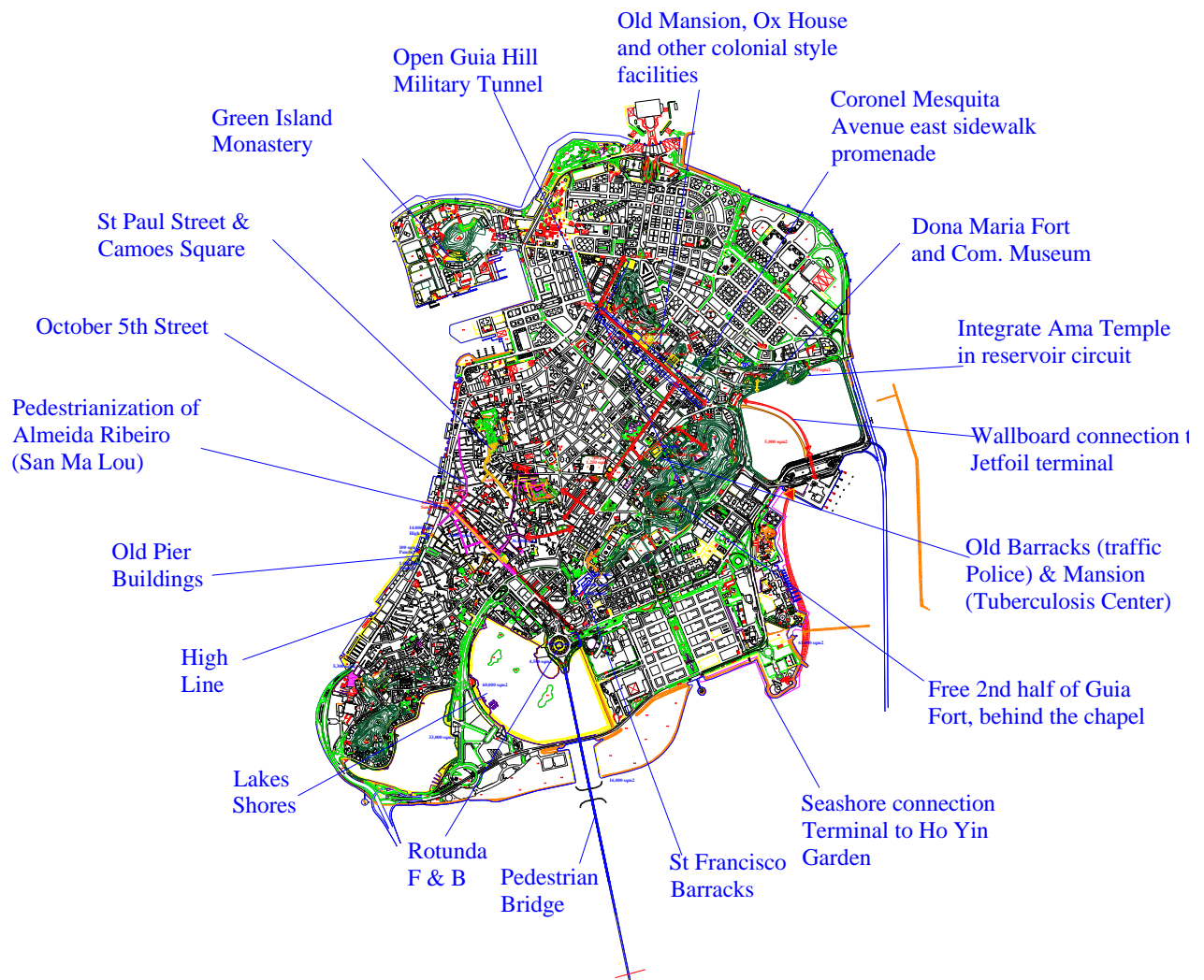
Lakes shores. Improvement and adaptation of the (wallboards and facilities)

93, 000 sqm. Seaside wallboards and landscape connection from Jetfoil Terminal, Fisherman Wharf,

Science Museum, and Ho Yin Garden: 61, 000 sqm

Wallboard connection from jetfoil/Grand Prix terminal, crossing water reservoir towards Guia Hill and Coronel Mesquita Avenue. 5,000 sq.

By our map calculations of the above mention areas, a total area of 180,000 sqm of open spaces and 49,900 sqm of the plot area (ground floor) of colonial facilities that are now used for the government, with some of them close, can be provided. Many historical and colonial facilities are used by the police force (17,500 sqm), which could be transferred to modern and more comfortable and efficient facilities. These facilities can be used as boutique hotels, restaurants, museums, etc., providing an important ground to improve the quantity and quality of tourist facilities.



Map 1: General CAD map area. To the existing 50,000 sqm of approximate area for public use, we can add, through urban rehabilitation of public use (180,000 sqm) and adapt facilities (49,900 sqm), totaling 229,900 sqm, thus representing a potential increase of 4.598 times more capacity. Map by the authors, based on DSCC map (Cartographic and Land Registry Bureau)

Table 2. Taipa island.

Solution 1. Pedestrianization

The current mass tourism areas are at the old Village (25,500 sqm) of open spaces and historical facilities and the five green mansions area, Carmo Church and gardens, occupying an area of 14,500 sqm. The two sites combine currently offer approximately 40,000 sqm.

Solution 2. Utilize existing historical buildings.

Make use of the buildings inside the abandoned Iec Long fireworks factory (please see solution 3)

Solution 3. Utilize the underutilized or abandoned sites

In order to increase the TCC, it is proposed to open to the public the wonderful Industrial Heritage and natural landscape of the Iec Long Fire Works Factory; 33,000 sqm, the adjacent west area of 18,000 sqm of the former settlement of Chun Su Mei, and landscape. The Iec Long old factor and the lake are two important zones work between the high-density residential areas of Taipa City and the Mega Integrated Resorts in COTAI.

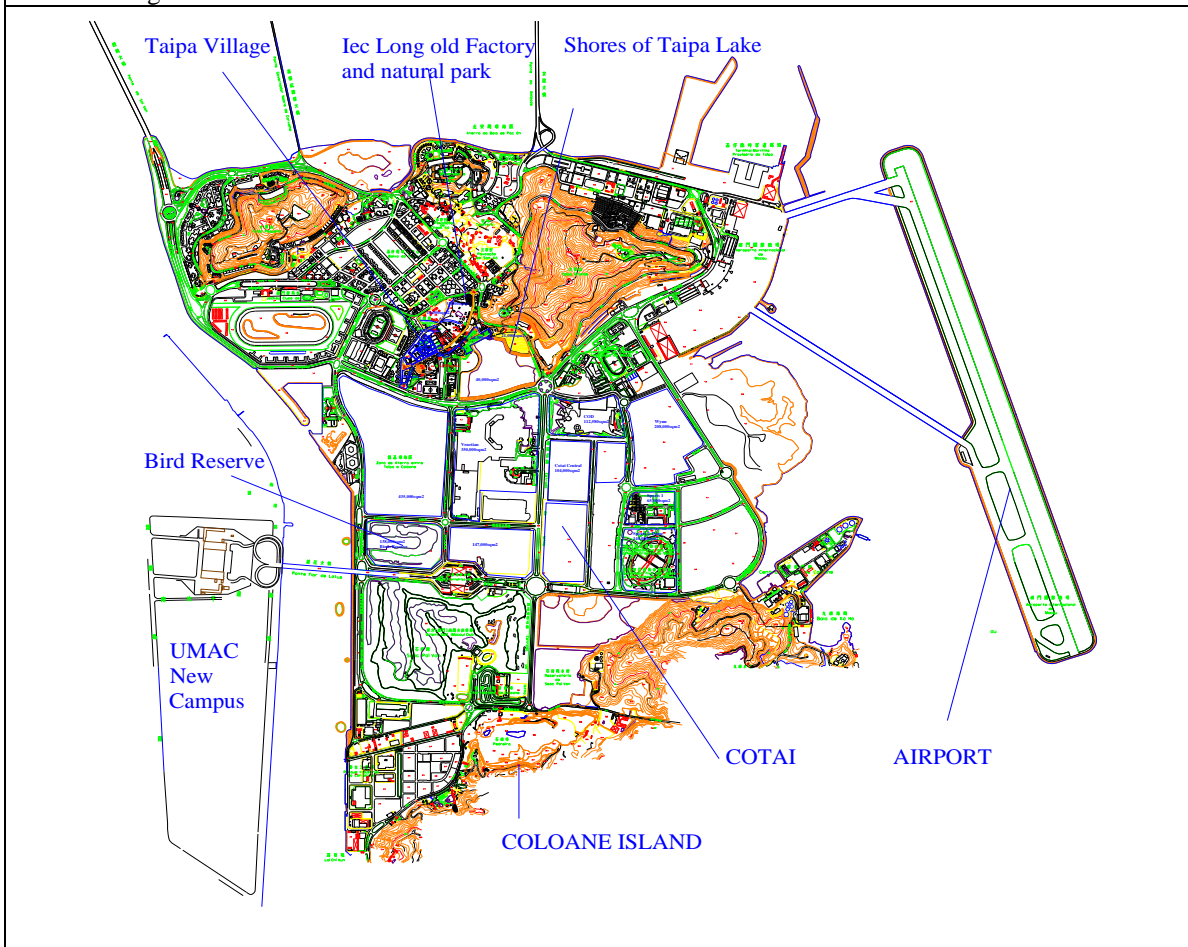
Solution 4. Utilize public spaces, sidewalks and corridors

The Taipa main Street (Fernan Mendes Pinto) adaptation to pedestrian use can provide more 6,000 sqm for tourist safe use, contributing for improving local business

Solution 5. Utilize the sea and waterfront areas

Open the public the 40,000 sqm shores area of the lake formed after closing the bay of Our Lady of Hope. These three new areas will add between 79,000 to 97,000 sqm (including the Chu Su Mei area,) corresponding approximately to double the capacity, that we estimate as an accurate and negotiable value of 80,000 sqm as the area newly added for Taipa Village

The natural bird reserve of 138,000 sqm in COTAI should be protected and the facilities improved. There is no marketing on this site.



Map 2 of Taipa and COTAI land Reclamation area. The tourist site capacity in Taipa can improve from the current 40,000 sqm to the double (80,000 sqm) of this capacity. Map by the authors, based on DSCC map

Table 3. Coloane island.

Solution 1. Pedestrianization

Comprises with approximately 42,000 sqm of the Coloane Village

Solution 2. Utilize existing historical buildings

10,000 sqm of the Ka Ho old leprosarium and church, adding F&B and toilets to this historical site.

Solution 3. Utilize the underutilized or abandoned sites

36,000 sqm by rehabilitating the area of the old Lai chi Vun shipyards.

Solution 4. Utilize public spaces, sidewalks and corridors

21,000sqm and 113,000 sqm of Cheok Van and Hac Sa Beaches, some mountain trails, and the 20,000 sqm, Ama Temple complex on top of the hills and Hac Sa Dam of 34,000 sqm, totaling an approximate scattered area of **230,000 sqm** (counting with Coloane Village area)

4,000 sqm bicycle trail on Hac Sa Road, making bicycle friendly go around the island.

62,000 sqm by landscaping and improving the green areas behind Hac Sa Resort and beach for sports and leisure facilities.

82,000 sqm by adapting the Ka Ho Dam area in camping, boating, and cycling areas for youth and lovers of nature.

Solution 5. Utilize the sea and waterfront areas

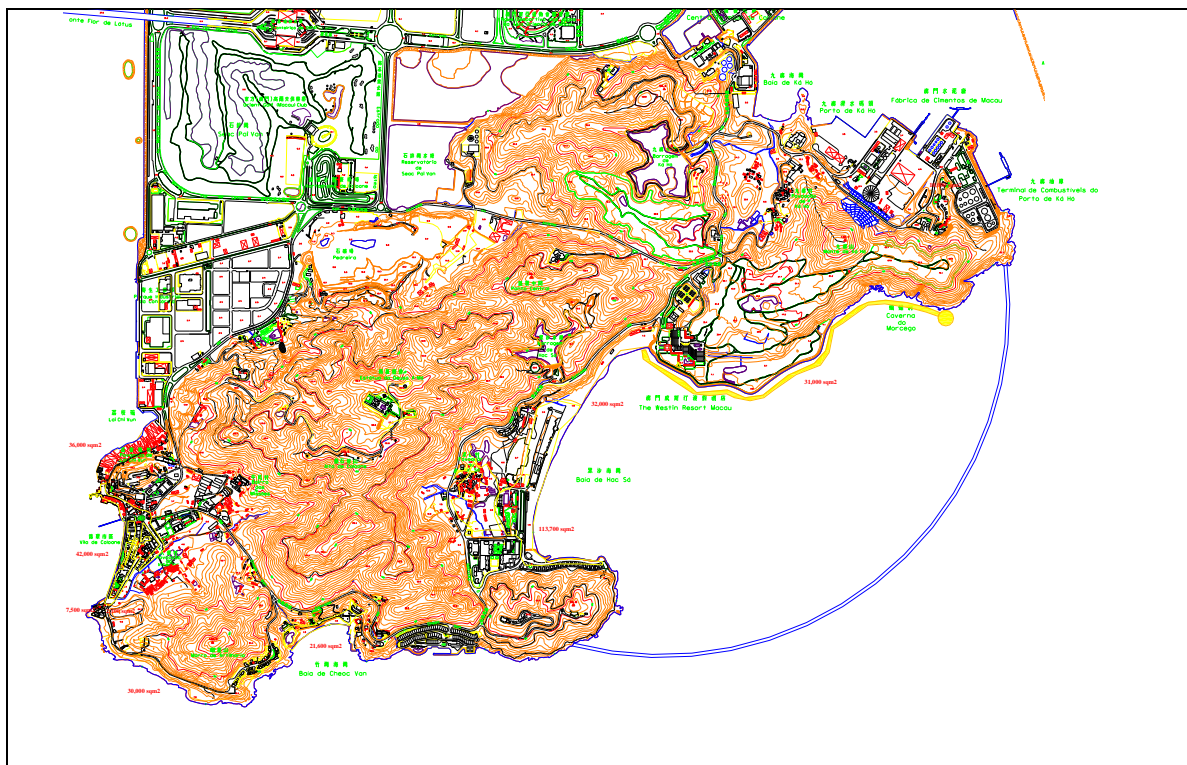
7,500 sqm, by making clean and accessible the beach around the above-mentioned fort (history linked).

30,000 sqm by improving the landscape around the old military road towards Cheoc Van "Portuguese" Village" and beach.

32, 000 sqm, by improving, landscaping, and attractive facilities at the beach shore between the existing barbecue area and Westin Resort. This area is dilapidated, with a lot of junk and abandoned dogs.

31,000 sqm, by building a sea boardwalk from Westin towards the Caverna do Morcego (Bat's and Pirates caves historical sites). For this Hac Sa beach water can be tamed and cleaned, converting in a bay lake, but bigger than Nam Van Lakes, and use for water sports and family venues with clean water and sand (now both are very polluted and hazardous for human use), thus providing several more thousands of square meters of space for recreation.

Thus, the new areas in Coloane with capacity for increasing the TCC, is approximately totaling 296,600 sqm.



Map 3 of Coloane island, with the actual approximate area of 230,000 sqm, which can be expanded with an extra 296,600 sqm, close to doubling the existing tourist area. Map by the authors, based on DSCC map

Table 4. A summary of how the previously discussed solutions can create a total of 606,500sqm new land for tourism activities, which expands 189% of the land, almost doubling the existing TCC.

Table 4. A Summary Table of New Land Supply to Expand TCC.

Area	Existing areas visited by tourists	Newly added spaces	Total new land can be created
Macao Peninsula	50,000 sqm	180,000 m2 (open spaces) + 49,900 m2 (use of existing facilities) totaling 229,900 sqm	4.6 times more capacity
Taipa Island	40,000 sqm	80,000 sqm	2 times more capacity
Coloane Island	230,000 sqm	296,600 sqm	Approximate 1.3 more capacity
Total	320,000sqm	606,500 sqm	Total 189% increase, almost doubling the existing capacity

Solution 6: Increase the number of entry/exit points: The way of increasing the carrying capacity and avoiding the jams of traffic flow has two vectors—one on the periphery of Macao, and the other internal, of core zones. For resolving the problem of the first vector it is necessary to increase the number of entry/exit points, as well as to open the border 24 hours. More entry/exit points will reduce the large queuing periods as well as the bus parking sites and traffic jams. More entry sites, for example near Ponte 16 and Almeida Ribeiro Avenue (popularly known as San Ma Lou), will provide comfortable and fast pedestrian access to the casinos. More entries in Taipa and Coloane will also remove or reduce bus traffic jams from Macao Peninsula.

Solution 7: Improve the existing urban planning system: A critical factor that affects the performance and efficiency of urban planning in Macao is that different government departments are in charge of urban planning [41]. For example, the Public Works and Housing department gives priority to buildings and infrastructures without considering heritage, tourism, or ecological and biological needs. This shortcoming was shown in the recent case to build high-rise residential buildings in Coloane, a place designated a few years ago in the Government Action Plan (Linhas de Acção Governativa) as the sacred “green lungs of Macao.” There were alternatives, such as redeveloping old urban areas near the Border Gate, adapting empty industrial buildings, and even renting land in Hengqin Island for social and private housing, as was done for expanding the University of Macao. Land in Hengqin is already available, without the need to create anti-ecological new land reclamations and wait 20 years for construction and development. With political and economic negotiations, a win-win situation can be achieved for the benefit of Macao and Zhuhai.

There is a lack of transparency that favors the arbitrary concession of government lands, and even historical sites and colonial building areas, to developers (e.g., Green Island). Another example of a lack of converging interests is the autonomy of DSAT (Traffic Department), which will make it practically impossible to convert more streets to pedestrian use for increasing the tourist carrying capacity, as was done in the 1990s in the Macao, Taipa and Coloane historical centers. An example is the postponing of converting San Ma Lou to pedestrian use that will help people flow without buses and pollution, from the Inner to the Outer Harbour casinos and CBD concentration. The Traffic Bureau (DSAT) implemented an absurd restriction of traffic on the weekend, allowing only public buses and taxis, which serves as a good reference. Under current circumstances, the Macao Government Tourist Office (MGTO) is powerless alone to implement any plan or urban guidelines to improve the carrying capacity. The Public Works and Land Department (DSSOPT) named on April 2022 to Lands and Urban Construction Bureau (DSSCU in Portuguese), Traffic (DSAT), Municipal Institute (IACM), now designated as Municipal Issues Institute (IAM) and Cultural Bureau (IC) need to work under the coordination of one central and top authority, like the Urban Redevelopment Authority (URA) in Singapore, which also has the mission to coordinate and direct the plans of private investors like casinos and real

estate developers, for the common good of the city and society. Singapore is considered the number one city in Asia [43]. Macao's bureaucratic approach, corruption, and lack of transparency and coordination need to be improved with tourism planning to bring new hope for a good city, instead of following the Third World practices of India and Africa [44] where bureaucracy and many bureau compartmentations are factors for slow development.

Efficient planning and management are the keys for success, as in the mega city of Tokyo with its 35.6 million inhabitants who enjoy a better quality of life than Macao with half a million inhabitants. Efficient planning and management are what make possible the transformation of Singapore from a mixture of slum towns to a city without slums. The outdated model of urban planning and city management in Macao is the primary hindrance to the sustainable development of the city [10]. The lack of participation of citizens and local universities is another handicap, leading decision-makers to follow the pressure of real estate developers and economic and oligarchic interests, and making the Master Plan a tool for private interests. Even the Public Works and Land Department and the legislative council have little power to interfere because it is not considered to be citizens' or policymakers' business [10].

When there is a will there is a way, and the opposite is also true. Without a clear vision for the city and strong political will to implement a plan coordinated by a central authority, like the Urban Renewal Authority (URA) in Singapore, then all good intentions and plans will be just wishful thinking. The key to success in Macao as in Singapore is not so much having a Master Plan, but having a master authority for the plan, one that could overcome the enormous amount of red tape, bureaucracy, and compartmentalization of the several autonomous government departments.

Along with this central bureau to coordinate different departments, the involvement of the private sector is absolutely necessary for the efficient increase of tourism carrying capacity, implemented by creating new pedestrian areas and the rehabilitation of old colonial facilities and shop houses (e.g., the remaining ones in Inner Harbour Chinatown, Iec Long Fireworks factory in Taipa, the revitalization and adaptation to a museum of the old Coloane Shipyards, etc.). With these steps, the estimated area that will be available to tourists and citizens is three times superior to the area offered currently. In general, these urban interventions focus on people, not vehicles, and such planning will provide environmental, safety, and health benefits, as demonstrated in the case of London [43].

Solution 8: Strengthen inter-governmental coordination to improve the tourist facilities: Poor coordination amongst inter-governmental departments has always been a major criticism of Macao [37]. It is apparent in the lack of management of the Nam Van and Sai Van Lakes, with different areas under the management of IDM (Nautical Center by the Sports Institute), IAM (seaside bars and esplanades), and DSSCU and DSAT (traffic and land). Meanwhile, the GIT (the Infrastructures Transportation Bureau developing the Light Train Rail (LRT)) has not shown to the public the environmental impact of the railway in the lakes.

In all these public spaces and facilities there are planned spaces for bars and restaurants, but they close or, in some cases, never open. The reason is a kind of phobia of F&B, which requires a bureaucratic process for the concession as well as some “trouble” in managing them. Not surprisingly, F&B facilities are minimal or absent in most facilities run by government departments, from public libraries (Culture Bureau and IAM), to sports facilities (Macao Dome, Tennis Center, Nautical Center) and the reservoir circuit (IAM). The alternative is to entrust professional F&B service providers to the private sector, freeing the government from this administrative and bureaucratic burden in order to provide better service to citizens and visitors.

5 Conclusion

This research contributes to proposing the opening to the public of Heritage Venues and historical sites increasing the tourist capacity of Macao, with numbers (please see tables and maps) that help visualize the locations. Also contributes to the TCC literature by adopting a dynamic approach to assess TCC. While a majority of the TCC literature and studies examine TCC by collecting residents’ and visitors’ opinions on their experience affected by tourism and the existing physical limits of tourism service providers [5, 21], this study echoes with Wang et al. [36] that constructing new tourist products and transforming the supply-side environment can lead to expanding the current carrying capacity. The case of Macao demonstrates how the city can expand 189 percent of new land for tourism, almost doubling the existing tourism carrying capacity. TCC is not just a limit of number of tourists, but a dynamic management tool that can be used to improve tourist visitation. By exploring the potential new land sources, destination planners will have more ideas of how much is available and where the new land has the potential to accommodate more tourists before they make plans and consult with the locals. New pedestrian and green areas are proposed, helping to improve the sustainability and quality of life of the city [13]. This research particularly contributes to planners of Macao by showing how new land sources can expand its current TCC almost to double. However, success in increasing the TCC as well as the quality of life of Macao residents will depend on the implementation of an appropriate planning and urban management model similar to the well-recognized model used in Singapore (i.e., URA). This research uses a quantitative mapping technology which reveals several spaces that are underutilized and can be adapted for increasing the TTC. The success of the plan by the central and regional governments envisioning Macao as a World Centre of Tourism and Leisure will depend ultimately on the improved planning practices and management models and practices implemented there. The success of increasing the TCC is in the government’s hands.

This study is not without its limitations. It estimates the maximum tourism carrying capacity in Macao, thus is case-specific and adopts a spatial approach only. In addition, maximum TCC is also examined by estimating the potential new land supply, and therefore, there are other

methods are excluded. Despite these limitations, the case of Macao can offer insights to planners of other destinations into the possible ways and solutions to expand their tourism carrying capacity. It contributes to the literature by understanding how TCC of a destination can be expanded by exploring new land resources to increase a city's physical/spatial capacity.

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ⁱ This number was not included in the calculation map of Macao Peninsula, that were made before the inauguration.