

## Article

# Visual Analysis of Social Media Data on Experiences at a World Heritage Tourist Destination: Historic Centre of Macau

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**Abstract:** The burgeoning field of sustainable tourism in historically significant urban districts has derived increasing attention in tandem with broader urban economic development. The perceived image of a tourist destination significantly affects tourist consumption behaviors and destination choices, while negative evaluations provide destination managers with insights for targeted improvements to tourist amenities, thereby contributing to the sustainable development of these historically significant districts. This study leveraged Python 3.12.3 software to collect online textual data from popular tourism websites, specifically Ctrip 8.71.4 and Mafengwo 11.1.7. Then, ROST CM6.0 software facilitated high-frequency word analysis, network semantic analysis, and sentiment analysis to outline the perceived image and characteristics of the Macau Historic District, a UNESCO World Heritage site, from the perspective of tourists. The findings are as follows: (1) The image of the Historic Centre of Macao as a tourist destination comprises four primary dimensions: cultural (16.02%), landscape (30.85%), emotional (16.97%), and local (36.16%). (2) Tourists perceive the Historic Centre of Macao as a blend of dynamism and tranquility, tradition, and modernity. (3) Emotional evaluations of the Historic Centre of Macao as a tourist destination are primarily positive (85.45%), whereas negative sentiments constitute 5.76%, with recurring themes pertaining to overcrowding, high prices, a lack of interactive experiences at attractions, excessive commercialization, and insufficient public rest facilities. These findings offer valuable directives for the future planning and development of tourism in Macau, a city recognized for its World Heritage status. (4) In summary, the thematic image of the Historic Centre of Macao can be considered authentic, romantic, and commercialized.

**Keywords:** Historic Centre of Macau; web text data; ultra-high-density; world heritage site; tourist destination image; visitor perception



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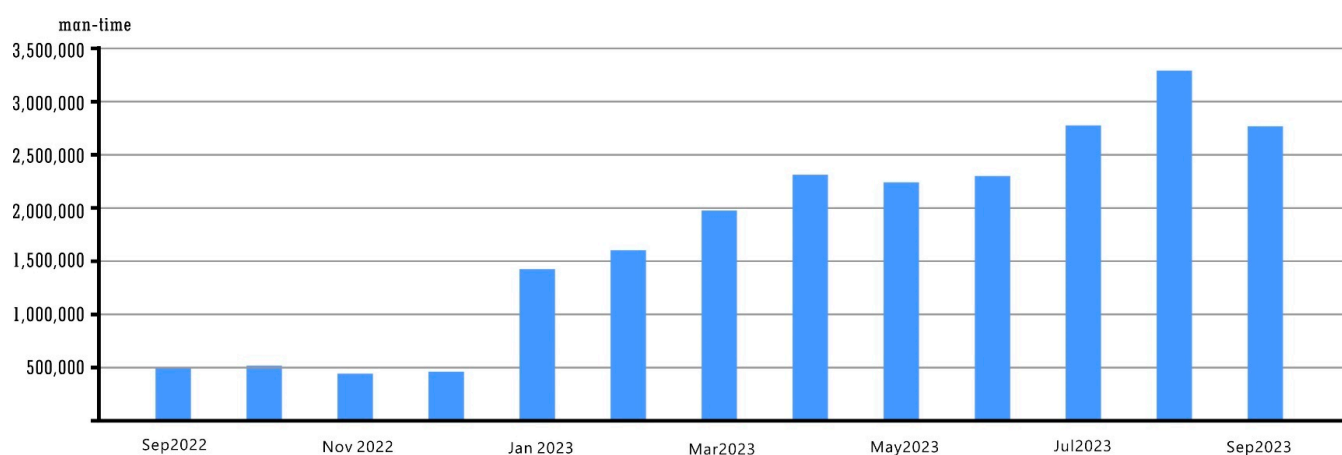
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## 1. Introduction

### 1.1. Research Background

Cultural heritage tourism offers tourists an immersive experience and understanding of urban landscapes. Tangible cultural heritage is instrumental in shaping the identity of a tourist city, representing its unique signature [1]. This image is a valuable asset for any tourist destination, significantly influencing tourist behavior and destination choices [2]. World Heritage sites, often the preferred choice for tourists, play a crucial role in regional tourism and local economic development [3]. Macau, as a World Heritage Site, is no exception. Therefore, analyzing online tourist reviews is essential for understanding the image and perception of tourist destinations [4]. A core city is situated in the Guang-dong-Hong Kong-Macau Greater Bay Area on the west bank of the Pearl River Estuary in southern China, the Macau Special Administrative Region. It shares a border with Guangdong Province and has a population of approximately 678,800 (as of Q2 2023 population statistics) [5]. Including a land area of 33.3 square kilometers (as of June 2023), Macau has a

high population density of 20,745 people per square kilometer, particularly in the northern Macau Peninsula, recognized as one of the most densely populated areas worldwide. Currently, Monaco holds the highest population density globally at 24,360 people per square kilometer, while Mongolia has the lowest with only 2.17 people per square kilometer [6]. Singapore and Vatican City follow closely, ranking second and fourth, respectively, with 7796 people per square kilometer and 1891 people per square kilometer. In a global comparison, Macau, China, has one of the highest population densities [7]. Macau's economy is primarily driven by the gambling, tourism, convention–exhibition industries, forming its three pillars [8]. Moreover, as a tourist city, Macau has experienced a steady rise in tourist numbers following the easing of COVID-19 restrictions (Figure 1). Based on pre-pandemic reception levels of approximately 30 million tourists annually, it is estimated that approximately 80,000 to 100,000 tourists visit Macau daily [9–11]. This influx places significant strain on the small city, intensifying the friction between its ultra-high-density urban environment and its tourist carrying capacity. Simultaneously, it presents new challenges for the Historic Centre of Macau, a critical heritage site for Macau tourism.



**Figure 1.** The number of tourists in Macau has gradually recovered after the epidemic.

Conversely, the Macau SAR government's current urban planning and development objectives center on enhancing tourist capacity, establishing Macau as a global tourism and leisure hub, and cultivating deeper integration between tourism and other industries [12,13]. Therefore, analyzing tourist destination images from the perspective of large tourist groups holds significant practical implications. It offers valuable insights for addressing current shortcomings in Macau's tourism industry reception capacity, affecting the development of Macau's urban tourism development, and guiding future urban planning.

## 1.2. Literature Review

### 1.2.1. Research the Content of Tourism Destination Image

The concept of tourism destination image (TDI), initially explored by John Hunt in the 1970s [14], refers to the subjective evaluations and overall impressions that tourists form about a particular destination [15]. Then, researchers focused on various facets of TDI, including influencing factors [16], underlying mechanisms [17], marketing strategies [18], and the relationship between TDI and tourist loyalty [19]. TDI can be broadly categorized into ontological, disseminated, and perceived images [20]. The ontological image pertains to the tangible presence and characteristics of tourist resources and cultural contexts in a destination [21]. Disseminated image centers on the information and promotional materials disseminated through various media channels about a tourist destination [22]. Finally, perceived image reflects the subjective understandings and attitudinal tendencies of audiences (such as tourists, local residents, etc.), toward the ongoing development of a tourist destination [23].

Regarding the selection of spatial or city typologies for TDI studies, existing research in the Chinese context has primarily concentrated on second and third-tier cities, including Nantong and Nanjing in Jiangsu Province, Xiamen in Fujian Province, Urumqi, and Xuancheng in Anhui Province [24–28]. These studies often employ a comprehensive, macroscopic analytical approach at the city level. Moreover, a considerable body of research has focused on case studies of renowned tourist attractions in mainland China, such as the ancient villages of Xidi and Hongcun in Anhui Province, the Tianzhu Scenic Area in Anhui, the Lushun Sun Valley, the Hefei Hechai 1972 Creative Park, the Tongguanyao Ancient Town Tourist Resort, the Nanjing Confucius Temple, the Beijing Imperial College District, and the Wanlong Ski Resort [29–35]. It is important to note that different tourist destination typologies may encounter unique challenges. Current research on tourist destinations in China primarily centers on ancient villages, natural scenic areas, industrial heritage parks, and historical blocks characterized by ancient architecture. However, there remains a need for further analysis of World Heritage sites situated in high-density urban environments as tourist destinations.

### 1.2.2. Tourist Destination Image Analysis Methods

Research into the image and perception of tourist destinations has traditionally relied on methodologies such as field surveys, target image analysis, and network data analysis [4,22,36–43]. Take, for instance, the widespread use of Likert scales in on-site tourist interviews to measure the significance of destination image in travel decision-making processes [36]. Researchers often factor in interviewee demographics alongside the temporal, historical, cultural, and aesthetic contexts of the research locations. Drawing upon principles of visual research, scholars hypothesize that a tourist destination's image represents a synthesis of textual and symbolic perceptions [37]. However, such approaches are not without their drawbacks. They demand significant time and financial investments and are vulnerable to researcher biases, potentially compromising the objectivity of data collection and analysis.

Target image analysis, in contrast, centers on the interpretation and comparison of destination images, with an emphasis on visual patterns of destination evolution. Word associations, picture associations, and collage methods, for instance, are frequently employed to identify both the diversity and commonalities in potential tourists' destination images, effectively capturing cognitive and emotional dimensions [38]. Further, analysis of traveler-generated photographs taken before, during, and after trips offers insights into the shifts in tourists' perceptions of destination images across their travel experiences [39]. This method, however, is limited by the constraints of the captured images, which may not fully represent the actual destination characteristics, thereby potentially affecting the accuracy of the research findings.

Network data analysis, including sophisticated methods such as machine learning and deep learning, has gained prominence for its capacity to handle large-scale datasets, particularly in the domains of text and image processing. This analytical approach has become increasingly prevalent with the rise of the internet era [40]. An application involves analyzing textual and visual information from various website subcategories to shed light on online representations of tourist destination images [22]. In addition, structural topic models, coupled with social network analysis, are leveraged to quantitatively and structurally identify differences in destination images during and after tourism [4]. The classification of user-generated content (UGC) images through computer programs is another application that enables researchers to study inbound tourists' perceptions of tourist destination images and identify potential factors influencing tourist choices [41]. However, this method faces limitations in obtaining comprehensive raw data, particularly from demographics such as older individuals and children who may have limited internet usage.

### 1.2.3. Research on Tourism Image of World Heritage Sites

World Heritage sites are prominent destinations in the tourism industry, attracting significant academic interest and research. For instance, researchers have explored the future behavioral intentions of visitors to World Heritage sites by evaluating the relationship between motivation, perceived authenticity, and destination image [42]. Further studies have evaluated the effect of traditional cuisine on tourist loyalty in World Heritage tourism [43]. The challenges posed by “over-tourism” in art-centric cities and the potential of technology-driven sustainable development strategies to reduce these issues have also been analyzed [44]. Scholars have likewise considered the effect of “over-tourism” on local communities and the opportunities presented to the tourism sector by the proliferation and adoption of new technologies [45]. In response to the issue of “over-tourism” in historical urban environments, research has assessed the multifaceted pressures exerted by tourism on historic city centers, proposing optimal models for the safeguarding of cultural landscapes and the advancement of tourism development in these settings [46], alongside analyses into tourist satisfaction in relation to World Heritage sites [47–49]. Moreover, the effect of augmented reality (AR) as a tourism marketing tool on the authenticity of visitor experiences has been a focus of literature [22,50].

Focusing on the World Heritage City of Macau, academics have undertaken various studies. Research on the tourist destination image of Macau initially employed local tourism website text and image data in 2007 to identify visitor perceptions of the city’s urban image [51]. Then, studies have contrasted the image recognition of Chinese and international tourists visiting Macau, drawing upon the image dissemination strategies employed on Chinese and English websites [52]. More recently, scholars have utilized text mining methods to analyze user-generated content pertaining to Macau on TripAdvisor, spanning from 2005 to 2013, comparing these findings with nationally recognized destination images [53].

While existing literature has employed social big data to explore the urban image of Macau [22,50–53], these questions have often focused on a macro-level perspective. Previous studies have largely concentrated on the overall image of Macau, overlooking the unique characteristics of its regions: the Macau Peninsula, Taipa Island, and Coloane Island. The Macau Peninsula, renowned for the World Heritage Historic Centre of Macao, has a rich cultural heritage, whereas Taipa Island and Coloane Island reflect more contemporary urban development, characterized by expansive entertainment complexes, diverse urban imagery, and supporting tourism infrastructure. Moreover, prior research has primarily relied on data extracted from platforms such as Sina Weibo and TripAdvisor, which cater to unique user demographics, potentially introducing variations in the textual data retrieved. Considering Macau’s current economic revitalization following the COVID-19 pandemic and the easing of travel restrictions, contemporary tourist experiences and the challenges encountered by the tourism industry may diverge from those observed in earlier studies. Therefore, this study carries out a micro-level analysis of the World Heritage Historic Centre of Macao, utilizing mid-2023 review data from Ctrip 8.71.4 and Mafengwo 11.1.7 for analysis and research.

### 1.3. Problem Statement and Objectives

The widespread accessibility of internet data [54] has resulted in a growing number of tourists utilizing social media platforms such as Xiaohongshu 8.44.1, Mafengwo 11.1.7, and Ctrip 8.71.4 to curate, arrange, and disseminate personalized travel itineraries, photographs, and accounts. These rich data sources have become essential for researchers [55]. For instance, visitor feedback on Macau is instrumental in constructing the city’s urban image and carries significant implications for future urban planning and tourism. Analyzing this feedback allows tourist destinations to better understand visitor desires and expectations, facilitating enhancements to tourism infrastructure and service quality, and finally enhancing visitor satisfaction. In addition, reviews function as organic promotional tools, attracting a larger influx of visitors and stimulating tourism revenue and employ-

ment prospects, whereas negative reviews can trigger prompt action from city officials to rectify problems, preserve the city's image, and inform the development of appropriate growth strategies.

To evaluate the image and perceptual characteristics of World Heritage tourist sites, this study compiles web text data from prominent tourism platforms such as Ctrip 8.71.4 and Mafengwo 11.1.7 utilizing Python 3.12.3 software. By employing high-frequency word analysis, network semantic analysis, and sentiment analysis, this study evaluates the fundamental processes shaping tourist perceptions and contributes to the existing body of theoretical research on the urban imagery of tourist destinations. Specifically, this study concentrates on the Historic Centre of Macao as a World Heritage site, addressing three key questions: (1) Which specific locales in the Historic Centre of Macao obtain the most tourist interest? (2) From the vantage point of tourists, what factors are most influential in shaping the overall image of Macao as a tourist destination? (3) What are the predominant components of negative and critical evaluations?

## 2. Research Area and Research Methods

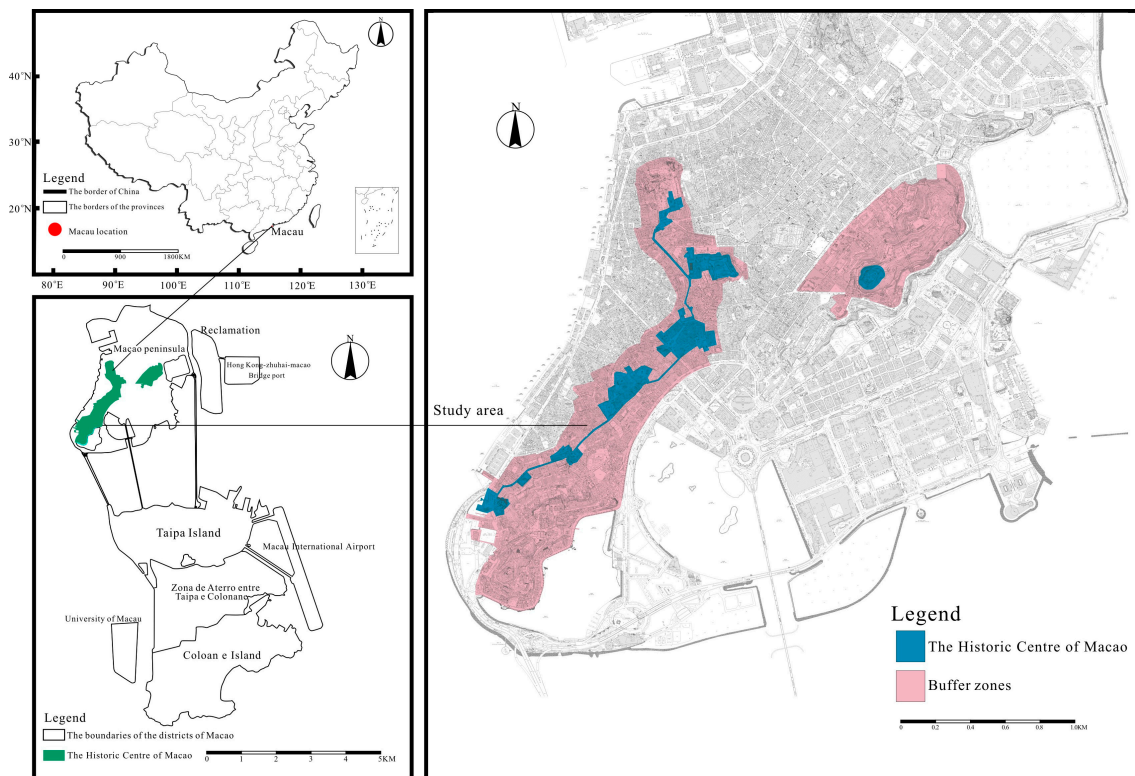
### 2.1. Research Area: The Historic Centre of Macau

Located in the central and southern regions of the Macau Peninsula, the Historic Centre of Macau represents the heart of the region's rich historical and cultural heritage. This site, comprising 22 structures and 8 squares, was formally recognized as a World Heritage site in 2005, becoming the 31st such designation in China [56]. The architectural composition of the Historic Centre presents a unique blend of traditional Chinese (particularly Cantonese in Lingnan), and Portuguese urban design (Figure 2). It stands as the most extensive collection of coexisting Eastern and Western architectural idioms in China, with a pronounced Lingnan Cantonese influence. However, in the face of urbanization and socio-economic advancement, the Historic Centre contends with the incursion of contemporary architectural materials. The surrounding residential density continues its upward trend (Figure 3), characterized by constricted streets, tightly packed ensembles of traditional Tang Dynasty-style buildings, and a preponderance of structures exceeding 40 years of age (Figure 4).

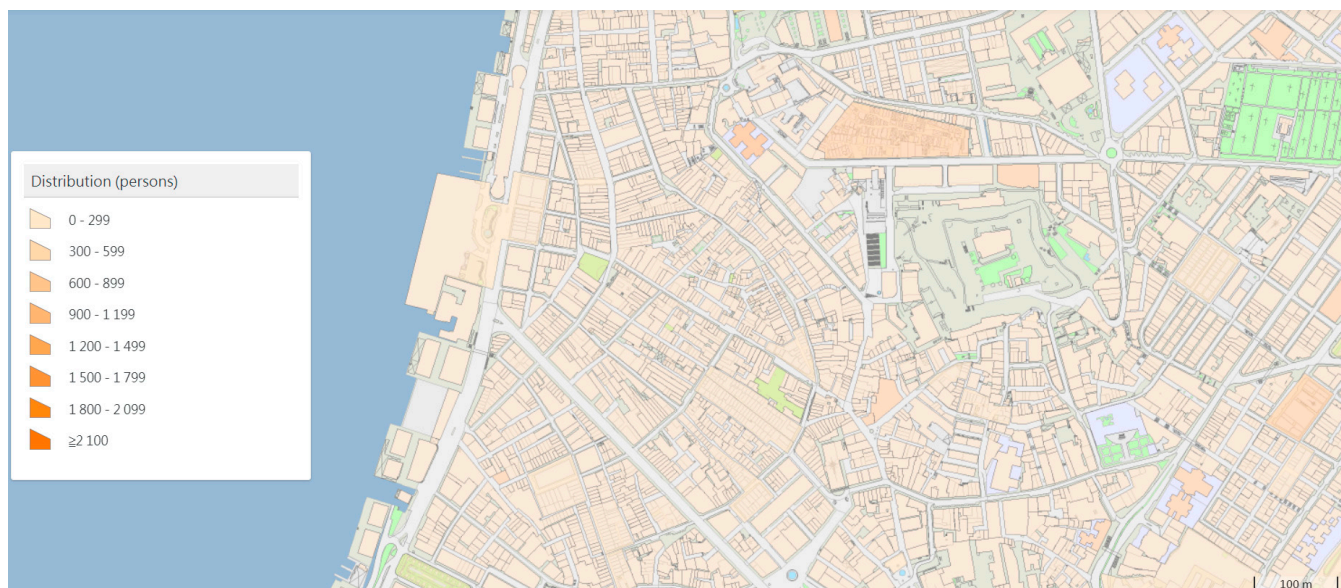
Upon its designation as a World Heritage site, the Macau Special Administrative Region government implemented various measures to cultivate urban cultural heritage tourism. This approach consisted of the restoration and protection of historical structures, ensuring their structural soundness, aesthetic appeal, and sustainability. In addition, the government has actively championed the advancement of cultural heritage site tourism through a diverse array of events, including but not limited to Macau Promotion Week [57], Macau Food Festival [58], Macau Cultural Heritage Exchange Day [59], Macau Government Open Day [60], and the Ruins of St. Paul's Music Festival [61]. These activities have captivated visitors, encouraging them to immerse themselves in Macau's rich historical and cultural heritage. Due to Macau's dedication to the expansion of urban cultural heritage tourism, iconic landmarks in its historical precincts, such as the Ruins of St. Paul's, Senado Square, and A-Ma Temple, have become synonymous with the city itself. As a distinguished World Heritage city, Macau consistently welcomes a large influx of tourists from across the globe. Data procured from the Macau Tourism Office indicates that in the second quarter of 2023 alone, 6,697,519 inbound tourists visited the city, signifying a threefold surge in comparison to the previous year. Moreover, during holidays and public breaks, these figures increase significantly. To illustrate, during the Golden Week in October 2023, Macau received 932,365 visitors, approaching 84% of pre-pandemic daily visitor levels [62].

Therefore, the selection of the Historic Centre of Macao as the focal point for this study is justified on the following grounds: (1) the Historic Centre of Macao represents a rich hub of Macau's cultural heritage, where the exhibition, preservation, and transmission of cultural heritage are paramount to Macau's historical memory, cultural identity, and urban image. (2) The Historic Centre of Macao stands as one of Macau's most prominent tourist destinations, attracting a significant number of visitors. This influx offers researchers

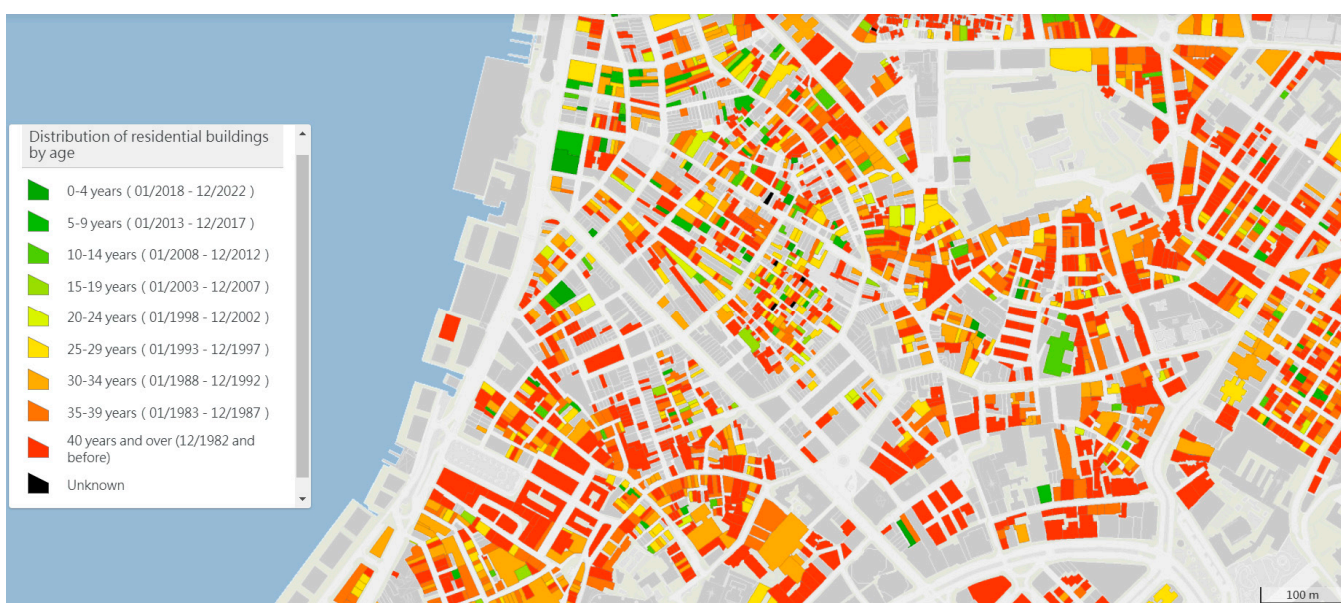
a wealth of valuable data for evaluation purposes and facilitates cultural exchange and dissemination in Macau.



**Figure 2.** Location and current status of the Historic Centre of Macau. (The Chinese characters in this photo are the names of the specialty stores along the street).



**Figure 3.** Distribution of people in the Historic Centre of Macao, the legend is on the left. (image source: Macau Statistical Geographic Information System).



**Figure 4.** Distribution of residential buildings by age in the Historic Centre of Macao, the legend is on the left. (image source: Macau Statistical Geographic Information System).

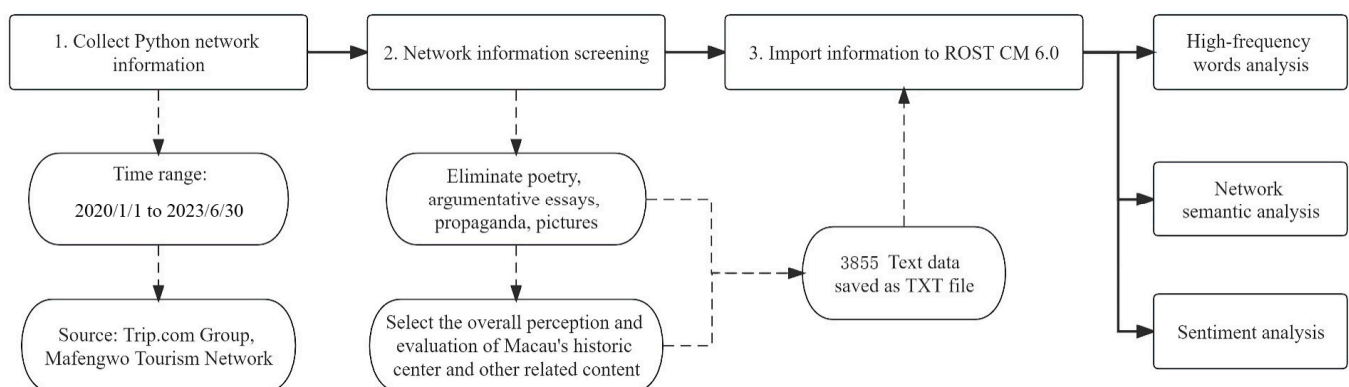
## 2.2. Data Collection and Filtering

This study employed Python 3.12.3 software to scrape web text data between 1 January 2020, and 30 June 2023, concentrating on core keywords such as the Historic Centre of Macao, Ruins of St. Paul's, and Senado Square. Data collection focused on mainstream travel websites, including Ctrip and Mafengwo. The acquired text data were then subjected to segmentation and filtering. Ctrip, as China's leading mobile transaction platform for travel bookings [63], was selected due to its expansive market share and diverse traveler demographics. Similarly, Mafengwo Tourism Network, a prominent online tourism review community in China, was chosen for its comprehensive travel information and broad user base [64,65]. Employing text analysis, this study performed empirical research by extracting tourism elements from the web text data. The selection criteria prioritized text that offered detailed accounts of the entire tourism process, particularly those pertaining to the overall

perception and evaluation of the Historic Centre of Macao while excluding poetry, essays, promotional material, and images. A total of 3855 valid text data points were collected and optimized for analysis.

### 2.3. Research Methods and Objectives

This study utilized ROST CM 6.0 software for both qualitative and quantitative analyses of tourist reviews. ROST CM 6.0, a text mining software developed by the doctoral team at Wuhan University in Shenyang [66], facilitates the organization, indexing, retrieval, and application of web text data. It is celebrated for its scalability, intelligence, and objectivity [67,68]. Capitalizing on the 3855 text data points of tourist evaluations on the Historic Centre of Macao collected utilizing Python tools, this study employed ROST CM 6.0 software to conduct high-frequency vocabulary analysis, network semantic analysis, and sentiment analysis. The research proceeded as follows: first, utilizing Python, data spanning a predetermined period was crawled from the Ctrip website, focusing on evaluations of Macau's historic city. Second, ROST CM was utilized to process the word segmentation, identify high-frequency feature words associated with Macau's historic city, and gain insight into tourist perceptions of the destination image of Macau's historic city. The third step involved utilizing the semantic network analysis function to capture the most impactful visual impressions of Macau's historic city. By analyzing the emotional words utilized by tourists, we can identify tourists' emotional tendencies and experiential perceptions of cultural heritage tourism sites. Finally, the author assesses the authenticity of tourist image perception of the Nanxun Ancient Town and offers suggestions for the preservation and revitalization of Macau Historic City (Figure 5).



**Figure 5.** Research method flow chart.

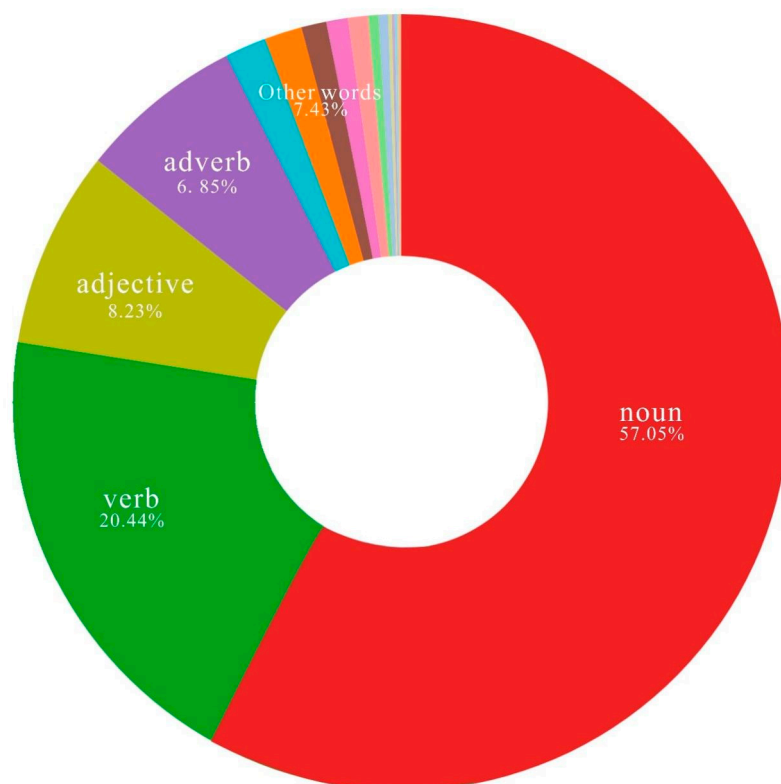
This study, according to the principles of architectural environmental psychology, employs a series of scientific and rigorous research methods to derive practical results. The paper analyzes the unique characteristics of public spaces in Macau's historic district and evaluates tourists' emotional responses to this unique environment. By shedding light on these aspects, this research aims to inform design principles for cultural heritage preservation and guide the construction and revitalization of public spaces in high-density historical urban areas. Finally, it aspires to meet the demands of future-oriented construction practices that prioritize a high-quality built environment, thereby enriching the tourism experience in Macau's historical urban areas and cultivating a more comfortable, healthy, and sustainable landscape for visitors.

## 3. Results

### 3.1. High-Frequency Word Analysis

Through the utilization of ROST CM 6.0 software, word segmentation and frequency analysis were conducted on 3855 textual data points. Meaningless high-frequency words were removed, retaining only those terms aligning with the perceptual image of the Historic

Centre of Macao. This process resulted in the identification of the top 50 high-frequency terms extracted from web text data (Table 1). These terms primarily consisted of nouns, verbs, and adjectives (Figure 6). Nouns primarily reflected geographical locations, objects of visitor engagement, and attractions. For instance, frequently occurring nouns included “fortresses”, “Ruins of St. Paul’s”, and “history”, representing 46.98% of the total. Verbs followed nouns in frequency, illustrating tourists’ activities, such as “visiting”, “checking in”, and “shopping”, constituting 20.44% of the total. Adjectives primarily conveyed tourists’ overall impressions of the destination. Common adjectives included terms such as “very”, “worthy”, and “good” (detailed classifications and rankings are offered in Table 1).



**Figure 6.** Proportional distribution of parts of speech in high-frequency words.

An analysis of the statistical list of high-frequency terms indicated a preponderance of nouns among the top 50, suggesting that the buildings, landmarks, and products of the Historic Centre of Macao leave a lasting impression on tourists. The frequent appearance of terms such as “fortress”, “Ruins of St. Paul’s”, “museum”, “church”, and “archway” (Figure 7) points to the unique value ascribed to historical structures in World Heritage sites. Such high levels of tourist interest emphasize the importance of these sites as key components of heritage tourism. Following nouns, adjectives constitute the second most frequent lexical category. Terms such as “worthy”, “good”, “liked”, and “ancient” indicate that visitors generally view the urban landscapes of the historic district favorably. This positive reception speaks both to the Macau government’s commitment to cultural heritage preservation and the creation of a world-class tourist destination and tourists’ recognition of the unique cultural heritage values embodied in these sites. The presence of verbs such as “photographing”, “checking in”, and “shopping” highlights the overall attractiveness and aesthetic appeal of the historic district, marking it as a destination for sightseeing and leisure. In addition, a visual analysis of new vocabulary in the Historic Centre of Macao yields additional insights (Figure 8). Terms such as “Rose Hall”, “Catholicism”, and “Virgin Mary” indirectly indicate the significant effect of Western religious culture on Macau’s development, with religious heritage buildings holding a particular appeal for tourists. Terms such as “China”, “Europe”, and “Portugal” reflect Macau’s role as a nexus of Chinese







integration of Portuguese-style architecture and Chinese–Western cultural elements in Macau, while enjoying modern entertainment such as luxurious casinos and world-class performances. In essence, tourists' perceptions of the Historic Centre of Macao's image reflect its significant appeal as a tourist destination.

### 3.3. Emotion Analysis from the Perspective of Tourists

Emotion analysis is the direct response of tourists to the tourist destination perception experience, and it is a dynamic process (Figure 10). Data analysis utilizing ROST CM 6.0 software (Table 3), indicates that positive emotions constitute the largest proportion of tourist sentiment (85.45% or 3294 responses), while negative emotions represent the smallest proportion (8.79% or 339 responses). Neutral emotions comprise the remaining 5.76% (222 responses).

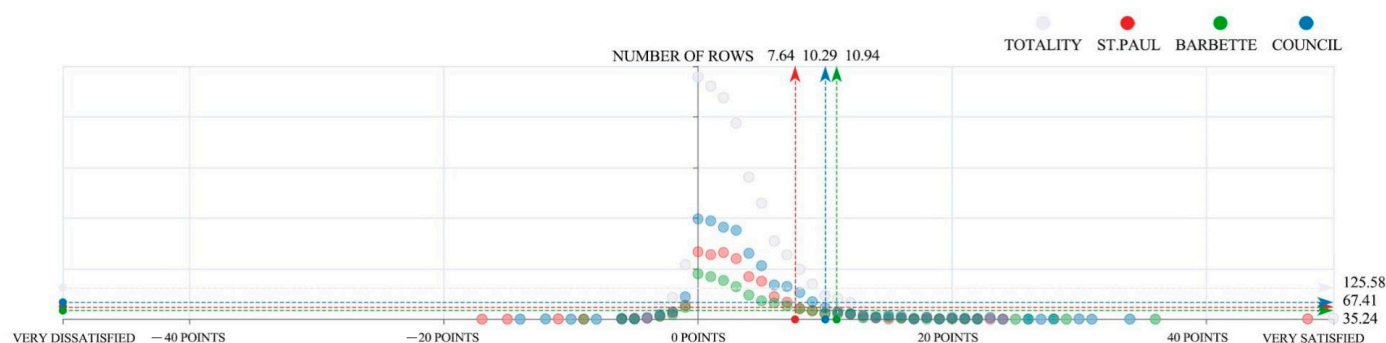


Figure 10. Distribution of emotional value and quantity.

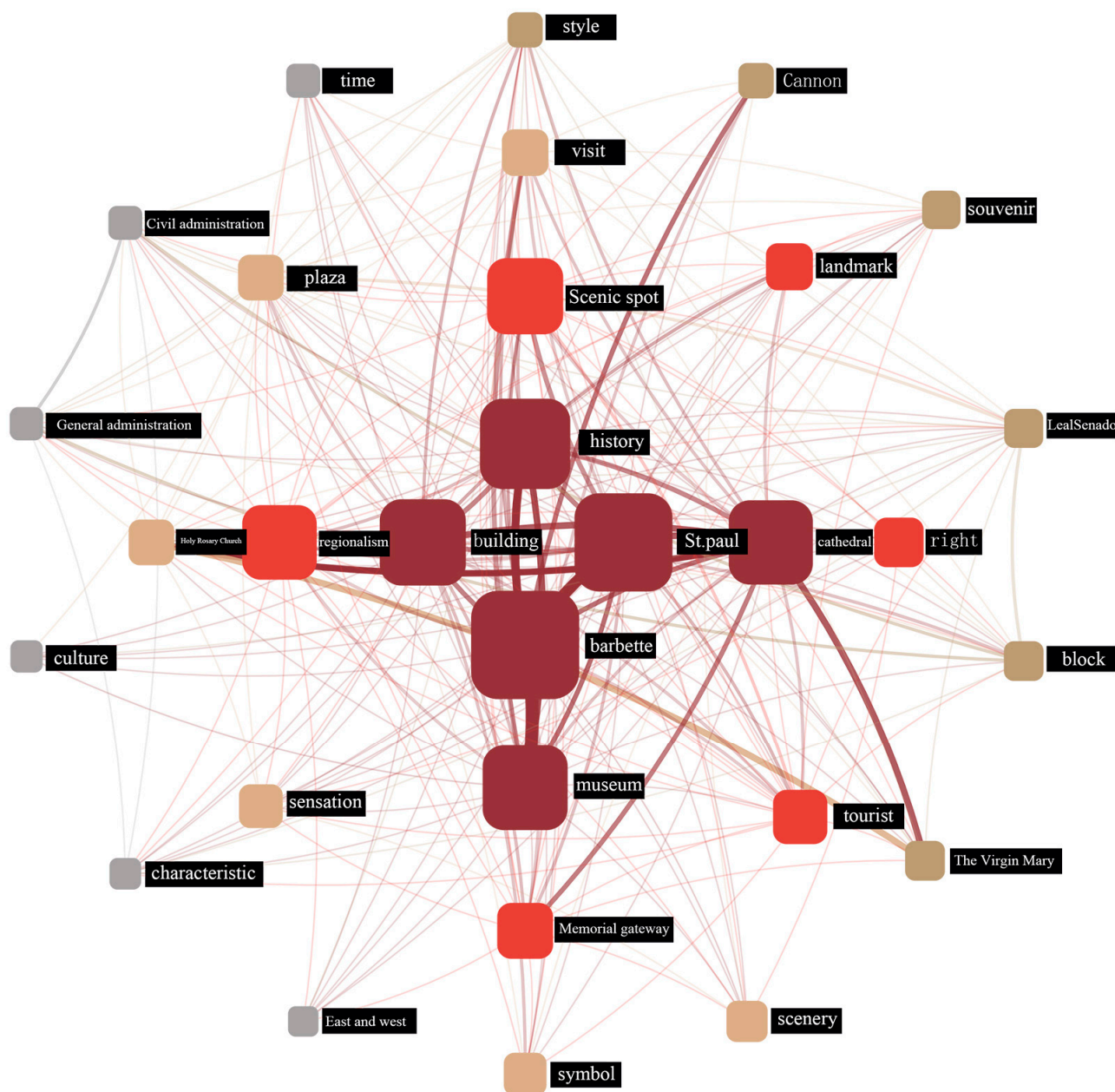
Table 3. Data chart of emotion proportion.

Emotional Category	Number of Articles	Proportion %	Emotional Segmentation Statistics	Proportion %
Positive emotions	3294	85.45	General (0–10)	39.38
			Moderate (10–20)	27.73
			High (More than 20)	18.34
Intermediate emotions	339	8.79		
Negative emotions	222	5.76	General (–10–0)	5.45
			Moderate (–20––10)	0.28
			High (–Under 20)	0.03
Total	3855	100		

Source: Author statistics.

Tourist appraisals of the Historic Centre of Macao indicate overwhelmingly positive sentiments, signifying a high degree of satisfaction and loyalty to this destination. A study of the emotional relationships network diagram (Figure 11) illustrates that the Historic Centre's rich historical and cultural heritage contributes significantly to these positive appraisals. The unique architectural style found in landmarks such as the Ruins of St. Paul's, the fortress, the Macau Museum, the Civic and Municipal Affairs Bureau building, and the Rose Hall are key factors in shaping these perceptions. The hospitality of the local population and the rich, internationally-influenced culinary scene also contribute significantly to positive tourist effects.

In the contemporary cultural context, a societal trend toward "anti-modernization" has developed in which individuals seek respite from the perceived monotony of modern life, characterized by a desire for both freedom and opportunities to explore history. The unique "locality" of the Historic Centre of Macao caters effectively to this trend of "anti-modernization", solidifying Macao's standing as a desirable tourist destination. Positive tourist appraisals further contribute to the development of positive emotional representations associated with the destination.



**Figure 11.** Emotion analysis network diagram. The different colors are just to differentiate between different levels of vocabulary.

Negative emotions, however, offer critical insights into visitor experience, finally shaping perceptions of Macau's historic district. This study identifies recurring negative sentiments expressed by tourists in online textual data, including (1) spatial limitations leading to overcrowding, particularly in areas such as Senado Square and Largo do Senado; (2) inflated prices for goods and services, including shopping, attractions, accommodation, transportation, and dining; (3) limited opportunities for meaningful engagement at attractions, with tourists often prioritizing photography over cultural immersion; (4) an oversaturation of commercial activities, detracting from the overall visitor experience; (5) a dearth of public facilities such as seating areas, impacting tourist comfort and leisure.

In conclusion, online post-visit tourist evaluations are essential in the construction of a destination image. These appraisals directly influence the decision-making processes of potential visitors, making them a significant factor in urban image development. Despite the overwhelmingly positive appraisals of Macau's historic district evidenced in the statis-

tical analysis of 3853 tourist evaluations, negative emotions offer invaluable insights for informing effective urban tourism development strategies.

### 3.4. Analysis of Tourist Destination Image Characteristics

The analysis of online textual data indicates a diverse range of tourist perceptions regarding Macau's historic district. While some visitors perceive it as a serene and authentic space, set apart from contemporary urban environments, others envision it as a romantic cityscape, with locations such as "Love Lane" eliciting associations with personal narratives of love. However, there is an undercurrent of concern regarding the gradual degradation of authenticity accordingly of urbanization. The district's bustling and commercialized character is perceived as a departure from its original essence. This study identifies three categories that represent the image of the historic district: authenticity, romanticism, and commercialization (Table 4).

**Table 4.** Summary of theme image characteristics (partial schematic).

Primary Code	Secondary Code	Original Text
Authentic image	Original historic buildings, landscapes, colors	"Little Macau is indeed another world; everywhere you look there are yellow walls, apple green buildings, and candy-colored beauty in reach. It seems that every corner has a story, and every turn makes my heart flutter". "The older the time, the brighter the heart. Macau's worldview is elegant and understated throughout, as if time has remained undisturbed for a hundred years, quietly maintaining its original design and color palette, moving forward with grace and ease". .....
Romantic image	Architecture symbolizing love; a strong Chinese and Western cultural atmosphere	"Love Lane", the setting for the famous movie "Elizabeth", is one of the most romantic lanes in Macau, with its typical Portuguese architecture". "A stay at the Hedong Library in the East-West style is very special: Chinese gardens and Western-style churches are intertwined here, and in the sunlight, the scene is especially beautiful". .....
Commercial image	Stores, shopping, food, camouflage lights, electronic screens	"Many stores have opened in the historic buildings of the historic district, and there are also many famous snack bars, and it is convenient for shopping". "Macau's street culture shares certain similarities with that of Hong Kong. The promotional signs are enormous and lit up at night with many camouflage lights. There are electronic screens mounted on several of the walls". .....

Source: Author statistics.

## 4. Discussion

The burgeoning field of cultural heritage tourism has recently seen a preponderance of research focused on the preservation and utilization of cultural heritage, tourism planning, and destination management. Much of this research, drawing on established scholarly definitions, utilizes visit frequency as a dependent variable to explain the factors driving demand for cultural heritage tourism [69]. For instance, recent studies have created separate indexes for the tourism sustainability indicators of cultural heritage sites and those of proximate communities [70]. Other studies have given particular emphasis to the distribution, typologies, planning modalities, and tourism-related instruments associated with cultural heritage [71], or explored integrated models of authenticity, perceived value, flow state, satisfaction, and destination loyalty [72]. Further illustrating this range, some research has evaluated the use of photovoltaic systems in conjunction with historical landscapes to offer energy security while prioritizing ecological preservation and reuse [73], while other work has employed the YOLOv4 machine learning model to automatically identify

five damage categories in historical gray brick buildings [74]. Building on these advancements, this study evaluates the cultural heritage tourism experience in Macau's historic urban area, taking as its starting point the behavioral and emotional experiences of tourists. Through mining high-frequency words in tourist reviews, analyzing semantic network relationships, and deeply exploring tourist emotional characteristics, this study derives a set of tourist perceptual dimensions. By integrating the profound emotional structure of both tourists and destinations and employing tourist perceptions of authenticity as a framework, this paper further evaluates the potential mechanisms influencing tourists' civic behavior. Specifically, this study evaluates the mediating role of cultural heritage tourism destinations in the relationship between authenticity perception and tourist civic behavior. This research addresses a gap in the literature concerning tourists' emotional perception of cultural heritage tourism, finally enriching the broader field of research on cultural heritage tourism and preservation.

Utilizing software technology, Italian scholars have devised a streamlined program for cultural heritage (CH) management, transforming point clouds acquired through geographical surveys into parametric objects in the 3D modeling software (Rhinoceros) to produce accurate architectural models [75]. Similarly, Greek scholars have employed GIS as a decision-support tool, pioneering novel methods for organizing and managing cultural routes by integrating standardized processes with information technology [76]. This study leverages Python and ROST CM6.0 software to extract and analyze network media data, conducting quantitative research on the emotional, cognitive, and holistic factors shaping the tourism experience in Macau's Historic Urban Area. This analysis indicated specific concerns in the tourism management of Macau's Historic Urban Area, offering valuable insights for cultural heritage tourism managers. Regarding theoretical research, prior studies on cultural heritage tourism have primarily concentrated on technical aspects, rarely assessing the landscape cognition and emotional responses of those engaging in the experience. This study evaluates how the tourism experience in Macau's Historic Urban Area influences participants' on-site travel intentions, evaluating their cognitive and emotional responses during the experience. Therefore, this research proposes a "heritage tourism experience—cognitive emotional response—travel intention appeal" theory.

Macau's historic downtown, geographically confined in the central urban area of the Macau Peninsula, presents a dense concentration of cultural heritage sites, including squares, temples, and churches. This high density, exacerbated by Macau's standing as one of the world's most densely populated cities and a burgeoning tourism industry, creates significant spatial constraints. The limited scale of streets and alleys amplifies the disparity between land availability and population, yielding challenges such as overcrowded public areas, insufficient neighborhood amenities, and the complex transformation of existing residences. Administrators recognize that the notion of cultural sustainability aligns more closely with social sustainability than with economic or environmental factors. Therefore, these cultural heritages have the potential to enhance the quality of life for residents while enriching the experiences of tourists [77]. Real-time monitoring of visitor traffic at various points of interest in the historic urban area, facilitated by satellite remote sensing technology [78], is employed to reduce disruptions to the daily lives of residents, cultivating a harmonious balance between community activities and tourism.

From the perspective of tourist perception and experience, this study offers valuable theoretical and practical implications for Macau's historical urban tourism industry. In the "Internet + e-commerce" economic landscape [79], the overall perception of Macau's historical urban area focuses on themes of "vitality and tranquility", "tradition and modernity", and "romanticism". This suggests that most tourists express satisfaction with the cultural landscape of Macau's historic urban area, particularly projects that emphasize unique local cultural characteristics. However, this study also indicates that "poor experience of tourism resources is the main factor leading to tourists' negative emotions, and tourists' negative tourism experience is mostly negative attitude towards" the authenticity of the built environment, "consumption level", "public facilities and services", "space

environment”, and “scenic spot projects”. Therefore, future urban renewal in historical and cultural contexts should prioritize reducing excessive commercialization, enhancing public service infrastructure, optimizing the landscape, and preserving and showcasing the unique character of the built environment and local culture. The value of preserving urban context necessitates the protection and transmission of historical and cultural elements, including the urban fabric, surrounding environment, local customs, and traditions. Such efforts represent vital enhancements and additions to the overall conservation of urban contexts. By cultivating positive travel experiences and cultivating a favorable destination image in the tourism market, Macau can ensure the appeal of its historical urban area [80].

From the perspective of artificial intelligence, the evolving sophistication of virtual reality (VR) technology is offering novel approaches and robust technical support for the restoration and safeguarding of ancient buildings and architectural heritage [81]. Concurrent with this technological advancement, the Macau government is dedicated to establishing a “digital government” and driving societal transformation through the application of artificial intelligence. This commitment comprises the optimization and elevation of industrial structures alongside the digitization and diversification of the economic landscape. Illustrative of this commitment is the Strategic Cooperation Framework Agreement on Building Smart Cities, inked by the Macau SAR Government and Alibaba Group. This partnership aims to propel the development of cloud computing centers, big data technology projects, and the foundational infrastructure for smart cities in Macau [82]. In addition, the formulation of a monitoring plan specifically tailored to the protection needs of the “Macau Historic Urban Area”, coupled with the standardization of technical specifications for heritage data collection, promises to further systematize and automate monitoring activities. The monitoring center, equipped with specialized monitoring instruments and robust communication networks, will interface with a dedicated monitoring cloud mobile phone application and incorporate manual data collection. This comprehensive data will then be relayed to the central monitoring and early warning system platform for comprehensive analysis and processing. This system facilitates the timely issuance of early warning messages, centralized management of diverse heritage protection and management data, and the accumulation of invaluable historical data for future analysis and reference. Finally, the various measures ensure that the protection of World Heritage sites in Macau aligns with the highest international and national protection and management benchmarks [83]. Enhancing these efforts, robust policy support and capital investment are driving innovation and advancement in digital cultural heritage protection technologies, thereby cultivating more comprehensive and effective protection of these irreplaceable assets [84]. Simultaneously, VR technology is transforming the tourism landscape, enriching tourist experiences and acting for sustained growth in the tourism industry [85]. The digitization and interactive capabilities in augmented and virtual reality environments represent the collaboration between cutting-edge technological potential and immersive user engagement [86]. In effect, the traditional paradigm of presenting cultural relics through static museum displays has been significantly transformed. By leveraging economic and technological advancements, we are witnessing an era where the “visitable” attribute of cultural resources is significantly strengthened. Innovative display modalities, such as the “Time Travel. . . Journey to St. Paul’s” VR experience, exemplify the transformative power of technology in cultural heritage presentation. By recreating the architectural splendor of the “St. Paul’s Mother Church of God” as it stood four centuries ago, this immersive experience transcends temporal boundaries, transporting visitors back in time. In this virtual space, visitors can engage with the original grandeur of the Church of the Mother of God at St. Paul’s College, gaining a profound appreciation for the charm of this cultural heritage.

## 5. Conclusions

This study emphasizes the value of tourist reviews in analyzing the perceived image of tourist destinations from a visitor’s perspective. By employing a mixed-methods approach, combining qualitative field analyses with quantitative textual analysis utiliz-

ing ROST CM6.0 software, this study indicates several key findings, as follows: (1) The image of Macau's historic district as a tourist destination comprises cultural, landscape, emotional, and local dimensions. (2) Tourists perceive Macau's historic district as a place where vibrancy and serenity co-exist, showcasing a blend of tradition and modernity. (3) Tourist sentiments toward Macau's historic district are largely positive, with negative sentiments remaining limited to concerns regarding overcrowding, inflated prices, lack of interactive experiences at attractions, excessive commercialization, and a shortage of public recreational spaces. These findings offer valuable insights for optimizing the future tourism development strategy of Macau, a designated World Heritage site. (4) This study identifies authenticity, romanticism, and commercialization as the primary thematic images associated with Macau's historic district.

This study leverages an analysis of online tourist evaluations and proposes key focus areas for the future development of Macau's historic district. (1) Crowd control measures should be implemented, informed by the district's actual carrying capacity, to optimize the visitor experience. (2) Reasonable price controls should be enforced on souvenir shops, gift shops, and restaurants operating in the area. (3) Cultivating a deeper integration between attractions and surrounding communities, for instance, by creating open museums and involving residents in heritage preservation and promotion, can bridge the gap between tourists and locals. This objective can be further advanced by diversifying exhibition formats, employing modern technology to facilitate engaging historical learning experiences, increasing the accessibility of free guided tours and interactive installations, and offering regular on-site lectures and artistic performances to enhance visitor engagement. (4) The tourism development of World Heritage buildings and spaces must be managed to protect their authenticity and reduce excessive commercialization. (5) Improvements to public facilities, such as increasing public seating, rest areas, and other amenities, will help cultivate a more convenient and enjoyable environment for visitors.

However, this study acknowledges several limitations. The analysis primarily focused on Ctrip and Mafengwo, neglecting other platforms such as Xiaohongshu, Weibo, Douyin, Facebook, Twitter, Instagram, and TripAdvisor, which could offer more diverse textual data for future studies. Moreover, incorporating image and video content from sources such as video bloggers could enrich textual analysis. This study's timeframe, including the past three years, introduces potential bias. During this period, Macau, similar to other mainland Chinese cities, implemented multiple lockdown policies due to COVID-19, significantly affecting tourist arrivals. As Macau is still in a state of recovery and has not yet reached pre-pandemic tourism levels, the data analysis might exhibit some degree of bias. Nevertheless, analyzing tourist reviews offers valuable insights into tourist cities. By understanding tourist needs and expectations, cities can enhance tourism facilities, enhance service quality, and strengthen tourist satisfaction. Tourist reviews can also function as a promotional tool, with positive reviews attracting more tourists, boosting revenue, and generating employment opportunities, whereas negative reviews can highlight areas requiring immediate attention, thereby reducing potential damage to the city's image and informing the development of effective strategies and market positioning.

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