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A mathematical model for tourism potential assessment

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HIGHLIGHTS

- Resource values and development state determine a site's tourism potential.
- A model for assessing the tourism potential of heritage sites is developed.
- The weights of indicators and sub-indicators are computed.
- The model generates a hierarchy of heritage sites based on their tourism potential.

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ABSTRACT

An audit of the potential for tourism development at heritage sites is a critical step in the planning process. An examination of the current literature on the evaluation of tourism potential reveals two main approaches: descriptive and qualitative. These approaches are not so effective for comparing the tourism potential of heritage sites in a region. Thus, this study aims to develop an operable, quantitative approach to measuring the potential of heritage sites. The mathematics model proposed in this study is characterized by different weights allocated to different indicators for tourism potential, based on resource values and development state. Applying the proposed model allows the assessment results of heritage sites to be compared, as the tourism potential of each site is represented by a value (0-1). A case study of two heritage sites in China demonstrates the effectiveness of the model.

1. Introduction

Put simply, tourism potential refers to the ability of a site to attract and receive tourists with concerns about accessibility, resource quality, interpretation of resources, and so on (Anderson, 2007). Tourism potential can be defined as "the totality of natural, cultural, historical and socio-economic background for the organization of tourist activity in the particular area" (Kuskov & Dzhaladyn, 2006, as cited in Shohan, Toleuuly, & Assadova, 2012, p. 34). Bassey (2015) further explained tourism potential as the pool of resources possessed by a community or a place that could be transformed and developed into tourist attractions or finished products. However, tourism potential should not be understood exclusively from a resource-based perspective; operational factors are important additions to the concerns about tourism potential. This is in line with Bassey's (2015) emphasis on the needs of tourist sites in terms of facilities, services, and infrastructure to make attractions visitor-ready.

Destination attractiveness is a term related to the tourism potential of heritage sites, considering that "[d]estinations could be on any scale, from a whole country… to a village" (UNWTO., 2007, p. 1). At the smallest scale, a destination can be a heritage site such as a historic village. The attractiveness of a destination can be examined from the supply or demand side. Formica (2000) noted the difference between the two perspectives: "The supply perspective is based on the number and quality of available attractions at destination. The demand perspective depends upon the perceptions and interests of travelers in the area." (p. 1) Buhalis (2001) further differentiated the two perspectives by identifying the supply-side factors as competitiveness and the demand-side factors as attractiveness. Vengesayi (2003) echoed this view of destinations from the two sides, which were closely related to each other, as "the overall tourist attractiveness of a destination is dependent upon the relationship between existing resources (natural, cultural, historical, etc.) and the perceived value of such resources" (Formica, 2000,

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p. 1). The present study uses the term "potential" rather than "attractiveness"; the former refers to an initial assessment at the very beginning of tourism development, and the latter refers to the evaluation of destinations on any scale and at any stage of development.

Before marketing a tourism place or site, it is necessary to know the potential of the locale or relevant resources. Doing so is helpful for making informed decisions on many related issues, such as planning, publicity, investment, and management. Accordingly, many studies have been conducted to evaluate the tourism potential of various sites or resources. These studies have been dominated by the model of du Cros (2001), which integrates concerns about the physical robustness of heritage into the assessment of potential, in parallel to the market appeal of heritage assets. In the model, robusticity and cultural significance constitute one dimension, and market appeal and product design constitute another. The assessment results are visually presented in a matrix, with heritage sites placed in nine areas according to their market appeal and ability to cope with increasing visitation.

The two-dimension model of du Cros (2001) has an internal flaw. Due to the mutually exclusive nature of the two dimensions, in the figural presentation of assessment results, heritage assets tend to be clustered together without forming a hierarchy (McKercher & Ho, 2006). The failure to generate such outcomes as a rank of resources or assets leads to doubts about the effectiveness of the model. By disaggregating the du Cros model, McKercher and Ho (2006) managed to rebuild a four-dimension framework (hereafter referred to as the McKercher framework) that relates to the cultural, physical, product, and experiential values of assets. Despite attempts to use an ordinal scale to mark sub-indicators of the fourfold values, the qualitative nature of assessment remains unchanged, as does the neglect of differentiating indicators in terms of their importance in the assessment system (McKercher & Ho, 2006; Sánchez Rivero, Sánchez Martín, & Rengifo Gallego, 2016). In other words, the framework of the four types of values inherited some weaknesses of the du Cros model.

This study aims to develop a new model for auditing the tourism potential of tourism sites. Applying the model to heritage site evaluation generates a hierarchy of sites, which would be helpful for comparing sites in terms of their potential for tourism development. A quantitative method is required to obtain a hierarchy of heritage sites based on levels of potential. Quantitative methods have been widely used for site evaluations for various developments, such as environmental conservation (Matin et al., 2016) and tidal energy development (Kolios, Read, & Ioannou, 2016). In addition to conducting site evaluations, studies have assessed sites for different forms of tourism development, such as casino construction (Ishizaka, Nemery, & Lidouh, 2013). Quantitative methods have been used to evaluate heritage sites (e.g., Al Mamun & Mitra, 2012; Malik & Bhat, 2015), and the quantified results are helpful for comparing the tourism potential of sites in a given area.

2. Literature review

The evaluation of tourism potential is an important aspect of destination development. A major reason for assessing tourism resources is the financial consideration. The municipal budget may be limited and thus the potential of regional tourism resources must be evaluated to help the local government make decisions on allocating resources for sustainable tourism development (Kuo & Wu, 2013). Apart from the financial factor, resources or attractions in a destination are not equally important; instead, there is a hierarchy of attractions (McKercher, 1996). The aim of such assessment is to determine the value of resources; thus, it is helpful for decision making in terms of allocating economic resources for the purpose of tourism development. In this sense, the evaluation of tourism potential is critical for tourism planning (du Cros, 2001). A clear understanding of the tourism potential of resources benefits destination development and marketing (Ptáček, Roubínek, & Jan 2015; Sheng & Lo, 2010).

Various resources enter the domain of assessment in terms of tourism potential. At the macro level, the object of assessment could be categorized into two types: cultural and natural. The cultural resources assessed cover a wide range of heritage sites, from the cultural to the industrial and agricultural (Landorf, 2016; Metsaots, Printsmann, & Sepp, 2015; Ptáček et al., 2015; Sun, Jansen-Verbeke, Min, & Cheng, 2011); from the world to regional level (Io, 2011; Teo & Yeoh, 1997); from large as a city or towns to small as a street or square (Bucurescu, 2013; Neupane, Anup, & Pant, 2013; Pawlusiński & Kubal, 2015; Southwell, 2002); from urban to rural (Fisher, 2006; Kuo & Wu, 2013); and from area to route (Božić & Tomić, 2016; Sánchez Rivero et al., 2016). Although cultural heritage has received the most scholarly attention, natural resources have not been neglected, as exemplified by the evaluation of nature-based tourism sites in Chiang Mai province of Thailand (Emphadhu & Ruschano, 2007, pp. 739–746), as well as the potential assessment of bird habitats in Serbia (Bjeljac, Ćurčić, & Brankov, 2012).

2.1. The du Cros model and the McKercher framework

Several methods for evaluating the tourism potential of resources or destinations have been adopted in other studies. The prevalent approach is du Cros's (2001) model, which consists of two dimensions of heritage: conservation of cultural value and commodification of market appeal (or heritage management and tourism development). The concept of robusticity has been used to represent the former dimension. Robusticity and market appeal form a three-level matrix, within which assessed heritage sites can be plotted at different positions. Based on the positions in the matrix, heritage sites can be classified into four types: high market appeal and relatively high robusticity; relatively high market appeal but low robusticity; moderate market appeal and relatively high robusticity; and low market appeal regardless of robusticity. The merit of the du Cros matrix lies mainly in the synthesis of the two major aspects associated with heritage: conservation and commodification. As Bucurescu (2013) explained, for sustainability considerations, evaluations of the tourism potential of heritage sites should not be bound to market appeal, but should be conducted while considering the factor of robusticity, namely, the ability to accommodate negative impacts derived from increased levels of visitation.

The du Cros model has been widely used in studies of tourism potential assessment. Stamenković and Jakšić (2013) applied the du Cros model straightforwardly to evaluate an old town center and made no modification. Li and Lo (2004) adopted the model to evaluate the tourism potential of single-surname villages in the New Territories, Hong Kong. While confirming the effectiveness of the model, the study criticized the matrix for the vague concept of "product design needs" in the market appeal dimension and the lack of community concerns in the robusticity dimension. Although many studies have adopted the du Cros model to assess cultural heritage, a few have attempted to apply the model to natural heritage with modified sub-indicators (Bjeljac et al., 2012).

A significant development of the du Cros model lies in the McKercher framework, which consists of four dimensions: cultural, physical, product, and experiential value. These dimensions were formed by disaggregating the factors in the du Cros model, including physical significance, robusticity, development needs,

and market appeal. In other words, most sub-indicators of the four dimensions were derived from the du Cros model. The McKercher framework was developed for auditing smaller heritage attractions in Hong Kong. With the addition of two extra factors, including marketing and leadership, a modified model was used to evaluate the tourism potential of nine public museums in Hangzhou, China (Sheng & Lo, 2010). The McKercher framework was also applied in a study of Chinese heritage assets in an Australian city (Laing, Wheeler, Reeves, & Frost, 2014), which focused on the experiential value of heritage assets. Two dimensions were added to the assessment, including critical points of tourist experience and the dichotomy of peak and supporting experience.

The du Cros model assumes that tourist arrivals at heritage sites will increase to the extent that the ability of sites to cope with increasing visitation becomes a noteworthy issue of concern. However, this assumption is not necessarily applicable to all heritage sites. For instance, although inscribed on the World Heritage List in 2005, the Historic Centre of Macao has been facing an awkward situation due to insufficient visitations (Io, 2011), and robusticity is seldom a problem there, regardless of the 30 million annual tourist arrivals in recent years. Tourists' relatively low interest in the World Heritage Sites may be partially explained by the overshadowing effect of the world-class casinos in Macau. To a certain extent, this effect applies to the prospect of historic villages in Zhuhai, a destination with newly established theme parks (Ong, 2017). In other words, the historic villages are not at the top of the hierarchy of attractions in Zhuhai. The number of tourist arrivals at the historic villages is small and thus the ability to accommodate visitations is not critical. In short, for some World Heritage Sites, the factor of robusticity is not an issue of concern, not to mention those regional heritage sites that are seldom visited. Accordingly, assessments of the tourism potential of historic villages in Zhuhai do not need to consider the issue of robusticity. In a sense, this approach is in line with a previous study of heritage sites (Laing et al., 2014) that chose to focus on two aspects of the McKercher framework: products and experiential value.

2.2. Alternative approaches

Different approaches for assessing the tourism potential of resources can be found in the literature.

2.2.1. Strengths, weaknesses, opportunities, and threats (SWOT) analysis

Assessment of the tourism potential of a place is a critical step at the very beginning of the planning process (Murphy & Murphy, 2004). Tourism planners tend to use a straightforward approach to evaluating the tourism resources in a given place, that is, SWOT analysis. SWOT analysis can be conducted at different levels (national, regional, and local) (Collins-Kreiner & Wall, 2007) to gain a holistic understanding of the potential of a destination. The SWOT analysis approach is advantageous in that it draws the attention of the raters to identifying strengths and weaknesses and examining opportunities and threats, both of which are crucial for tourism development in a given destination. Strengths and weaknesses are internal factors of the place or site under evaluation, and opportunities and threats are external or contextual factors (Lawhead et al., 1992; as cited in Collins-Kreiner & Wall, 2007). Strengths and opportunities represent the values and appeal of the assessed site, and weaknesses and threats refer to the constraints of tourism development. To varying degrees, these factors are reflected in the McKercher framework in terms of cultural, physical, product, and experiential value.

2.2.2. Descriptive analysis

This approach is characterized by a presentation of heritage resources/assets and tourism development. Grafenauer (2015) offered thoughtful insights into a well-preserved medieval town (in Slovenia) that was full of heritage aspects yet remained unpopular in the tourist market. The analysis began with a description of the major heritage sites, including the Capuchin Bridge and Monastery, the Town Square with historic statues and buildings, the Lower Square with a granary transformed into a painting gallery, and the Castle houses converted for the exhibition of museum collections. The analysis considered the presentation of cuisine and souvenirs as representative of the town at different levels and ended with a narrative of events associated with the town's history, leading to many suggestions for enhancing the town's attractiveness. Similarly, a study of Olomouc (a Czech city) asserted that the city had a high tourism potential by analyzing its major attractions in terms of its natural heritage and tangible and intangible cultural heritage (Ptáček et al., 2015). These studies used a descriptive approach to make suggestions for marketing and development; however, the degree of tourism potential of the evaluated sites remains unclear.

2.2.3. Geographic information systems (GIS)

Information technology has been applied in evaluations of tourism potential. An early study in this area attempted to use information technology to evaluate the potential of tourism resources (Molnár & Tózsa, 1983). This process covers factors such as slope, altitude, climate, vegetation and land use, fauna, culture and sport facilities, transportation, accommodation, and so on. Remote sensing and GIS have been used to assess tourism potential (Poonia, 2013). This method is more appropriate for an overall assessment of a whole region rather than separate sites and can be used to compare the potential of different areas. Assessed resources include both natural and cultural resources as well as tourism infrastructure. Applying this assessment method produces a hierarchy of tourism centers. Mikhailidi (2014) used GIS to assess the tourism potential of the Altai Mountainous Area, a *trans*-boundary territory with diversified natural and cultural attractions. For natural, cultural, and historic sites, large-scale evaluation considers the significance levels and types of these sites without involving specific aspects. In short, while GIS helps with large-scale evaluation and the results can be visually presented on a map with the distribution of sites at different levels in a hierarchy, the method is not so helpful in identifying detailed information for assessment and is thus not applicable to small-scale sites.

2.2.4. Item response theory model

It has been argued that there is a hierarchy of tourism potential indicators for the tourism resources of a given destination (Sánchez Rivero et al., 2016). Sánchez Rivero et al. (2016) used an item response theory model to weight the qualitative and hierarchical evaluation attributes they adopted to evaluate and rank resources. In their study, tourism potential was evaluated based on two dimensions: internal (intrinsic resources) and external (infrastructure and additional services). Application of this model generates a scenario similar to that of the du Cros model: the potential of places is embodied in the internal and external aspects, which leads to a certain degree of vagueness. The assessment is conducted from a resource-based perspective, neglecting the market factor in the audit of tourism potential. Furthermore, the computation procedure is daunting for users who lack mathematics proficiency.

2.2.5. Stakeholders' assessment

Assessment of tourism resources and tourist attractions is an integral component of tourism planning, which is a pluralistic

decision-making process featuring the interplay of various stakeholders (Wan, 2013). Different stakeholders have been adopted in tourism potential evaluations, including marketers, hoteliers, tour experts, government professionals, attraction managers, cultural/historical experts, residents, and tourists (Formica, 2000). Local residents come first; they should have opportunity to express their opinions in the tourism planning process, otherwise they may disagree with the manner in which their own land and resources are exploited (Chhabra, 2015; Jimura, 2011). Despite the inclusion of a question about residents' need or not for tourism in the McKercher framework, residents are seldom considered in the potential evaluation process, which focuses on resources and products. Apart from residents and tourists (discussed subsequently), most of these stakeholders can be regarded as experts, and their opinions are valued in assessments. Experts' evaluations have been extensively used in attractiveness evaluations; however, this approach is not without bias considering the latent overemphasis of certain attributes in relation to the expert's expertise, such as hoteliers overrating the lodging dimension and cultural/historical experts overemphasizing the relevant attributes (Formica, 2000). Accordingly, a balanced sample consisting of experts from different fields and sectors is advocated. Similar to the situation of experts, residents may overestimate the overall attractiveness of a destination, as shown in Tang and Rochananond's (1990) study of Thailand.

Marketers represented by tour guides are special types of stakeholders or experts, as they are the intermediaries between the supply and demand sides. They are familiar with the situations of the two sides, and are thus in a good position to audit the potential or attractiveness of heritage sites. For an assessment of the attractiveness of Macau's World Heritage Sites, Io (2011) interviewed guides and managers of travel agencies. The interview questions revolved around interviewees' itinerary design practices, site selection criteria, evaluations of individual sites, and the possibility of including more heritage sites in package tours. The four key attributes identified for assessing the market appeal of heritage sites were listed as follows: accessibility, tourist facilities, entertaining appeal, and competitiveness against other tourist attractions within the destination. Although the study adopted a supply-side point of view, it showed that stakeholders' (such as tourists and tour marketers) opinions were important for a holistic understanding of the marketing appeal of heritage sites. Similarly, Huang (2011) investigated the tourism potential of Chinese heritage sites in the Otago region of New Zealand by interviewing tour guides and management staff. From the perspective of the Chinese tour guides, Chinese heritage sites in the region had low potential in the Chinese outbound tourism market. The tour guides suggested there was no need to develop the heritage sites further, as they were ineffective at attracting Chinese tourists. Such opinions may oppose site management viewpoints. A comparison of the two groups—guides and management—shows that the heritage values perceived by the market are critical for assessing tourism potential.

2.3. The need for method improvement

In short, a majority of assessment studies were conducted from the supply-side perspective, leading to an imbalanced research scenario. One reason for the disequilibrium lies in the dominance of the du Cros model and its modified form: the McKercher framework. Inclusion of the robusticity conception in the model and framework makes the relevant assessment studies difficult to conduct from a purely market-based perspective, as suggested by the work of Li and Lo (2004). Despite attempts to apply the indicators derived from the supply-side perspective to the demand side (Kuo & Wu, 2013), the indicators are more appropriate for researchers and experts than for such stakeholders as tourists and marketers, as a grasp of sufficient information serves as a precondition for rating the indicators as demonstrated by McKercher and Ho (2006).

Application of the McKercher framework leads to a qualitative assessment (Laing et al., 2014; Sheng & Lo, 2010). Under these circumstances, a quantitative approach to auditing the tourism potential of heritage sites is needed. The quantitative approach should generate a hierarchy of heritage sites or attractions, which would be helpful for a clear understanding of the relative positions of heritage sites in the hierarchy of sites. Furthermore, the indicators and sub-indicators developed by McKercher and Ho (2006) should be reexamined. For instance, it is not always necessary to include robusticity-related indicators in an assessment when the physical state of a heritage is not a concern, or where the assessed heritage sites have similar robust physical values (Laing et al., 2014).

2.4. Weighted sum model

The weighted sum model/method (WSM) is an extensively used method for multi-criteria decision analysis; it refers to making preference decisions over the available alternatives characterized by multiple attributes (Kasim, Kayat, Ramli, & Ramli, 2016). The operational definition of WSM is that an overall value for each alternative involved in the decision-making process is computed by summing the scores of attributes multiplied by their respective weights. Put simply, it is the “sum of weighted scores” (Ishizaka et al., 2013, p. 212). The WSM assumes that more important factors result in higher values in the final output, and thus is helpful for classifying study sites or areas into different levels of appropriateness for a given purpose, such as to identify the high natural value of farmland for environmental conservation (Matin et al., 2016), to select a site for casino construction (Ishizaka et al., 2013), and to compare the business environments in different countries (Esangbedo & Che, 2016). The WSM is also effective in the decision-making scenarios other than site choice, such as evaluating and prioritizing risks related to tidal energy development (Kolios et al., 2016) and allocating resources to regions according to the levels of development related to innovation activities and processes (Nekolová, Rouag, & Stejskal, 2015).

A user-friendly approach to assessing tourism potential was developed within the guidelines of WSM and fulfilled through the computation of physical and social attributes, which were quantified through ranking and scaling techniques (Al Mamun & Mitra, 2012). The physical attributes include accessibility, accommodation, catering, information and guide services, and parking and shopping facilities. The social attributes consist of tourist arrivals, length of stay, and frequencies of fairs and festivals. The approach presents a modified application of WSM, and its strength lies in the use of normalized weights for indicators or attributes at two different levels. Normalization occurs when the sum of all weights at the same level is one. A 5-point scale is used to measure the indicators, and in the computation process, values from 0.2 to 1.0 are allocated to different scales. The approach is easy to understand and apply; however, the selection of indicators is arbitrary or unconvincing. Focusing on the external attributes of resources or sites, the evaluation approach neglects the internal attributes, referring to items used to assess the tourism resource per se, such as the heritage value. Another weakness is the lack of a theoretical foundation for measuring social attributes with such items as annual tourist arrivals, sojourn time, and festival frequency. As noted by Al Mamun and Mitra (2012), data on annual tourist arrivals and length of stay cannot be recorded. By focusing on product attributes, their study neglected the values of resources per se.

Despite its weakness, the evaluation approach of Al Mamun and

Mitra (2012) was used by a study evaluating the tourism potential of a historic square in Nepal (Neupane et al., 2013). There was no alternative in the study, which showed the effectiveness of the approach. Specifically, as the value of the tourism potential of a study site falls into the interval (0, 1), the value per se can inform judgment without the need for comparison with the site's counterparts. Recognizing the weakness of the approach for indicator selection, Malik and Bhat (2015) used it in a modified form by adopting the four indicators of natural resources, cultural resources, adventure and sports facilities, and infrastructural facilities to assess the tourism potential of Kashmir. According to the evaluation outputs, locations in the study area were differentiated by the levels of tourism potential: high, medium, and low. Despite the improvement in selecting the indicators for tourism potential, Malik and Bhat's (2015) approach neglects the factor of market appeal, which is critical for understanding the value of tourism resources.

2.5. The demand-side perspective

In evaluation studies of tourism potential, a supply-side perspective is widely used; however, when it comes to investigations of destination attractiveness, the demand-side perspective becomes predominant. This difference may be caused by the different connotations of the two terms. Potential signifies an evaluation of resources; attractiveness is naturally linked to tourists' perceptions. The studies discussed subsequently exemplified the demand-side perspective on the attractiveness of destinations. Morachat (2003) examined the attractiveness of Chiang Mai (in Thailand) through analysis of tourists' perception of the eight destination attributes, including cultural features, reception, price, natural factors, services, recreation and shopping facilities, accessibility, and infrastructure. Similarly, an Indian destination, Varanasi, was examined, and factor analysis of key destination attributes generated the following seven factors: ease of accessibility, touristic infrastructure, support services, ancient flavor of the city, distinctive local features, psychological and physical environment, and cultural attributes (Das, Mohapatra, Sharma, & Sarkar, 2007). Again, Krešić and Prebežac's (2011) study of seven Croatian counties identified the following factors: accommodation and catering, activities at the destination, natural features, destination aesthetics, environmental preservation, and destination marketing. Apart from the three aforementioned studies, many others have investigated the attractiveness of destinations of different scales or types. The major research interest of these studies was to identify the key factors determining destination attractiveness, rather than disclose the level or degree of attractiveness.

A few studies of tourism potential evaluation have also adopted the demand-side perspective. Based on the du Cros model, a study of Hong Kong's rural heritage conducted a survey on the demand side "to collect tourists' opinions on the accessibility and the attractiveness of the assets, the availability of the tourist information, and the provision of the amenities" (Li & Lo, 2004, p. 792). Adopting the McKercher framework, another study of heritage sites in Tainan surveyed tourists who had experience of visiting these sites (Kuo & Wu, 2013). Starting from the value of resources, these initial attempts signified the need for a demand-side perspective, as the market's perceptions of the relevant values are critical for the prospect of tourism development at heritage sites (Formica, 2000). The conventional way of evaluating the tourism potential of heritage sites is to rely on experts' opinions, which leads to the prevalence of the supply-side perspective. However, the market's perceptions of resource values are also important in the assessment of heritage sites, which calls upon a demand-side perspective on the tourism potential of heritage sites. Such a shift in perspective from the supply to demand side has been seen in destination attractiveness studies in recent decades as a response to increasing buying power (Formica, 2000).

3. Method

3.1. Measurement

The scale of tourism potential developed in this study consists of two indicators: resource values and development state. Resource values were measured based on the following seven factors: aesthetic value, historical value, awareness level, ambience or setting, complementarity with adjacent attractions (Li & Lo, 2004), value for money, and authenticity (McKercher & Ho, 2006; Yeung, 2012). The second indicator, development state, was measured based on the following factors: accessibility or transportation, proximity to other attractions, tourist facilities (Li & Lo, 2004), interpretation in situ, tourist information, time for on-site visitation (McKercher & Ho, 2006), and catering services in situ (Sánchez Rivero et al., 2016). The rationale for determining the measurement is set out in the Discussion section.

An ordinal scale was adopted to evaluate each sub-indicator. The five categories of values from low to high proposed by McKercher and Ho (2006) were adopted for some sub-indicators. For others, different categories were used, but the sequence remained the same: from low to high or from negative to positive. For coding, values were assigned to each category: 0.2 for the lowest value, followed by 0.4, 0.6, 0.8, and 1 (the highest value). After that, the indicators and sub-indicators were respectively ranked by the authors and respondents. The sub-indicators were ranked from 1 to 7 according to their importance for tourism development.

3.1.1. Weights of indicators and sub-indicators

The present study assumed that if a sub-indicator was ranked higher, it contributed more to the final value calculation. In other words, each rank should be assigned a weight to reflect its relative place in the structure of ranks (Al Mamun & Mitra, 2012). The weighted value for each rank was computed with the following formula:

$$R_i = (MAX(i) + 1 - i) \Big/ \sum I \quad (1)$$

where *i* is the ordinal number of ranks.

The weighted values of the seven ranks were computed with formula (1) (Table 1).

Every response was considered in terms of the computation of weights for the sub-indicators. In doing so, a more accurate calculation of weights could be achieved. The weights of the sub-indicators were calculated with the following formula:

$$W_{ji} = \sum (C_{ji} * R_i) \Big/ N \quad (2)$$

where j is a constant referring to a given indicator, *i* represents the ordinal number of sub-indicators, C_i is the count of occurrence of the *i*-th rank for a given sub-indicator, and N is the sample size.

The authors allocated the weights of the indicators. Considering the value of resources comes first in tourism development, the indicator of resource values was ranked first, followed by

Table 1
Weighted values for the ranks of sub-indicators.

Rank	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7
Value	0.250	0.214	0.179	0.143	0.107	0.071	0.036

development state. According to the computation methods noted previously, the weight for resource values was 0.67 and that for development state was 0.33.

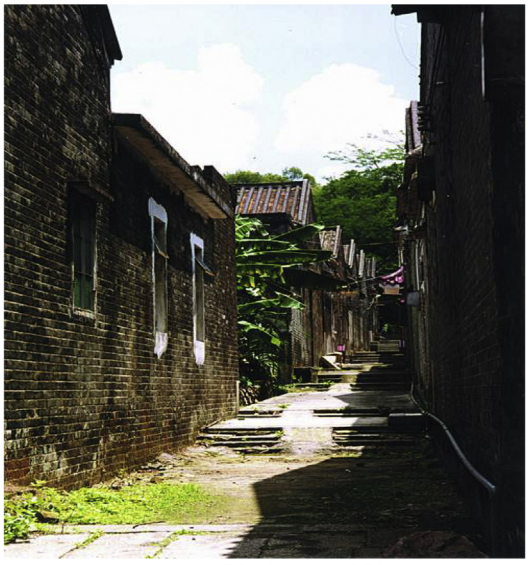
3.1.2. Computation of aggregate potential value

$$V = \sum W_j (W_{ji} * S_{ji}) \quad (3)$$

where S_{ji} is the mean score for the *i*-th sub-indicator in the *j*-th indicator set.

3.2. Description of the study sites

Academic interest in heritage sites is imbalanced: much more attention is allocated to the World Heritage Sites, while heritage sites of regional significance are less investigated (Huang, 2006). The situation is inconsistent with the tourist market's increasing interest in heritage at the regional level (Timothy, 2014). Considering this, the authors planned to evaluate all four rural heritage sites (see Table 2) in Zhuhai, an emerging destination close to Macau. This evaluation was used to test the effectiveness of the proposed model. Located in Zhuhai, Guangdong province, China, the physical environments of the four sites have been deemed historic villages at the provincial level.



Sources: http://blog.sina.com.cn/zftrblog
Photo 1. Huitong Village.

Source: Bo Wendy Gao

Source: http://blog.sina.com.cn/tinacn2000
Photo 2. Jiexia Village.

In the first stage of the survey, the authors found it unrealistic to obtain responses from Paishan and Wanshan, both of which received few tourists. Several on-site visitations obtained fewer than 20 responses. The local residents informed the authors that they observed few tourists throughout a year. By contrast, another two historic villages, Huitong and Jiexia, had received the patronage of both group package tour participants and independent tourists, albeit on a small scale (no data on annual visitations). The two sites are included in some travel agencies' itineraries. The municipal government is planning to develop such villages as Jiexia into high-ranking resorts. Despite the interest of market and industry, the tourism potential of such historic villages has received little attention from scholars.

3.3. Data collection

Self-administrated questionnaires were collected from May to July 2016 and in February 2017. The survey time included low and high seasons. The first stage of data collection resulted in

Table 2
Description of the rural heritage sites in Zhuhai.

Sites	Description
Huitong village	Dating back to 1732, more than 40 historic buildings are well preserved in the village, representing the style of rural communities in the region of Xiangshan (corresponding to the present territories of Zhuhai, Zhongshan, etc.). The village was planned with three horizontal streets and eight vertical lanes. It claims to be the earliest village with electricity and a cinema in China. In recent years, some local artists have been living in the village.
Jiexia zhuang (village)	Constructed in the first half of the 19th century, the small village was believed to be the residence place of the descendants of a Song Dynasty royal family. Fourteen courtyards and a stone street 100 meters in length are well conserved. Bamboo and other landscape plants surround the village, as does a manmade circular river. A drawbridge over the artificial river is located at the entrance. An ancestral shrine (Luyitang) built by initial residents of the village is located nearby.
Paishan village	Initially built in 1778, the village possesses approximately 100 historic houses. These buildings are characterized by yellow earthen walls, with decorations of wooden and stone carvings. This feature is typical of rural residence buildings in the region of Lingnan (South of the Five Ridges), referring to the territory of Guangdong, Guangxi, and Hainan. A new-moon-shaped lake is located at the entrance.
Wanshan village	With a history starting from 1765, the village retains its original look and features. Approximately 70% of the historic buildings present the Qing Dynasty style of rural residences with yellow earthen walls, or the Lingnan style of blue brick walls. The well-planned streets and lanes are consistent in size and shape, representing the residence culture of the Pearl River area.

Note: Another two sites, Hushan and Lishan, were added to the list of historical villages in Zhuhai at the completion of this study.
Source: www.okzhuhai.com

Table 3
Counts of ranks and weights for the sub-indicators ($N = 332$).

Item	R1[a]	R2	R3	R4	R5	R6	R7	Weight
Historical value (C15)	125	90	37	37	19	17	7	0.199
Retaining the traditional style (C16)	92	113	48	27	23	15	14	0.192
Aesthetic value (C11)	48	33	68	67	48	37	31	0.150
Ambience or setting (C12)	19	39	60	78	63	46	27	0.138
Awareness levels (C13)	25	17	42	47	65	63	73	0.115
Complementarity with adjacent attractions (C14)	12	26	43	40	47	89	75	0.109
Value for time and money (C17)	13	21	43	36	63	59	97	0.105
Total of resource values								1.0
Accessibility (C21)	101	45	56	39	36	27	28	0.172
Tourist facilities (C26)	67	70	57	42	42	34	20	0.167
Interpretation in situ (C24)	59	49	52	47	40	45	40	0.151
Tourist information (C27)	46	52	51	55	40	50	38	0.147
Catering services (C23)	13	55	45	69	67	43	40	0.134
Capability of retaining tourists (C22)	35	47	29	38	50	64	69	0.126
Proximity to other attractions (C25)	14	15	48	40	57	67	91	0.106
Total of development state								1.0

[a] R1 refers to Rank 1 and so forth.

Table 4
Mean scores for the sub-indicators.

	Huitong ($N = 160$)			Jiexia ($N = 172$)		
Sub-indicator	Mean[a]	SD	Alpha if items deleted	Mean	SD	Alpha if items deleted
Aesthetic value (S_{11})	0.704	0.192	0.85	0.730	0.162	0.80
Ambience or setting (S_{12})	0.573	0.172	0.84	0.588	0.167	0.80
Awareness level (S_{13})	0.395	0.116	0.85	0.391	0.108	0.81
Complementarity with adjacent attractions (S_{14})	0.538	0.211	0.84	0.637	0.202	0.80
Historical value (S_{15})	0.725	0.185	0.85	0.770	0.181	0.80
Retaining the traditional style (S_{16})	0.739	0.171	0.85	0.737	0.178	0.80
Value for time and money (S_{17})	0.609	0.216	0.84	0.623	0.200	0.80
Accessibility (S_{21})	0.526	0.231	0.85	0.588	0.235	0.81
Capability of retaining tourists (S_{22})	0.538	0.202	0.84	0.544	0.197	0.78
Catering service (S_{23})	0.629	0.179	0.85	0.619	0.175	0.80
Interpretation in situ (S_{24})	0.474	0.180	0.85	0.556	0.204	0.81
Proximity to other attractions (S_{25})	0.495	0.185	0.85	0.623	0.174	0.82
Tourist facilities (S_{26})	0.571	0.178	0.84	0.640	0.151	0.80
Tourist information (S_{27})	0.461	0.197	0.84	0.469	0.179	0.80

[a] Items were measured on an ordinal scale, with .2 representing the lowest score and 1.0 the highest score.

approximately 100 effective questionnaires, as only a few tourists visited the study sites during the summer. The Chinese New Year period was chosen for the second stage of data collection, during which more than 150 effective questionnaires were received. The convenience sampling approach was adopted due to the nature of tourism development at the study sites, that is, the early stage of development with few tourist arrivals. The questionnaires were distributed both online and onsite. The online data collection was conducted through www.sojump.com, a popular online questionnaire platform in China. The respondents were selected if they had experience visiting at least one of the four historic villages within one year. Onsite questionnaires were administered by the authors and trained undergraduates; a Chinese culture bookmark was used as an incentive for each respondent.

Table 5
Tourism potential value calculation.

Indicator	*Huitong* village	*Jiexia zhuang*
Resource values	0.638	0.665
Development state	0.530	0.579
Total	0.602	0.636

The number of questionnaires totaled 362, including 64 online responses and 298 onsite responses. Ultimately, 332 valid questionnaires were used to compute the weights for the sub-indicators. To compute the mean scores for the sub-indicators, the dataset was divided into 2 subsets according to the study sites: 160 questionnaires for Huitong and 172 for Jiexia. Overall, males accounted for 42% and females 58% of the participants; 56% were aged between 18 and 34, 41% between 35 and 64, and 3% 65 or above. In terms of origins, 65% were from the City of Zhuhai, 17% from other places in Guangdong province, 17% from other provinces of mainland China, and 1% from other territories. The major transportation tool was private car (65%), followed by tour bus (16%), public bus (8%), walking (6%), and bicycle (5%).

4. Results

With the ranks of all sub-indicators counted, formula (2) was used to calculate the weights for the sub-indicators. Table 3 presents the results.

As the table shows, in the set of resource values, historic value comes first, followed by authenticity (retaining the traditional style). Of medium importance is aesthetic value and ambience or setting. The three factors, including awareness level in the market, complementarity with adjacent attractions, and value for time and money, were regarded as lowest in importance. In the development state set, the factor of accessibility ranked first, followed by tourist facilities, interpretation in situ, tourist information, catering service, and capability of retaining tourists. The weights of these items decrease averagely along this series. Proximity to other attractions was regarded as the least important factor for development state; this echoes the previous item of complementarity with adjacent attractions, which was also regarded as being of least importance in terms of resource value. From the participants' point of view, the heritage attraction per se and the relevant facilities were of paramount importance to tourism development; by contrast, the relationship of a heritage site to adjacent attractions was a minor issue.

Mean score analysis was conducted for the two sets of sub-indicators, which were respectively associated with resource values and development state. The results are presented in Table 4. The Cronbach's alpha coefficients of all of the items are above 0.78. Overall, most of the mean scores for the second heritage site in the table were higher than for the first site. Despite this scenario, some similarities and dissimilarities can be discerned. For both heritage sites, in the resource value set, the mean scores for the three items of historical value, authenticity, and aesthetic value were significantly higher than the scores for the remaining items. Regarding complementarity with adjacent attractions, the mean score for Jiexia was significantly higher than that for Huitong, which reflects reality. The heritage site of Jiexia is a part of the rural area of Nanmen, which consists of several geographically separated communities at various levels of appeal. The tourist market's awareness of the two heritage sites is almost at the same low level (0.39), which shows that the municipal government has made insufficient effort to promote these historic villages.

Looking at the development state set, the sub-indicator mean scores for the two heritage sites present a different picture. The three highest scores for Huitong were allocated to catering service, tourist facilities, and capability of retaining tourists, respectively; in contrast, the three highest scores for Jiexia were allocated to tourist facilities, proximity to other attractions, and catering service, respectively. The mean score for interpretation in situ was much higher for Jiexia than for Huitong. For both heritage sites, the mean score for tourist information was the lowest. This result is consistent with the low awareness level in the resource values aspect. The score for tourist facilities was much higher for Jiexia than for Huitong, revealing that the latter lacks basic facilities such as tourist toilets and planned sightseeing paths. In terms of proximity to other attractions, the score was also significantly higher for Jiexia than for Huitong, revealing that another historic village (Yuxiu) and the ancestral shrine of Luyitang are located near Jiexia. In the immediate neighborhood of Huitong, no other attractions can be found. The mean score for accessibility was again higher for Jiexia than for Huitong, which reflects that it takes less time to take the public bus to the former than to the latter. Finally, the mean scores for catering service for both sites were very close, which reflects that both sites offer a certain level of food and beverage service.

The tourism potential values of the two study sites were computed using formula (3). The values show that the study sites had moderate to high levels of tourism potential (Table 5). For both sites, the value for development state was significantly lower than that for resource values, which suggests the two heritage sites were underdeveloped. The lower value for development state decreased the overall potential value.

Table 6
Importance of destination attributes compared with other studies.

	High importance	Medium importance	Low importance
Present study: historic villages, Zhuhai, China	Historical value, authenticity, accessibility, and tourist facilities	Aesthetic value, ambiance, interpretation, and tourist information	Reputation, complementarity, value for time and money, catering services, capability of retaining tourists, and proximity to other attractions
Mikulić et al. (2016): Croatia	Value for money, accommodation, restaurants, and cultural heritage	Friendliness of residents, sports and recreation, and entertainment	Shopping, picturesqueness and tidiness, ecology, transport accessibility, safety, and natural beauty
Omar, Abooali, Mohamed, and Mohamad (2014): Penang Island, Malaysia	Safety and security, destination image, accessibility, attraction diversity, and value for money	Friendliness of residents, accommodation services, and cultural/historical uniqueness	Sanitation, tourist information, local transportation, and ease of communication
Das et al. (2007): Varanasi, India	Ease of accessibility	Touristic infrastructure, support services, and ancient flavor	Distinctive local features, psychological and physical environs, and cultural attributes
Morachat (2003): Chiang Mai, Thailand	Cost/price, cultural features, and infrastructure	Services, natural factors, facilities, and reception	Accessibility

5. Discussion

The mathematics model presented in this study rectifies the flaw of the du Cros model, which consists of two mutually exclusive dimensions, resulting in a failure to generate a hierarchy of heritage sites (McKercher & Ho, 2006). The cause is the inclusion of the robusticity conception, which does not apply to such assessment scenarios as under-visited heritage sites or heritage sites with small-scale visitation. Heritage sites of considerable regional significance (Huang, 2006) receive moderate or low levels of visitation, which means the capability of dealing with visitation is less likely to be a concern for site management. By removing the robusticity concern from assessment and differentiating items with regard to their importance to a heritage site's tourism prospects, the model proposed in this study effectively produces an explicit hierarchy of heritage sites, with potential values in the interval (0, 1). As such, the model is helpful in differentiating heritage sites in terms of their potential for tourism development.

In the present study, attributes of sites and products were weighted on the basis of tourists' rankings. Based on the weights, the importance of site attributes could be placed at three levels: high, medium, and low, which were comparable to some destination attractiveness studies that ranked the importance of destination attributes (see Table 6). Table 6 shows that the perceived importance of destination/site attributes differed across the studies. The lack of consistency lies in the nature of the concept of importance. Regarding destination attributes, there are two types of importance: stated and derived. Stated importance reflects a general judgment independent of any particular context, and derived importance indicates personal reactions to a specific context (Mikulić, Krešić, Prebežac, Miličević, & Šerić, 2016). Although stated importance is relatively stable, derived importance is very dynamic. The studies noted in Table 6 were context-based, and tourist perceptions of attributes fall into the category of derived importance. As a result, the perceived importance of destination attributes varies from case to case. For instance, historical value for heritage sites comes first in China, value for money comes first in Croatia, safety and security comes first in Malaysia, ease of accessibility comes first in India, and tour cost comes first in Thailand (see Table 6).

The weighted sum model was improved to assess cultural heritage sites. The modified model rectifies the weakness of other studies that have neglected the market appeal of heritage sites or the perceived value of resources (see Al Mamun & Mitra, 2012; Malik & Bhat, 2015; Neupane et al., 2013). In applying the model, the selection of site attributes to involve was of paramount importance. The indicators of tourism potential were mainly derived from the du Cros model and McKercher framework. The present study adopted some indicators from the du Cros model, including market appeal, cultural significance, and product design needs. Cultural significance measures historical and aesthetic values, and market appeal focuses on ambiance and setting, awareness levels, and complementarity with other activities. All of these items reflect the value of tourism resources; thus, they were referred to as resource values in this study. Furthermore, another two sub-indicators from the McKercher framework, authenticity and value for time and money, were added to the indicator of resource values. The term "product design needs" is misleading (Li & Lo, 2004) and thus was renamed "development state," as the indicator is mainly concerned with the status quo of infrastructure, facilities, and services. In addition to the sub-indicators in the du Cros model, three sub-indicators derived from the McKercher framework were incorporated: interpretation in situ, tourist information services, and capability of retaining tourists. The selection of tourism potential indicators turned out to be a further defragmentation and refinement of the du Cros model and McKercher framework.

It is necessary to explain why certain indicators were disregarded by the present study. The first indicator is robustness (in the du Cros model), which revolves around such issues as "fragility, state of repair, management plans and the likely impact of increased visitation" (McKercher & Ho, 2006, pp. 475–476). As the construct of robustness conflicts with market appeal, it was neglected in this study. To a large extent, such concerns apply to physical value in the McKercher framework. Cultural value was ignored in part as it is related to stakeholders' attitudes, sites' invulnerability to visitation, and so on. The "stakeholder" is a broad concept that is not measurable for multiple social groups such as government agencies, business sectors, residents, and tourists. If the concept is narrowed down to residents, then their attitude is not a critical factor in the assessment. Destination lifecycle studies have shown that at the initial stage of development, residents tend to embrace tourism (Murphy & Murphy, 2004). The small scale of visitation of ordinary heritage sites has no significant influence on the destination community and its resources. Social value was also neglected in the present study. Social value lacks substantial meaning and is thus difficult to measure (McKercher & Ho, 2006). It is unconvincing to measure social value based on such items as annual tourist arrivals, sojourn time, and festival frequencies (see Al Mamun & Mitra, 2012).

Although the reliabilities of the sub-indicators were acceptable, the item of interpretation in situ could be improved in future studies. The mean score for this item was much higher for Jiexia than for Huitong, which was the opposite of the authors' onsite observation results. Huitong has a village history museum that displays considerable numbers of pictures and artifacts, plus descriptions of the collections. In contrast, Jiexia lacks such static interpretation, yet the site scored higher in terms of interpretation. The live interpretation of tour guides at Jiexia contributed to the higher score. Accordingly, future studies should divide the item of interpretation into two items: static and live interpretation, respectively.

This study's main limitations lie in the survey aspect. Ranking sub-indicators can be a tough task for participants, who might have had difficulty understanding such sub-indicators as complementarity with adjacent resources. Despite the ranking requirement, a few participants filled in the same numbers for different sub-indicators. Such alternative responses, if thoughtful, might have suggested their doubt about the existence of a hierarchy of items. Furthermore, in onsite surveys, the ranking of sub-indicators can be distorted by respondents' consideration of site features. For instance, the relationship of a heritage site with adjacent attractions in terms of proximity and complementarity was regarded as the least important factor, perhaps due to subconscious consideration of the distance from city centers. Specifically, the two study sites were one hour away from urban areas by bus, and this feature could have overshadowed the significance of the relationship between heritage sites and adjacent attractions. A destination's proximity to adjacent attractions is supposed to have a significant bearing on its tourism potential, as disclosed by Landorf's (2016) study of an Australian city known for its industrial heritage.

The findings of the present study have some implications for

future studies. Based on the previous discussions, the ranking of indicators and sub-indicators can be completed by experts, who could help to improve the reliability of the ranking because of their expertise, professional knowledge, and lack of onsite experience. The last feature could be helpful for rectifying the distortion caused by linking the importance of a given attribute to the specific situation of the assessed site. Furthermore, when assessing heritage sites that are barely presented on the regional tourism map, it would be unrealistic to conduct a tourist survey. In the beginning of this study, the authors planned to evaluate the potential of all four historic villages in Zhuhai, but few tourists could be found in the other two historic villages. Finally, the two sites were excluded from the audit due to the impracticability of the tourist survey therein. Future studies could consider approaching another type of respondent to solve the problem—that is, expert respondents, referring to local tourism scholars, travel agency professionals, and tourism officials.

6. Conclusion

This study presents a mathematics model for assessing the tourism potential of heritage sites. A case study of two heritage sites in China shows the model's effectiveness. The model consists of two indicators: resource values and development state, each of which consists of a series of sub-indicators. Overall, the model adopts a weighted sum method for computing values for tourism potential. Different weights were allocated to indicators and sub-indicators, as the items made varying contributions to the overall potential of a given site (McKercher & Ho, 2006; Sánchez Rivero et al., 2016). The quantitative approach adopted in the present study helps rectify the situation caused by the domination of qualitative assessment methods in current studies of tourism potential assessment. The present study adopted a demand-side perspective, that is, tourists rated the potential of heritage sites.

The tourism potential assessment model is user-friendly for mathematics laypeople. The two-step weighted sum method is easy to understand. The model's quantitative nature suggests that it is appropriate for assessing and comparing heritage sites in a region. According to the results of potential values, the assessed sites would fall into three categories: low potential ($V < 0.4$), medium potential ($0.4 \leq V < 0.7$), and high potential ($0.7 \leq V < 1$). At present, there are hundreds of historic villages and towns in Guangdong province and thousands more in China. The model could be used to audit such heritage sites of large quantity, thus creating an overall understanding of their potential for tourism development. This understanding would be helpful in deciding the priorities in developing and marketing these regional ordinary heritage sites, which are attractive in the eyes of new tourists who seek authentic heritage experiences regardless of the size and reputation of the sites (Timothy, 2014). Extensive investigation of the tourism potential of heritage sites in a region is a critical step in the planning stage (du Cros, 2001), and development of those sites with higher potential would be helpful to better cater to the needs of the tourist market, with its growing interest in rural heritage of less significance (Wang, 2016), in contrast to world-class and national heritage sites. Thorough assessment of tourism resources would ensure that the limited financial resources of municipal or provincial governments are allocated to the sites with relatively high potential (Kuo & Wu, 2013).

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