



EVALUATION OF THE KEY DEVELOPMENT FACTORS FOR THE SHANGHAI CRUISE TOURISM INDUSTRY USING AN INTERVAL-VALUED FUZZY NUMBER METHOD

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Key words: cruise tourism industry, Shanghai, interval-valued fuzzy number, fuzzy ranking.

ABSTRACT

Rapid development has occurred in the cruise tourism sector in Asia accompanied by a global cruise market shift to the East. Rapid economic development has led to substantial growth in China's cruise tourism. Because of this rapid development and new demand for cruise tourism, Shanghai has become the largest cruise port in Asia. Because Shanghai is under pressure from the increasing demand for cruises, analyzing the key factors for developing the cruise tourism industry in the city is necessary. The main purpose of this study was to evaluate the key developmental factors of Shanghai's cruise tourism industry by using an interval-valued fuzzy number method and to rank them by importance. The results reveal the influencing factors of Shanghai's cruise tourism industry and provide a reference for Shanghai Municipal Government and cruise companies.

I. INTRODUCTION

The cruise industry has become one of the fastest-growing sectors and an essential part of the tourism industry and global economy (Dwyer and Forsyth, 1998; Sun et al., 2011). The global cruise industry dates to the 1840s (Hoseason, 2000). The modern cruise tourism industry has expanded significantly over the last three decades (Bonilla-Priego et al., 2014; Satta et al.,

2015). Cruise tourism has developed mainly in North America, Europe, Australia, and Asia. Cruise tourism in Asia has experienced rapid development, and the world's cruise market has shifted eastward. Therefore, cruise tourism in Asia has become an increasingly prominent research topic.

As China's economy has transformed from a manufacturing economy to a consumer economy, demand for cruise tourism has grown substantially in the Asian market. China's cruise tourism industry has experienced an average annual growth of 40% in recent years. The number of cruise tourists is anticipated to reach 5 million by the year 2020 and 10 million by 2030. Shanghai is the top cruise port in China. In 2015, 344 cruises berthed in Shanghai's cruise port, accounting for 54.7% of the 629 cruises that berthed in China's top 10 cruise ports. Shanghai has witnessed a 26.5% increase in the number of berthed cruises and a 35.1% increase in the number of tourists going on cruises. (Wang et al., 2016). Shanghai, Hong Kong, and Tianjin are the fastest-growing port cities in China that can accommodate large cruise ships (Sun et al., 2014). McCarthy (2003) claimed that cruise ports in Asia must improve their services and remain competitive to maintain pace with the growth of the cruise market. Because of the rapid development and increased market demand for cruise tourism in Shanghai, the city is under pressure and must solve multifarious problems.

This paper is organized as follows. Section 1 introduces the development of the Chinese cruise tourism industry. A literature review of the key development factors for China's cruise tourism industry is summarized in Section 2. Section 3 explains the methods applied in this study using the interval-valued fuzzy number method. The results are presented in Section 4. Conclusions and research opportunities are presented in Section 5.

II. LITERATURE REVIEW

1. Main Factors for the Cruise Tourism Industry

The cruise tourism industry, consisting of transportation, tourism, and sightseeing, is the core of the cruise economy (Wild and

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Dearing, 2000). In accordance with the competitive forces of the industry, Porter (1990) highlighted the importance of supply and demand in analyzing the development of industries. The global cruise tourism market has faced increasing demand: 22.04 million people boarded cruises in 2014, an increase of 3.4% over the previous year, and 2013 witnessed a 2% increase over 2012. Asian countries, especially China, have seen substantial growth in the cruise tourism industry, bringing 2.48 million inbound tourists. China has become the fourth largest country in terms of cruise tourism resources; the number of inbound and outbound tourists reached 1.64 million in Shanghai in 2015 (Wang et al., 2016).

The demand for cruise tourism indicates that supply should be the starting point for analyzing the key development factors in the cruise tourism industry. Wie (2005) identified a shortage in the cruise tourism industry, which suggests that supply should be another starting point for examining the cruise tourism industry. Rodrigue and Notteboom (2012) claimed that the cruise tourism industry appears to be driven by supply. Therefore, supply is crucial in development of this industry.

An industry is developed on four pillars: policies, infrastructure and services, products, and talent. Liu (2011) suggested that aspects such as industry policies, cruise lines, personnel training, and the development of legal protection for cruise tourism must be improved in China. Sun et al. (2014) demonstrated that cruise policies, cruise ports, and terminals play a key role in the development of the cruise tourism industry. They also claimed that training and education for cruises were not keeping up to date with the industry's rapid development. Chen (2016) stated that laws and regulations, cruise port facilities, and personnel training were crucial factors affecting the development of the cruise tourism industry in Taiwan. He also stated that international marketing and new niche markets are two factors influencing the development of the cruise tourism industry. Terry (2011) asserted that the cruise tourism industry must overcome workforce shortages during its development.

Based on the key development factors discussed and the circumstances specific to Shanghai, this study explored four topics: relevant policies, infrastructure and services, cruise products, and talent. The first part of this paper discusses related policies. Port facilities and related services are evaluated in the second part. The third part explores cruise line design and onshore trips. The fourth part discusses personnel training.

2. Relevant Policies

Relevant policies are critical to the development of the cruise tourism industry. Robles et al. (2015) showed that, beginning in the late 1990s, the rapid growth of the Brazilian cruise tourism industry owed its success to the new cruise shipping and port regulations. They also determined that its future development faces challenges from high-tax policies and restrictions on certain crew members. Chen (2016) investigated the laws, policies, and regulations affecting the development of the cruise tourism industry. Liu (2011) described the development of the cruise tourism industry as being largely dependent on policies on in-

dustry access, stipulated port fees, multiple ports of call, and finance.

Therefore, the development of the cruise tourism industry in Shanghai will be affected by such factors as finance and tax policies, multiple ports of call, cooperation among ports, permission for the duration of stay of foreign cruises, and casino regulations.

3. Port Facilities and Service

Robles et al. (2015) asserted that the port of Santos should exert effort to properly balance meeting cruise passengers' requirements and managing the challenges of the growth of cruise passenger volume and ship size. After investigating ports in the Caribbean, Teye and Paris (2011) found that the shopping environment and entertainment facilities in port cities greatly supported the local cruise tourism industry. Lekakou et al. (2009) explored the port services offered to passengers as key criteria when cruise companies select a homeport, such as transportation itineraries inside ports, duty-free shops, and time for security checks. McCarthy (2003) believed that as the cruise market grows, cruise ports in Asia will come under pressure to improve their services and to remain competitive in terms of passenger terminal development and related tourism infrastructure. Liu (2011) compared Chinese ports with European and U.S. ports and concluded that the transportation links between ports and cities should be improved in China to facilitate sightseeing for cruise passengers. Robles et al. (2015) asserted that convenient transportation links between ports and cities promote the development of cruise ports.

Based on the circumstances of the cruise ports in Shanghai, several factors must be considered for promoting the rapid development of the cruise tourism industry, namely the number of cruise ports, their expansion and maintenance, improvement of the entertainment facilities, the transportation links between the ports in the center of Shanghai and tourist attractions, and the efficiency of customs checks. Thus, the facilities and services provided by the ports are also necessary for the development of the cruise tourism industry.

4. The Improvement and Innovation of Cruise Tourism Products

Sun et al. (2014) found that the length of cruise trips in China is usually less than 1 week, whereas the average length of cruise trips in the North American market is more than 1 week. Andriotis and Agiomirgianakis (2010) investigated ports in the Mediterranean and discovered that historical sites, museums, commercial areas, and scenic spots were popular among cruise tourists and that these factors promoted local cruise tourism. Chen (2016) asserted that cruise tourists enjoy trips that involve a "colorful journey," including heritage and cultural sites and natural scenery. Wang et al. (2014) suggested that several vital factors affect the development of cruise ports, such as historical sites, cultural and natural resources, and various onshore tourism programs.

Overall, 90% of cruise lines that choose Shanghai as a home-

Table 1. The study framework.

C1. Improving policies for cruise tourism industry
F1. Financial support policy and tax benefits policy
F2. Relaxing VISA policies with tourism landing permits and exit permissions
F3. Encouraging cooperation policy between cruise ports
F4. Deregulating casinos
C2. Strengthening of ports facilities and service
F5. Increasing the number of cruise terminals or berths
F6. Expanding leisure and shopping facilities at the terminal
F7. Improving transport links to port terminals
F8. Improving service relating to security checking and clearance
C3. Improvement and innovation of cruise tourism products
F9. Diversifying cruise lines
F10. Strengthening the inclusion of natural scenery and historical sites on shore
F11. Increasing shopping trips and local traditional entertainment activities
F12. Innovating cruise souvenirs and local delicacies
C4. Cultivation of cruise tourism talents
F13. Cultivating cruise staffs with international abilities
F14. Training cruise planners and tour guides
F15. Fostering talents for cruise port management

port are bound for Japan or South Korea (Wang et al., 2016). However, due to legal restrictions, such cruise lines cannot offer trips to international waters or trips without a predetermined destination. Effort must be made to diversify cruise lines. Moreover, promoting natural scenery and historical sites to tourists, developing shopping trips and local and traditional entertainment activities, and Innovating cruise souvenirs and local delicacies can also enhance the performance of Shanghai's cruise tourism industry.

5. Training Personnel for the Cruise Tourism Industry

The development of the cruise tourism industry requires numerous qualified workers. Sun et al. (2011) described a severe shortage of trained personnel for cruise trips in China. Myriad aspects must be considered when operating a cruise, including economics, management, transportation, hospitality, entertainment, and the knowledge of languages and cultures, all of which depend on professional knowledge. According to Terry (2011), cruise staff working directly with passengers must have excellent interpersonal skills, which includes the social responsibility of fulfilling work even under tremendous pressure. Chen (2016) illustrated the importance of cultivating cruise talent for developing the cruise tourism industry in Taiwan because service quality is a crucial aspect in the industry. According to Hobson (1993), the development of the cruise tourism industry also requires the sales channels of travel agencies. Cruise companies must cooperate with professional cruise committees and other training agencies to train their staff. Zhou and Shi (2013) suggested that strengthening talent cultivation and paying attention to the importance of the internship experience on cruises were necessary for developing Shanghai's cruise tourism industry.

Training cruise staff is a crucial factor in the development

of the cruise tourism industry in Shanghai. Various professionals are required to developing this industry, namely qualified cruise staff who can meet the needs of both domestic and foreign customers, cruise trip planning and promotional staff, and port managers.

III. METHODS

This chapter explains the procedures, frameworks, and methods used in this study in three parts: the framework of the factor analysis used in this study, the data gathered from questionnaires, and the fuzzy theory and the fuzzy method.

1. The Framework of Factor Analysis

Factors affecting the development of the cruise tourism industry fall into four categories: related improvement policies, port facilities and services, the innovation of cruise tourism products, and the cultivation of cruise tourism talent, as stated in the literature review. Furthermore, based on previous studies, the current study identified 15 factors, which are divided into four categories (Table 1).

In the first category, four crucial items have been identified for boosting the cruise tourism industry, namely providing financial support policies and tax benefit policies (Liu, 2011; Robles et al., 2015; Ye, 2016), relaxing visa policies with tourism landing permits and exit permissions (Wang et al., 2014; Yoo and Kim, 2016), encouraging cooperation policies between cruise ports (Pallis et al., 2014; Ye, 2016), and deregulating casinos (Yoo and Kim, 2016). In the second category, increasing the number of cruise terminals or berths (Lekakou et al., 2009; Papatheassis and Beckmann, 2011; Sun et al., 2014), expanding leisure and shopping facilities at terminals (Urbanyi-Popiołek, 2014; Satta et al., 2015), improving transportation links to port

terminals (Urbanyi-Popiołek, 2014; Satta et al., 2015; Yoo and Kim, 2016), and improving services related to security checks and clearances are all pivotal for developing the cruise tourism industry (Chen, 2016; Yoo and Kim, 2016). In the third category, diversifying cruise lines (Hwang and Han, 2014; Pallis et al., 2014), strengthening the inclusion of natural scenery and historical sites on shore (Brida et al., 2012; Toudert and Bringas-Rábago, 2016), increasing shopping trips and local and traditional entertainment activities (Urbanyi-Popiołek, 2014; Toudert and Bringas-Rábago, 2016), and innovating cruise souvenirs and local delicacies (Chen, 2016; Sanz-Blas and Buzova, 2016) are also valuable for promoting cruise tourism. The last category emphasizes the importance of talent education for the cruise tourism industry, including cultivating cruise staff who can work with international customers (Véronneau and Roy, 2009; Papatthanassis and Beckmann, 2011; Sun et al., 2011), training cruise planners and tour guides (Wu, 2016; Yoo and Kim, 2016) and fostering talent for cruise port management (Véronneau and Roy, 2009; Ye, 2016).

The questionnaire was based on the study framework with 15 key factors in the four categories, as shown in Table 1. The respondents were required to rank these factors from “very important” to “very unimportant” on a 7-point Likert scale.

2. Data Gathered from the Experts Questionnaire

The respondents were experts familiar with the cruise tourism industry. Nworie (2011) and Chen (2016) suggested that for a questionnaire to be designed for experts to answer, the number of experts should be between 10 and 18. Based on their suggestions, 16 respondents in different but related fields were chosen to complete the questionnaire. Of the respondents, four were directors from the government sector, namely the tourism administration bureau, the Shanghai Development and Reform Commission, and a municipal government; six were professors from a university or other research institutions; and six were professionals from the cruise tourism industry, namely the cruise port administrative organization, a cruise company, or a travel agency. All of the respondents were experienced.

3. Fuzzy Method

Zadeh (1965) presented the fuzzy set and proposed the membership function as the basic concept of fuzzy theory. Since 1965, fuzzy theory has undergone many changes. Fuzzy set theory has been widely used in academic and practical fields to solve multicriteria decision-making problems. The fuzzy method overcomes the subjectivity of decision-makers and linguistic variables to accurately reflect the judgment of experts. Many approaches to the solution processes with the fuzzy method exist. Gorzalczany (1987) presented interval-valued fuzzy sets, whereas Lee et al. (2016) developed an extended fuzzy-preference relation for normal triangular interval-valued fuzzy numbers and ranking algorithms.

Upon studying the cruise tourism industry, Wang et al. (2014) used the fuzzy analytic hierarchy process to analyze the key factors involved in choosing a cruise’s port of call, mainly using

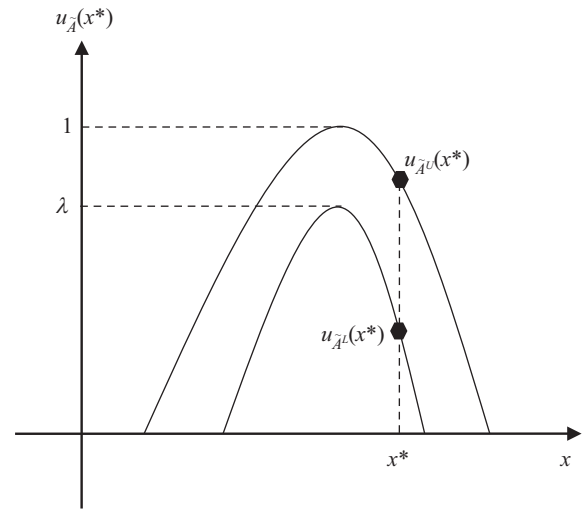


Fig. 1. Interval-valued fuzzy set \tilde{A} .

the triangular fuzzy numbers extent analysis method. Chen (2016) used the normal triangular fuzzy numbers to analyze the crucial aspects of the cruise tourism industry in Taiwan.

In this paper, key factors are ranked more accurately comparing with the traditional fuzzy numbers methods. All information collected from the questionnaires was treated as the interval-valued fuzzy numbers, which were applied to the extended fuzzy-preference relations and ranking algorithm by using an interval-valued fuzzy numbers approach (Lee et al. 2016). It is detailed as follows.

According to Gorzalczany (1987), an interval-valued fuzzy number is defined as

$$\begin{aligned} \tilde{A} &= \{x, [\mu_{\tilde{A}^l}(x), \mu_{\tilde{A}^u}(x)]\}, x \in (-\infty, \infty), \mu_{\tilde{A}^l}, \\ \mu_{\tilde{A}^u} &: (-\infty, \infty) \rightarrow [0, 1], \\ \mu_{\tilde{A}^l}(x) &\leq \mu_{\tilde{A}^u}(x), \forall x \in (-\infty, \infty), \\ \mu_{\tilde{A}}(x) &= [\mu_{\tilde{A}^l}(x), \mu_{\tilde{A}^u}(x)], x \in (-\infty, \infty), \end{aligned}$$

where $\mu_{\tilde{A}^l}(x)$ is the lower limit and the upper limit of the degree of membership. An interval-valued fuzzy number is shown in Fig. 1 as the degree of membership at x^* being within the interval $[\mu_{\tilde{A}^l}(x^*), \mu_{\tilde{A}^u}(x^*)]$.

Yao and Lin (2002) defined the triangular interval-valued fuzzy number \tilde{A} as represented by two fuzzy numbers $\tilde{A}_x^L = (a_1^L, a_2^L, a_3^L; \tilde{w}_A^L)$ and $\tilde{A}_x^U = (a_1^U, a_2^U, a_3^U; \tilde{w}_A^U)$

$$\tilde{A} = [\tilde{A}_x^L, \tilde{A}_x^U] = [(a_1^L, a_2^L, a_3^L; \tilde{w}_A^L), (a_1^U, a_2^U, a_3^U; \tilde{w}_A^U)]$$

satisfying that $a_1^U \leq a_1^L$, $a_3^L \leq a_3^U$, and $\tilde{w}_A^L \leq \tilde{w}_A^U$ where \tilde{w}_A^U and \tilde{w}_A^L are the heights of \tilde{A}_x^U and \tilde{A}_x^L . To facilitate computa-

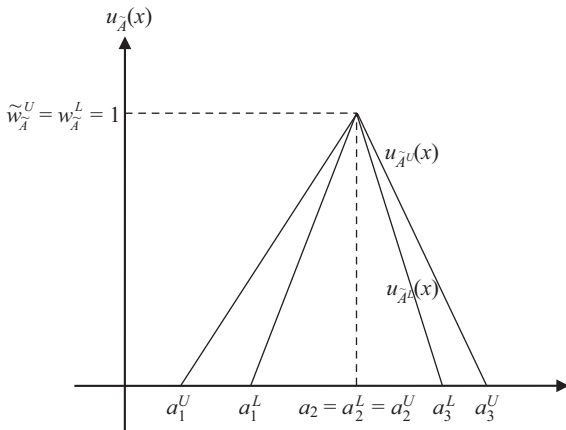


Fig. 2. A normal triangular interval-valued fuzzy number.

tion, a more restricted triangular interval-valued fuzzy number is adopted in real applications, where $a_2^L = a_2^U$ and $\tilde{w}_A^L = \tilde{w}_A^U = 1$. In this study, a formal definition is provided for this restricted triangular interval-valued fuzzy number, and when a triangular interval-valued fuzzy number happens to $a_2^L = a_2^U$ and $\tilde{w}_A^L = \tilde{w}_A^U = 1$, let $a_2 = a_2^L = a_2^U$. Subsequently, a normal triangular interval-valued fuzzy number A is represented by $A = (A^L, A^U) = ((a_1^L, a_2^L, a_3^L), (a_1^U, a_2^U, a_3^U)) = (a_1^U, a_1^L, a_2, a_3^L, a_3^U)$, as shown in Fig. 2.

Given the two normal triangular interval-valued fuzzy numbers A and B , the arithmetic operations of A and B are as follows (Hong and Lee, 2002; Chen and Chen, 2008):

- (1)
$$A \oplus B = (a_1^U, a_1^L, a_2, a_3^L, a_3^U) \oplus (b_1^U, b_1^L, b_2, b_3^L, b_3^U)$$

$$= (a_1^U + b_1^U, a_1^L + b_1^L, a_2 + b_2, a_3^L + b_3^L, a_3^U + b_3^U)$$
- (2)
$$A \ominus B = (a_1^U, a_1^L, a_2, a_3^L, a_3^U) \ominus (b_1^U, b_1^L, b_2, b_3^L, b_3^U)$$

$$= (a_1^U - b_1^U, a_1^L - b_1^L, a_2 - b_2, a_3^L - b_3^L, a_3^U - b_3^U)$$
- (3)
$$A \otimes B = (a_1^U, a_1^L, a_2, a_3^L, a_3^U) \otimes (b_1^U, b_1^L, b_2, b_3^L, b_3^U)$$

$$= (a_1^U \times b_1^U, a_1^L \times b_1^L, a_2 \times b_2, a_3^L \times b_3^L, a_3^U \times b_3^U)$$
- (4)
$$A \oslash B = (a_1^U, a_1^L, a_2, a_3^L, a_3^U) \oslash (b_1^U, b_1^L, b_2, b_3^L, b_3^U)$$

$$= (a_1^U / b_1^U, a_1^L / b_1^L, a_2 / b_2, a_3^L / b_3^L, a_3^U / b_3^U)$$

Regarding the extended fuzzy-preference relation, Lee et al. (2016) gave these definitions as follows:

An extended fuzzy-preference relation R on a normal triangular interval-valued fuzzy number is an extended fuzzy subset of the product of normal triangular interval-valued fuzzy numbers with the membership function $-\infty \leq \mu_R(A, B) \leq \infty$ being the preference degree of the normal triangular interval-valued

fuzzy number A over the number B . The preference relation R is reciprocal only if $\mu_R(A, B) = -\mu_R(B, A)$ for all normal triangular interval-valued fuzzy numbers A and B .

The preference relation R is transitive only if $\mu_R(A, B) \geq 0$ and $\mu_R(B, C) \geq 0$ implies that $\mu_R(A, C) \geq 0$ for all normal triangular interval-valued fuzzy numbers A, B , and C . The preference relation R is additive only if $\mu_R(A, C) = \mu_R(A, B) \oplus \mu_R(B, C)$ for normal triangular interval-valued fuzzy numbers A, B , and C . The preference relation R is a total ordering only if R is reciprocal, transitive, and additive.

Let A_m denote the triangular fuzzy number obtained by averaging the lower triangular fuzzy number and upper triangular fuzzy number of a normal triangular interval-valued fuzzy number $A = (A^L, A^R)$: $A_m = (A^L \oplus A^R) / 2$. For any normal triangular interval-valued fuzzy number A and B , we define the extended fuzzy-preference relation $R(A, B)$ by the membership function: $\mu_R(A, B) = \int_0^1 ((A \ominus B)_{m\alpha}^L + (A \ominus B)_{m\alpha}^U) / 2 d\alpha$. R is clearly reciprocal, additive, and transitive. If $R(A, B) = 0$, A and B have the same preference. If $R(A, B) > 0$, we prefer A to B , and vice versa.

In this study, the ranking algorithm is given as follows. Assume that m factors are under evaluation by n experts. Let the normal triangular interval-valued fuzzy number A_{ij} be the rating of the i -th factor under the j -th expert and the normal triangular interval-valued fuzzy number W_j be the weight of the j -th expert. We define the preference intensity function of one normal triangular interval-valued number A over another number B as follows:

$$Q(A, B) = \max\{\mu_R(A, B), 0\}.$$

Let J be the set of the positive criteria with each expert

$$J = \{1 \leq j \leq n \text{ and } j \text{ belongs to the positive criteria}\}$$

By positive criteria, we mean the larger their value is, the more critical the factor is. The advantage of the i -th factor under the j -th expert is given by

$$a_{ij} = \sum_{k \neq i} Q(W_j A_{ij}, W_j A_{kj}), j \in J \tag{1}$$

Likewise, we define the disadvantage of the i -th factor under the j -th expert given by

$$d_{ij} = \sum_{k \neq i} Q(W_j A_{kj}, W_j A_{ij}), j \in J \tag{2}$$

Both a_{ij} and d_{ij} are crisp numbers. The superiority of the i -th factor is given by

Table 2. Linguistic variables and their corresponding normal triangular interval-valued fuzzy numbers.

Very important (VI)	(9, 9.5, 10, 10, 10)
Important (I)	(7, 8, 9, 9.5, 10)
Medium important (MI)	(5, 6, 7, 8, 9)
Fair (F)	(3, 4, 5, 6, 7)
Medium unimportant (MU)	(1, 2, 3, 4, 5)
Unimportant (U)	(0, 0.5, 1, 2, 3)
Very unimportant (VU)	(0, 0, 0, 0.5, 1)

$$S_i = \sum_{j=1}^n a_{ij} \quad (3)$$

The inferiority of the i -th factor is given by

$$I_i = \sum_{j=1}^n d_{ij} \quad (4)$$

The composite index for the i -th factor is given by

$$C_i = \frac{S_i}{S_i + I_i} \quad (5)$$

According to the questionnaire, the significance of the 15 factors in the four categories is given by each expert through linguistic variables. The employed linguistic variables and their corresponding fuzzy numbers are shown in Table 2.

The evaluation process with the ranking algorithm is as follows:

- Step 1. Identify the evaluation expert's corresponding weight $W_j, j = 1, \dots, n$.
- Step 2. Build the matrix of the original data to show the significance of the four categories and 15 factors that were given by each expert.
- Step 3. Build the importance matrix $[A_{ij}]_{m \times n}$, where A_{ij} is a normal triangular interval-valued fuzzy number denoting the rating of the i -th factor under the j -th expert.
- Step 4. Calculate the advantage matrix $[a_{ij}]_{m \times n}$, where a_{ij} is a scalar denoting the advantage of the i -th factor under the j -th expert given by Eq. (1).
- Step 5. Calculate the disadvantage matrix $[d_{ij}]_{m \times n}$, where d_{ij} denotes which disadvantage of the i -th factor under the j -th expert is given by Eq. (2).
- Step 6. Obtain the superiority index S_i for the i -th factor given by Eq. (3).
- Step 7. Obtain the inferiority index I_i for the i -th factor given by Eq. (4).
- Step 8. Obtain the composite index C_i for each factor given by Eq. (5) and rank all factors according to the composite indices obtained.

Sixteen experts participated in this study. Every expert was considered equal; thus, the weight of each expert was the same. As a normal triangular interval-valued fuzzy number $w_j = (9, 9.5, 10, 10, 10)$. Subsequently, the matrices of the original data are shown in Table 3 and Appendix A. Appendix A shows the matrix of the original data using the corresponding normal triangular interval-valued fuzzy numbers. The importance matrix for the factors is shown in Appendix B. In this paper, before building the importance matrix $[A_{ij}]_{m \times n}$, each factor's fuzzy number is multiplied by the categories' fuzzy numbers to which it belongs. Subsequently, the product is multiplied by w_j to obtain A_{ij} . The advantages of the factors can be computed according to Eq. (1). The advantages of the factor under each expert are shown in Appendix C. For example, the fourth factor has an advantage of 128.88 under expert 1, but has no advantage under expert 5. Subsequently, according to Eq. (2), the disadvantages of the factors are computed. The disadvantages of the factors under each expert are shown in Appendix D. For example, the third factor has no disadvantage under expert 1 but has a disadvantage of 1440.19 under expert 2. The superiority index for each factor is obtained according to Eq. (3). The superiority indices for the factors are shown in the second column of Table 4. The inferiority index for each factor is obtained according to Eq. (4). The inferiority indices for the factors are shown in the third column of Table 4. Finally, the composite significance index for each factor is obtained based on Eq. (5). The composite significance indices for the factors are shown in the fourth column of Table 4. In the fourth column, the maximum composite significance indices is 0.9146, which indicates that the first factor is the most critical under evaluation.

Table 4 shows the superiority index, inferiority index, and composite significance index of the 15 key development factors. By comparing the composite significance index of each item, we obtained a ranking of 15 key development factors. Overall, the factors of financial support policies and tax benefit policies ranked highest with respect to all 15 key development factors. Therefore, these policies should be prioritized by the Shanghai cruise tourism industry. However, the factors of local delicacies and cruise souvenirs had the lowest ranking, meaning that these factors have less influence on the cruise tourism industry than the other 14 factors. This may be because most cruise passengers in Shanghai ports are homeport passengers, meaning that they are not highly attracted to local delicacies and cruise souvenirs.

The category for improving cruise tourism industry policies

IV. RESULTS AND FINDINGS

Table 3. The matrix of original data using linguistic variables.

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
C1	VI	VI	I	VI	VI	I	VI	VI	F	VI	VI	VI	VI	VI	VI	I
C2	VI	F	MI	MI	VI	I	VI	I	F	VI	VI	I	I	VI	I	MI
C3	MI	MI	VI	MI	I	MI	VI	MI	F	MI	MI	VI	I	I	I	VI
C4	I	I	MI	MI	MI	MI	I	I	I	I	VI	VI	I	I	MI	VI
F1	I	MI	MI	I	VI	I	I	VI	MI	VI	VI	VI	I	VI	VI	I
F2	I	I	I	I	VI	I	I	F	I	MI	VI	I	I	VI	I	VI
F3	VI	F	VI	VI	MI	I	I	I	I	MI	I	VI	MI	I	VI	I
F4	F	MU	I	I	F	F	MI	F	F	F	VI	F	F	MI	V	MI
F5	VI	VI	MI	VI	I	F	I	I	MI	I	I	VI	MI	F	I	F
F6	VI	F	MI	I	VI	MI	I	MI	I	VI	I	VI	I	I	I	F
F7	I	I	I	I	VI	I	I	I	MI	I	VI	VI	I	I	I	I
F8	MI	MI	VI	I	I	I	VI	F	I	I	MI	V	VI	I	VI	I
F9	VI	F	U	VI	VI	I	VI	VI	I	I	I	VI	I	I	I	I
F10	VI	VI	MI	V	MI	I	VI	MI	MI	MI	MI	VI	I	I	VI	I
F11	MI	MI	MI	VI	I	I	VI	F	MI	MI	MI	VI	VI	MI	I	MI
F12	F	I	MI	I	I	MI	I	MU	F	MI	MI	I	MI	MI	I	MU
F13	I	I	MI	VI	I	VI	VI	VI	I	I	VI	VI	I	I	MI	I
F14	VI	MI	MI	VI	I	MI	I	MI	I	MI	I	VI	I	I	F	I
F15	MI	MI	F	I	I	MI	I	MI	I	I	MI	VI	I	VI	MI	F

Table 4. Three types of indexes and the final ranking of each factor.

Factor	Superiority index	Inferiority index	Composite significance index	Rank
Factor 1	35194.34	3287.06	0.9146	1
Factor 2	31996.70	5831.61	0.8458	2
Factor 3	30145.58	7801.03	0.7944	3
Factor 4	10787.58	38311.70	0.2197	14
Factor 5	16756.55	22205.05	0.4301	9
Factor 6	18851.17	17244.83	0.5223	7
Factor 7	22095.53	9978.64	0.6889	4
Factor 8	18549.75	15841.38	0.5394	6
Factor 9	11787.38	22370.22	0.3451	12
Factor 10	14880.70	20450.69	0.4212	10
Factor 11	11369.83	26202.31	0.3026	13
Factor 12	6627.55	40137.38	0.1417	15
Factor 13	25121.09	13053.89	0.6581	5
Factor 14	17818.88	20170.19	0.4691	8
Factor 15	14156.25	25550.69	0.3565	11

is the most crucial for the Shanghai cruise tourism industry because factors one to three were ranked in the top three of all 15 key development factors. Except for financial support policies and tax benefits policies, the results revealed that relaxed visa policies and policies encouraging port cooperation are crucial to the tourism industry and that these matters should be addressed early. However, deregulating casinos ranked 14th among the key development factors, which means that the operation of cruise casinos, which is banned only in domestic Chinese waters, has a weaker influence than the other 13 factors.

Because the three factors in this category were ranked in the top 50%, the category of strengthening port facilities and services is also relatively key for cruise tourism. The factor of transportation links had the fourth highest ranking of all 15 key development factors and the highest ranking of the four factors in this category. Therefore, transportation links to cruise terminals should be improved earlier than the other three factors in this category. The Wu Songkou Cruise Terminal is the main cruise terminal in Shanghai, which is far from the city center, airport, and railway stations. Although the Shanghai International

Customer Center Terminal is near to the downtown, it has no subway access. The factor with the lowest ranking among these four items was building new cruise terminals and berths. Therefore, the problem of expanding terminals and berths can be solved after solving the other three matters in this category. Two cruise terminals with four berths currently operate in Shanghai, which can accommodate ships and passengers in the short term.

Regarding the category of the improvement and innovation of cruise tourism products, the four factors were ranked near the bottom of all 15 key development factors. Therefore, these factors can be developed relatively late. Because the Chinese cruise tourism industry is still in its infancy, most cruise passengers pay more attention to activity on board than to that on shore.

The last category relates to the education of talent, with the three associated factors ranked and separated by large gaps. The factor of cultivating cruise staff was ranked fifth among all 15 key development factors and was the highest of the three items in this category. Therefore, cultivating cruise staff should be prioritized among the three factors. The demand in Shanghai for cruise staff is presumably higher than that for cruise planning tour guides and port management talent.

V. CONCLUSION

Because the demand for the cruise tourism industry in China is growing rapidly, the government and cruise tourism operators must accelerate its development in Shanghai. The cruise tourism industry involves multiple development factors, some of which should be prioritized. This study examined four categories, comprising 15 key development factors, and used the interval-valued fuzzy method to analyze them. Normal triangular interval-valued fuzzy numbers grasp vagueness more precisely than do triangular fuzzy numbers, a method used in related studies. The results of this study can assist the government and cruise tourism operators to identify priorities for developing Shanghai’s cruise tourism industry.

Future research should examine the performance of the 15 key development factors in greater detail to improve understanding of the cruise tourism industry. Moreover, the analysis of the key development factors should consider the differences between home ports and ports of call.

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Appendix A. The matrix of original data using corresponding normal triangular interval-valued fuzzy numbers.

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
C1	(9,9.5,10,10,10)	(9,9.5,10,10,10)	(7,8,9,9.5,10)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(9,9.5,10,10,10)	(9,9.5,10,10,10)	(7,8,9,9.5,10)
C2	(9,9.5,10,10,10)	(3,4,5,6,7)	(5,6,7,8,9)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(9,9.5,10,10,10)	(7,8,9,9.5,10)	(5,6,7,8,9)
C3	(5,6,7,8,9)	(5,6,7,8,9)	(9,9.5,10,10,10)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(7,8,9,9.5,10)	(7,8,9,9.5,10)	(9,9.5,10,10,10)
C4	(7,8,9,9.5,10)	(7,8,9,9.5,10)	(5,6,7,8,9)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(7,8,9,9.5,10)	(5,6,7,8,9)	(9,9.5,10,10,10)
F1	(7,8,9,9.5,10)	(5,6,7,8,9)	(5,6,7,8,9)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(9,9.5,10,10,10)	(9,9.5,10,10,10)	(7,8,9,9.5,10)
F2	(7,8,9,9.5,10)	(7,8,9,9.5,10)	(7,8,9,9.5,10)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(9,9.5,10,10,10)	(7,8,9,9.5,10)	(9,9.5,10,10,10)
F3	(9,9.5,10,10,10)	(3,4,5,6,7)	(9,9.5,10,10,10)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(7,8,9,9.5,10)	(9,9.5,10,10,10)	(7,8,9,9.5,10)
F4	(3,4,5,6,7)	(1,2,3,4,5)	(7,8,9,9.5,10)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(5,6,7,8,9)	(7,8,9,9.5,10)	(5,6,7,8,9)
F5	(9,9.5,10,10,10)	(9,9.5,10,10,10)	(5,6,7,8,9)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(3,4,5,6,7)	(7,8,9,9.5,10)	(3,4,5,6,7)
F6	(9,9.5,10,10,10)	(3,4,5,6,7)	(5,6,7,8,9)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(7,8,9,9.5,10)	(7,8,9,9.5,10)	(3,4,5,6,7)
F7	(7,8,9,9.5,10)	(7,8,9,9.5,10)	(7,8,9,9.5,10)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(7,8,9,9.5,10)	(7,8,9,9.5,10)	(7,8,9,9.5,10)
F8	(5,6,7,8,9)	(5,6,7,8,9)	(9,9.5,10,10,10)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(7,8,9,9.5,10)	(9,9.5,10,10,10)	(7,8,9,9.5,10)
F9	(9,9.5,10,10,10)	(3,4,5,6,7)	(0,0.5,1,2,3)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(7,8,9,9.5,10)	(7,8,9,9.5,10)	(7,8,9,9.5,10)
F10	(9,9.5,10,10,10)	(9,9.5,10,10,10)	(5,6,7,8,9)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(7,8,9,9.5,10)	(9,9.5,10,10,10)	(7,8,9,9.5,10)
F11	(5,6,7,8,9)	(5,6,7,8,9)	(5,6,7,8,9)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(5,6,7,8,9)	(7,8,9,9.5,10)	(5,6,7,8,9)
F12	(3,4,5,6,7)	(7,8,9,9.5,10)	(5,6,7,8,9)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(5,6,7,8,9)	(7,8,9,9.5,10)	(1,2,3,4,5)
F13	(7,8,9,9.5,10)	(7,8,9,9.5,10)	(5,6,7,8,9)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(7,8,9,9.5,10)	(5,6,7,8,9)	(7,8,9,9.5,10)
F14	(9,9.5,10,10,10)	(5,6,7,8,9)	(5,6,7,8,9)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(7,8,9,9.5,10)	(3,4,5,6,7)	(7,8,9,9.5,10)
F15	(5,6,7,8,9)	(5,6,7,8,9)	(3,4,5,6,7)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(9,9.5,10,10,10)	(5,6,7,8,9)	(3,4,5,6,7)

Appendix B. The importance matrix for the factors

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
F1	(567, 722, 900, 950,1000)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(441, 608, 810, 902.5,1000)
F2	(567, 722, 900, 950,1000)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(567, 722, 900, 950,1000)

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
F3	(729,857.375,1000, 1000,1000)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(441, 608, 810, 902.5,1000)
F4	(243, 361, 500, 600,700)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(315, 456, 630, 760,900)
F5	(729,857.375,1000, 1000,1000)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(135,228,350,480,630)
F6	(729,857.375,1000, 1000,1000)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(135,228,350,480,630)
F7	(567, 722, 900, 950,1000)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(315, 456, 630, 760,900)
F8	(405, 541.5, 700, 800,900)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(315, 456, 630, 760,900)
F9	(405, 541.5, 700, 800,900)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(567, 722, 900, 950,1000)
F10	(405, 541.5, 700, 800,900)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(567, 722, 900, 950,1000)
F11	(225,342,490,640,810)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(405, 541.5, 700, 800,900)
F12	(135,228,350,480,630)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(81,180.5,300,400,500)
F13	(441,608,810,902.5,1000)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(567, 722, 900, 950,1000)
F14	(567, 722, 900, 950,1000)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(567, 722, 900, 950,1000)
F15	(315, 456, 630, 760,900)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	(243, 361, 500, 600,700)

Appendix C. The advantage matrix for the factors

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
F1	2059.50	2440.00	1247.48	1647.06	2674.45	2200.94	335.94	4982.34	1082.00	3636.61	2591.59	1101.77	1579.50	2551.17	2911.36	2152.63
F2	2059.50	4783.75	2860.48	1647.06	2674.45	2200.94	335.94	438.38	2299.50	867.75	2591.59	447.81	1579.50	2551.17	1696.88	2962.00
F3	3180.56	720.81	3993.61	2954.97	440.56	2200.94	335.94	3674.44	2299.50	867.75	1657.38	1101.77	316.69	1336.69	2911.36	2152.63
F4	128.88	34.81	2860.48	1647.06	0.00	0.00	0.00	438.38	98.75	0.00	2591.59	0.00	0.00	316.69	1696.88	974.06
F5	3180.56	974.19	516.98	1647.06	1646.81	0.00	335.94	2703.19	98.75	2422.13	1619.88	447.81	130.88	0.00	968.44	63.94
F6	3180.56	0.00	516.98	837.69	2674.45	712.25	335.94	1214.50	616.25	3636.61	1619.88	447.81	689.19	1336.69	968.44	63.94
F7	2059.50	507.69	1247.48	837.69	2674.45	2200.94	335.94	2703.19	98.75	2422.13	2591.59	447.81	689.19	1336.69	968.44	974.06
F8	760.13	162.69	1742.98	837.69	1646.81	2200.94	1363.58	310.50	616.25	2422.13	613.00	285.94	1579.50	1336.69	1696.88	974.06
F9	621.88	110.69	0.00	82.13	1372.44	527.88	1100.19	1468.38	420.00	349.38	248.63	933.50	545.69	545.69	844.56	2616.38
F10	760.13	2440.00	1742.98	0.00	130.88	712.25	1363.58	484.00	98.75	9.13	0.00	1101.77	689.19	689.19	1696.88	2962.00
F11	147.13	784.69	1742.98	185.81	999.31	712.25	1363.58	138.00	98.75	9.13	0.00	1101.77	1579.50	130.88	968.44	1407.63
F12	0.00	1758.69	1742.98	0.00	999.31	103.50	335.94	0.00	0.00	9.13	0.00	447.81	130.88	130.88	968.44	0.00
F13	1412.00	3650.63	516.98	185.81	130.88	1269.69	335.94	3674.44	4160.25	1612.75	2591.59	1101.77	689.19	689.19	138.00	2962.00
F14	2059.50	1758.69	516.98	185.81	130.88	103.50	93.13	1214.50	4160.25	496.13	1657.38	1101.77	689.19	689.19	0.00	2962.00
F15	512.38	1758.69	240.98	0.00	130.88	103.50	93.13	1214.50	4160.25	1612.75	613.00	1101.77	689.19	1336.69	138.00	450.56

Appendix D. The disadvantage matrix for the factors

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16
F1	280.27	267.19	793.88	93.42	0.00	0.00	373.69	0.00	1073.94	0.00	0.00	0.00	0.00	0.00	0.00	404.69
F2	280.27	0.00	80.94	93.42	0.00	0.00	373.69	2360.48	465.19	1243.41	0.00	747.38	0.00	0.00	186.84	0.00
F3	0.00	1440.19	0.00	0.00	1778.38	0.00	373.69	93.42	465.19	1243.41	467.11	0.00	1348.13	186.84	0.00	404.69
F4	3852.77	3646.38	80.94	93.42	4230.00	2727.50	2648.69	2360.48	2160.69	3267.84	0.00	5802.69	3923.63	1777.78	186.84	1552.06
F5	0.00	1168.56	1889.63	93.42	373.69	2727.50	373.69	336.23	2160.69	186.84	492.11	747.38	2091.38	4353.28	672.47	4538.19
F6	0.00	4133.75	1889.63	498.11	0.00	837.25	373.69	1173.48	1384.44	0.00	485.86	747.38	323.75	186.84	672.47	4538.19
F7	280.27	1866.44	793.88	498.11	0.00	0.00	373.69	336.23	2160.69	186.84	0.00	747.38	323.75	186.84	672.47	1552.06
F8	1591.83	2815.19	360.31	498.11	373.69	0.00	0.00	2871.98	1384.44	186.84	2033.67	1799.56	0.00	186.84	186.84	1552.06
F9	1591.83	2815.19	7057.41	1243.11	373.69	837.25	0.00	801.86	1384.44	1800.84	2714.98	0.00	323.75	753.41	672.47	0.00
F10	1591.83	267.19	360.31	1986.36	2397.75	837.25	0.00	2269.23	2160.69	3140.09	4175.98	0.00	323.75	753.41	186.84	0.00
F11	3734.14	1367.19	360.31	1243.11	940.25	837.25	0.00	3993.23	2160.69	3140.09	4175.98	0.00	0.00	2521.03	672.47	1056.56
F12	5657.02	514.94	360.31	1986.36	940.25	2054.75	373.69	5925.23	3543.19	3140.09	4175.98	747.38	2091.38	2521.03	672.47	5433.31
F13	846.83	80.94	1889.63	1243.11	2397.75	465.63	373.69	93.42	0.00	591.53	0.00	0.00	323.75	753.41	3994.22	0.00
F14	280.27	514.94	1889.63	1243.11	2397.75	2054.75	1344.94	1173.48	0.00	1800.84	467.11	0.00	323.75	753.41	5926.22	0.00
F15	2273.14	514.94	3683.63	1986.36	2397.75	2054.75	1344.94	1173.48	0.00	591.53	2033.67	0.00	323.75	186.84	3994.22	2991.69

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