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A fuzzy-based framework for evaluating cruise ports of call

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Abstract: The cruise industry plays a pivotal role in the development of the tourism sector of nations. Yet, policies to attract cruise liners to call at a cruise terminal are still questionable. To fill literature gaps, the purpose of the study is to discuss the selection of cruise carriers (CCs) at ports of call. Based on relevant research and the operating features of cruise ships, the port selection factors (PSFs) that CC consider for port calls are firstly explored. A demand gap model based on a fuzzy Analytic Hierarchical Process (AHP) is then proposed to evaluate perceived differences on PSFs between port companies (PCs) and CCs. Finally, for a practical application, the PMP Exploitation Joint Stock Company (PMC) and its customers (i.e., CCs) in the BRVT port were surveyed to validate the model. The result shows that “port travel features” and “port management” concern CCs the most. Furthermore, currently, the BRVT port is facing two significant gaps, including: “health and sanitation conditions of the local population” (positive gap) and “existence of modern tourist centers” (negative gap). This study may provide useful information for port authorities to suggest practical policies in developing its cruise businesses. Besides, the sample size is a research limitation; thus, future research should extend the number of respondents for better policies.

1 Introduction

The cruise industry has proliferated worldwide at the beginning of 20th century [1]. Initially, it was very popular in North America and a part of Europe and dramatically shifted to Asian countries in the last few decades [2-4]. As a result, global tourism revenue, including the contribution from the tourism industry in Asian areas, grew comparatively rapidly at the end of the 2000s. This also led to rapid growth of the global cruise industry.

Along with the quick growth of the cruise sector, the income of cruise lines and ports also surged aftermath [5]. Consequently, port cities and/or nearby tourist attractions have experienced a significant economic impact. It is noteworthy that there are two types of ports: the “homeport” and the “port of call”. The former refers to the port that is the starting, or ending, point for a cruise, or even both these points [6-8]. The latter is used in reference to any port where a cruise stops for a short time when it is visiting several places [4,9,10]. These types of ports generate revenues for cruise liners and port companies.

Undoubtedly, port operations are highly complex, especially at the port of call. Such a process may enable the development of port to attract tourist ships. It has been argued that enhancing cruise port operations is essential for cruise carriers to select ports of call. Martínez Moya and Feo Valero [11] found that environmental and cultural treasures of the port, such as facilities, accessibility, security, infrastructure, and provisioning (local supply of foods, drinks, and freshwater), port charges (dockage fees, etc.) are main factors for the port of call. Kodzi and Saeed [12] postulated the importance of critical factors, such as port connectivity, tourism infrastructure, safety, security, city travel services, and public transportation networks for the port of call from the cruise's perspective. Nonetheless, to the best of the authors' knowledge, no single previous study has assessed the PSFs from the port companies' point of view.

The vast majority of past studies, when assessing crucial PSFs, often base on unilateral perspectives of port stakeholders, such as cruise liners [13], travel agencies [14], or cruise brokers [15]. So, proposed solutions did not reflect the requirements of port companies, which are also an imperative port stakeholder. It could be said that the determination of the demand gap, which is defined as the discrepancy between cruise liners and port companies in terms of PSFs, is necessary to appeal to more cruise carriers in the context of severe competition in the cruise industry. Yet the determination of the demand gap in previous research is rarely addressed. It can be argued that the demand gap guides port companies to re-allocate scarce resources optimally. Thanks to that, port operations might be improved to maximize cruise carriers' requirements, thereby encouraging them to elect an appropriate port to call.

Moreover, in practice, the determination of critical PSFs for the port of call is basically MCDM (multiple criteria decision-making) problem [5,16,17]. The fuzzy AHP (Analytic Hierarchy Process) is arguably the most popular method applied to solve multifaced issues, especially under the ambiguous, uncertain judgment environment [18]. Its major

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advantage is to address many complex decision-making problems with a simple computational procedure. Accordingly, the application of fuzzy AHP might be the theoretical contribution for MCDM research.

The purpose of the study is to assess the selection of ports of calls for cruise carriers. Unlike prior studies, this article surveyed the cruise carriers in the PM Vietnam Cruise Port (PMP) and the PMP Exploitation Joint Stock Company (PMC) as an empirical study. From the relevant literature and cruise ship operations, the current article first investigated PSFs that cruise carriers consider when electing a port to call. Next, the fuzzy AHP method was adopted to estimate PSFs' weights from the viewpoint of CCs and PCs. Finally, a demand gap model (DGM) was proposed to assess the perceived difference on PSFs between CCs and PCs. From that, PCs can make managerial policies to boost their ports' operations, and attract more CCs.

The structure of the paper is as follows: Sections 2 and 3 examine PSFs in the cruise industry and the research methodology, respectively. Section 4 then presents research findings. Lastly, we offer conclusions, acknowledge the study's limitations, and propose directions for future research.

2 Literature reviews

It has been argued that most prior literature pays most attention to factors of port selection based on the demand of cruise liners, passengers and travel agents [7,12,19]. In the early phase of the cruise-service development, some studies were performed to identify critical factors impacting the port of call. For example, Demirel and Yucenur [20] found that there are two groups of PSFs, including cruise terminal facilities and local characteristics. More specifically, the former comprises berthing facilities, port fees, maritime rescue systems, oil water supply facilities, passenger service centres, cruise terminal concession policy, and political stability. Meanwhile, the latter embraces the natural environment at ports, important historical sites, cultural and natural attractions, and convenient transportation. Among these, traffic at the cruise port, the local natural environment, and government policies are illustrated to have the largest effect size on the port of call. On the other hand, competition among cruise ports tends to focus on understanding the services offered by the port to cruise liners and passengers, as well as comprehending the life cycle of travelers at the port of call and the marketing strategies employed. According to Brida, et al. [3], there are 8 key factors considered when selecting the port of call from the cruise ship associations' viewpoint. They are natural and cultural assets, port facilities, the distance between the home port or the departure port and the next port, port security, port infrastructure, material supply replenishment, port expenses, and market sales.

Some research on cruise tourism in East Asia stressed the significance of PSFs, for instance, 24-hours tourism service centres, logistic services, special government units, as well as planning and development resources to attract CCs for a port of call. According to Wang, et al. [21], the port transportation is concerned by CCs to select a port of call. Several studies also suggest that the traffic congestion problem at cruise ports can be overcome by multimodal transportation and improving infrastructure to develop cruise tourism. It is widely admitted that this solution might help PCs avoid unnecessary competition with some larger ports outside the region in attracting international cruise operators.

Past studies also accentuated the importance of physical appearance and cultural qualities of the port location in selecting the port of call from the cruise liners' viewpoint [22,23]. Besides, Sanz-Blas, et al. [10] posited that reputation, and awareness of the cruise port are very effective and important factors for the cruise passenger to visit a port. Thus, these two factors are argued to have influence the port of call. Tseng and Yip [24] studied about the Magong port development of international cruise tourism with the help of the Taiwan Port Corporation. By surveying the Taiwan cruise companies, shipping agencies and travel agencies, they found that the local government should center on local cultural activities, natural landscape, and the transport connectivity to attract cruise carriers. Moreover, James, et al. [25] argued that the development of berthing facilities, the cost of the cruise terminal, and the effect of the weather positively impact the selection of CCs for a port of call. On top of that, some features of CPs (i.e., port infrastructure, services for cruise passengers, and the political and regulatory framework) impact CCs' decisions.

Lekakou, et al. [8] also postulated that the fruitful partnership between cruise companies and ports is an essential factor for cruise liners in selecting a port of call. It is explained that such a relationship helps improve port marketing communications and the local economy. Besides, a sufficient source market, the berthing wharf, and dedicated facilities are noticed by cruise carriers [26]. Other studies also argued that incentive schemes provided by port governments are crucial factors for CCs in calling a port [2]. Thus, these factors are asserted to affect the competitiveness of cruise ports. Kodzi and Saeed [12] demonstrated that service provided from the waterside area and landside area, and service quality are the basic requirements that CCs demand for the port of call. From the result, it can be confirmed that port of call quality may play a vital role in meeting customer satisfaction, and in turn, affecting their intention to revisit port cities.

According to the above literature review, it has been argued that most previous literature on PFSs has taken a unilateral perspective, focusing on cruise operators, travel agents, and passengers. Hence, this paper fills this literature gap by evaluating PSFs for the port of call from the viewpoint of CCs and PCs.

3 Research method

3.1 Research framework

The purpose of this research is to assess PSFs of cruise carriers. In doing so, the research framework is shown in Figure 1. This research first bases on the characteristics of the cruise operating and related literature to create PSFs for cruise carriers. Secondly, a fuzzy AHP is then adopted to weight the PSFs from the viewpoint of CCs and PCs. Next, the DMG based on those weights is established. Improved policies are ultimately proposed to enhance port companies' operations and attract more cruise carriers.

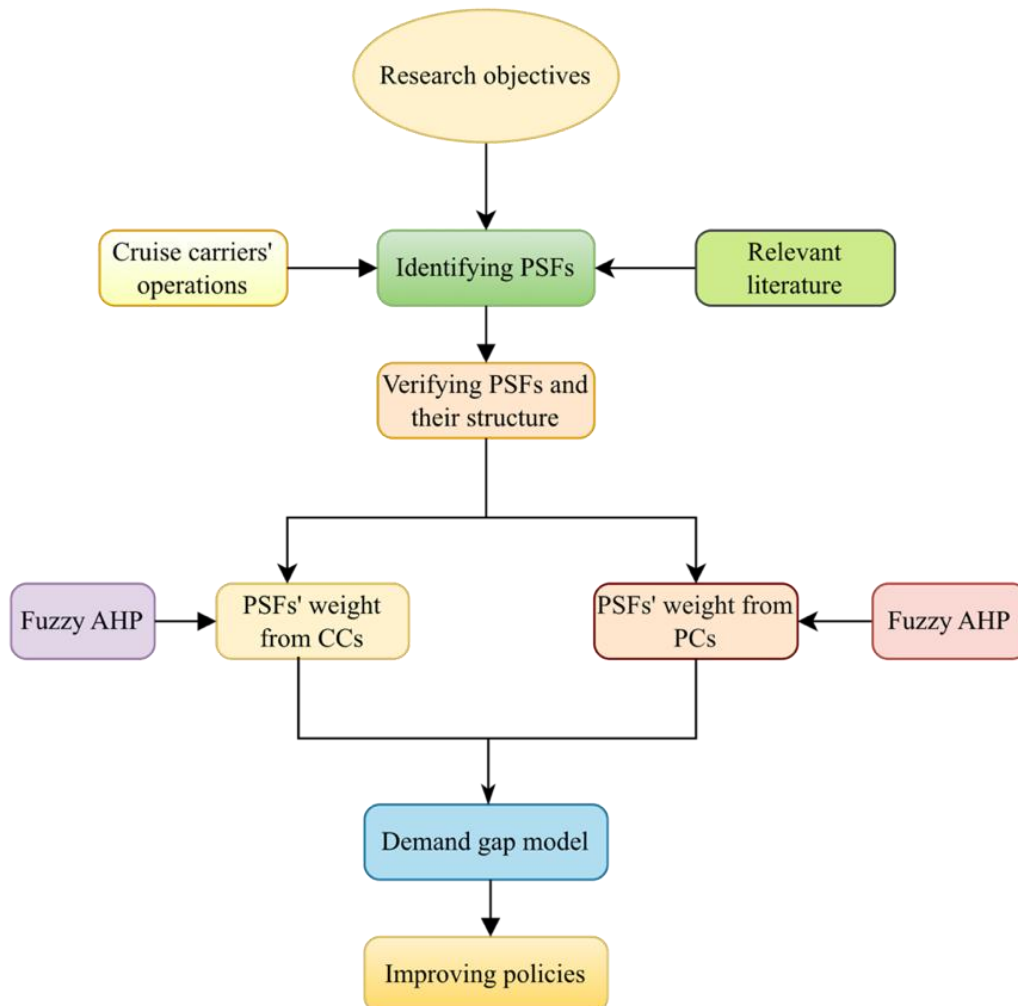


Figure 1 Research framework

3.2 Establishment of cruise port selection factors

From the operational features of CCs and the relevant literature, sixteen PSFs are generated, as follows:

(1) Port environment:

The port's geographical location is a critical criterion for attracting cruise carriers as a port of call. In addition, the local city image, which is represented by the culture, food, languages, historical, and attractive places, is argued to be an imperative element for cruise carriers to select the port of call. Also, political factors are crucial for selecting the port of call.

(2) Port inland transportation:

For the large cruise market, the convenience of port traffic is crucial. Tourists use convenient transportation to travel to cultural sites and downtown for sightseeing. They also spend time in metropolitan areas before and after sailing.

(3) Port travel features:

The overall attractiveness of the cruise port is likewise reflected by the adequacy of tourist interest and landmarks. Additionally, different cruise ports, and different shore excursions are chiefly dependent on historical, geographical, social, and cultural aspects.

(4) Port operations management:

For cruise operators, a sound policy, such as reasonable taxes and port fees, can attract them to berth. Further, visa-free provision, the convenience of customs, immigration control and quarantine (CIQ), and the rescue system are the main factors impacting the port of call.

Thanks to such definitions, the paper created a hierarchical structure for PSFs. Moreover, five practical industrial panels from CCs and PCs were invited to revise PSFs to ensure that they were understandable for the official interview. Moreover, the interdependencies among PSFs were verified. As a result, the official hierarchy structure of cruise PSFs is seen in Table 1, including four constructs and 16 PSFs.

Table 1 The hierarchy structure of cruise PSFs

Layer1: Constructs	Layer 2: Cruise PSFs		Sources
Port environment (PE)	PE1	Port location	[7,12]
	PE2	Health and sanitation conditions of the local population	[15,25]
	PE3	Reputation and image of the local city	[14,19]
	PE4	Political stability	[6,24]
Port inland transportation (PT)	PT1	Port accessibility	[2,4]
	PT2	Availability of inland transport systems	[2,23]
	PT3	Proximity international airports	[3,20]
	PT4	Frequency of flights and planning of flight routes	[12,21]
Port travel features (PF)	PF1	Variety of land-based tourism opportunities	[4,23]
	PF2	Availability of local historic landmarks	[2,19]
	PF3	Existence of modern tourist centers	[14,19]
	PF4	Hosting of large-scale local entertainment events	[4,6]
Port operations management (PM)	PM1	Visa-free access for cruise passengers	[4,6,19]
	PM2	Efficiency of customs, immigration control, and quarantine procedures (CIQ)	[2,19]
	PM3	Incentive programs for cruise ships to dock at the port	[6,24]
	PM4	Specifications for maritime rescue systems	[2,4]

3.3 Data collection

Because of using the fuzzy AHP method to estimate PSFs' weights, a pair-wise comparison questionnaire developed by Saaty and Tavana [27] was drafted to capture the perception on PSFs from the perspectives of CCs and PCs. Based on Table 1, we developed a survey questionnaire comprising four constructs and 16 PSFs.

Based on the assistance from the VNCC port government, the paper elected six cruise liners with experienced cruise businesses (i.e., Royal Caribbean International, Princess Cruise, Holland America Lines, Celebrity Cruise, Norwegian Cruise Lines, Carnival Cruise Lines) to answer the CCs' expert questionnaires. Meanwhile, 10 senior employees from PMC were singled out to fill out the PCs' expert questionnaires. As a result, we had 24 respondents in total. Further, for verifying the validation and reliability of the surveys, responses were tested by the Consistency Index (CI) and Consistency Ratio (CR), as follows:

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (1)$$

and:

$$CR = \frac{CI}{RI} \quad (2)$$

Where: $\lambda_{\max}$ is the maximum eigenvalue for individual pairwise comparison matrixes (IPCMs) while n is the number of elements in IPCMs. Besides, RI is a randomized index shown in Table 2 [27]. In practice, it is suggested that the $CR \leq 0.1$ is an acceptable range. In this paper, the software package "eigen ()" in RStudio was first used to find $\lambda_{\max}$.

Then CI and CR were obtained by Equations (1) and (2). Consequently, several samples' CI or CR were greater than 0.1, thus corresponding respondents were asked again to revise their responses until the CI and CR tests were fitted.

Table 2 The randomized index (RI) for the consistency test

<i>n</i>	3	4	5	6	7	8	9	10	11	12
RI	0.58	0.882	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48

The profiles of the sample, shown in Table 3, demonstrate that all respondents from CCs and PCs have at least five years of working experience in the cruise business. Besides, over half of the subjects have managerial positions (8/17 for CCs and 8/11 for PCs). Note, the high level of qualifications of the respondents endorses the reliability of the survey.

Table 3 The profile of respondents in the VNCC case

Features	Range	CCs		PCs	
		Frequency	%	Frequency	%
Age	30-40	4	23.53	3	27.27
	41-50	7	41.18	6	54.55
	Over 50	6	35.29	2	18.18
Education	Professional high school	4	23.53	1	9.09
	Bachelor	8	47.06	7	63.64
	Master or above	5	29.41	3	27.27
Seniority	5~10	6	35.29	2	18.18
	11~16	7	41.18	6	54.55
	Over 16	4	23.53	3	27.27
Job title	Senior staff	9	52.94	5	45.45
	Manager	5	29.41	4	36.36
	President/General Director	3	17.65	2	18.18

3.4 The weights of the PSFs

To estimate the weight of the PSFs, this paper surveyed 17 respondents from CCs and 11 from PCs. To explain how to use fuzzy AHP, this paper deployed the PE constructs (including PE1, PE2, PE3, and PE4) from CCs' responses. Note that there are 17 responses from CCs.

3.4.1 Combination of fuzzy positive reciprocal matrix (FPRM)

Assume that the matrix $\tilde{A}$ is a combined fuzzy matrix with n criteria (i.e., PSFs) as (3):

$$\tilde{A} = [\tilde{a}_{ij}]_{n \times n} = \begin{bmatrix} 1 & \tilde{a}_{12} & \dots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \dots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \dots & 1 \end{bmatrix} \quad (3)$$

Where: element $\tilde{a}_{ij}$ is triangular fuzzy numbers (TFNs) with parameters:

$$\tilde{a}_{ij} = \begin{cases} [l_{ij}, m_{ij}, u_{ij}], & \text{if } i > j \\ [1, 1, 1], & \text{if } i = j \\ [\frac{1}{u_{ji}}, \frac{1}{m_{ji}}, \frac{1}{l_{ji}}], & \text{if } i < j \end{cases}.$$

From m respondents in the sample data, then we have m individual matrixes. Such m matrixes can be combined to generate the fuzzy matrix $\tilde{A}$ with elements $\tilde{a}_{ij}$ as:

$$\tilde{a}_{ij} = [l_{ij}, m_{ij}, u_{ij}] = \left[\min_{1 \leq k \leq m} \{a_{ij}^{(k)}\}, \left(\prod_{k=1}^m a_{ij}^{(k)} \right)^{1/m}, \max_{1 \leq k \leq m} \{a_{ij}^{(k)}\} \right] \quad (4)$$

$$i = 1, 2, \dots, n, \quad j = 1, 2, \dots, n \quad \text{and} \quad k = 1, 2, \dots, m.$$

For the sample data of the PE construct, we obtained 17 matrices. Thanks to Equation (4), the FPRM (termed $\tilde{A}'$) can be formed as:

$$\tilde{A}' = \begin{bmatrix} [1.000, 1.000, 1.000] & [0.111, 0.182, 4.000] & [0.333, 0.362, 0.500] & [0.143, 0.333, 0.500] \\ [0.250, 5.499, 9.000] & [1.000, 1.000, 1.000] & [0.250, 0.255, 0.500] & [0.333, 0.345, 1.000] \\ [2.000, 2.765, 6.000] & [2.000, 3.927, 4.000] & [1.000, 1.000, 1.000] & [0.500, 0.708, 1.748] \\ [2.000, 3.007, 7.000] & [1.000, 2.897, 3.000] & [0.572, 1.413, 2.000] & [1.000, 1.000, 1.000] \end{bmatrix}$$

3.4.2 Crisp positive reciprocal matrix (CPRM)

The present paper uses geometric mean to defuzzify the $\tilde{A} = [\tilde{a}_{ij}]_{n \times n}$ into CPRM $A = [a_{ij}]_{n \times n}$. In doing so, the fuzzy element $\tilde{a}_{ij} = [l_{ij}, m_{ij}, u_{ij}]$ in $\tilde{A}$ is defuzzified adopting the formula:

$$a_{ij} = \sqrt[4]{l_{ij} \cdot 2m_{ij} \cdot u_{ij}}, \quad i = 1, 2, \dots, n, \quad j = 1, 2, \dots, n \quad (5)$$

Revert to the example, Equation (5) is used to defuzzify the matrix $\tilde{A}'$:

$$A' = \begin{bmatrix} 1.0000 & 0.3482 & 0.3843 & 0.2981 \\ 2.8720 & 1.0000 & 0.3001 & 0.4464 \\ 2.6025 & 3.3328 & 1.0000 & 0.8134 \\ 3.3543 & 2.2400 & 1.2294 & 1.0000 \end{bmatrix}$$

3.4.3 The PSFs' weights

According to Saaty and Tavana [27], the weights of criteria (i.e., PSFs) is estimated from the eigenvector of matrix $A = [a_{ij}]_{n \times n}$. Let $W = [w_1, w_2, \dots, w_n]$ be the weights of criteria (i.e., PSFs). Then, the vector W is found by (6):

$$\begin{cases} AW = \lambda W \\ \sum_{i=1}^n w_i = 1, \quad i = 1, 2, \dots, n. \end{cases} \quad (6)$$

Besides, thanks to the feature of reciprocity of the matrix A , Saaty and Tavana [27] proposed NGMR (Normalization of the Geometric Mean of the Rows) to compute W . Accordingly, the $W = [w_1, w_2, \dots, w_n]^T$ is obtained by the normalized geometric means of a_{ij} in matrix A as:

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$$W = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{bmatrix} = \begin{bmatrix} \left(\prod_{j=1}^n a_{1j} \right)^{1/n} / \sum_{i=1}^n \left(\prod_{j=1}^n a_{ij} \right)^{1/n} \\ \left(\prod_{j=1}^n a_{2j} \right)^{1/n} / \sum_{i=1}^n \left(\prod_{j=1}^n a_{ij} \right)^{1/n} \\ \vdots \\ \left(\prod_{j=1}^n a_{nj} \right)^{1/n} / \sum_{i=1}^n \left(\prod_{j=1}^n a_{ij} \right)^{1/n} \end{bmatrix}, i = 1, 2, \dots, n. j = 1, 2, \dots, n. \quad (7)$$

Back to the example, the weight of matrix A^1 is found by Equation (7):

$$W = \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{bmatrix} = \begin{bmatrix} 0.4469 / 4.6076 \\ 0.7876 / 4.6076 \\ 1.6296 / 4.6076 \\ 1.7433 / 4.6076 \end{bmatrix} = \begin{bmatrix} 0.0970 \\ 0.1709 \\ 0.3537 \\ 0.3784 \end{bmatrix}$$

By the same way, the local weights of the remaining PSFs are computed and exhibited in the fourth field of Table 4 (for CCs) and Table 5 (for PCs).

Table 4 The final weights of PSF's for CCs

Layer 1: Constructs	Global weights (%)	Layer 2: PSFs	Local weights (%)	Global weights (%)
PE	21.88	PE1	9.70	2.12
		PE2	17.09	3.74
		PE3	35.37	7.74
		PE4	37.84	8.28
PT	23.26	PT1	24.3984	5.68
		PT2	30.024	6.98
		PT3	24.8472	5.78
		PT4	20.7304	4.82
PF	28.99	PF1	30.4365	8.82
		PF2	29.1924	8.46
		PF3	19.6527	5.70
		PF4	20.7184	6.01
PM	25.87	PM1	30.47	7.88
		PM2	29.32	7.59
		PM3	18.56	4.80
		PM4	21.65	5.60

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Table 5 The final weights of PSF's for PCs

Layer 1: Constructs	Global weights (%)	Layer 2: PSFs	Local weights (%)	Global weights (%)
PE	26.99	PE1	17.07	4.61
		PE2	27.26	7.36
		PE3	34.31	9.26
		PE4	21.36	5.77
PT	23.08	PT1	27.62	6.38
		PT2	26.42	6.10
		PT3	26.41	6.09
		PT4	19.55	4.51
PF	21.96	PF1	31.61	6.94
		PF2	32.02	7.03
		PF3	14.04	3.08
		PF4	22.34	4.90
PM	27.97	PM1	31.68	8.86
		PM2	33.44	9.35
		PM3	18.04	5.05
		PM4	16.83	4.71

3.4.4 Consistency test

We substitute Equation (7) into Equation (6). As a result:

$$\lambda I = (AW)W^{-1} \quad (8)$$

Where $\lambda I \approx (\lambda_1, \lambda_2, \dots, \lambda_n)$. Aftermaths, the maximum eigenvalue of matrix A ($\lambda_{\max}$) is approximated by averaging the $(\lambda_1, \lambda_2, \dots, \lambda_n)$ as:

$$\lambda_{\max} \approx \frac{1}{n} \cdot \sum_i^n (\lambda_1 + \lambda_2 + \dots + \lambda_n) \quad (9)$$

For the matrix A' , from Equations (8) and (9), $\lambda_{\max}$ is attained:

$$\begin{bmatrix} \lambda_1 \\ \lambda_2 \\ \lambda_3 \\ \lambda_4 \end{bmatrix} = \left(\begin{bmatrix} 1.0000 & 0.3482 & 0.3843 & 0.2981 \\ 2.8720 & 1.0000 & 0.3001 & 0.4464 \\ 2.6025 & 3.3328 & 1.0000 & 0.8134 \\ 3.3543 & 2.2400 & 1.2294 & 1.0000 \end{bmatrix} \times \begin{bmatrix} 0.0970 \\ 0.1709 \\ 0.3537 \\ 0.3784 \end{bmatrix} \right) \times \begin{bmatrix} 0.0970 \\ 0.1709 \\ 0.3537 \\ 0.3784 \end{bmatrix}^{-1} = \begin{bmatrix} 4.1779 \\ 4.2388 \\ 4.1942 \\ 4.0211 \end{bmatrix}$$

$$\Rightarrow \lambda_{\max} \approx 4.2388$$

With the $\lambda_{\max}$ of 4.2823 found by Equation (9), the consistency of matrix A' is tested by CI and CR, as seen in Equations (1) and (2). Consequently, $CI = 0.0796$ and $CR = 0.0903$ ($< 10\%$) illustrate the consistency for judgments. Likewise, the remaining judgment in the VNCC case can be tested and shown in Table 6. Arguably, they are all consistent.

Table 6 The results of the consistency test for the sample data in the VNCC case

Respondents	Layers	$\lambda_{\max}$	RI	CI	CR
Cruise carriers	Layer 1	4.1593	0.882	0.0531	0.0602
	Layer 2: PE	4.2388	0.882	0.0796	0.0903
	Layer 2: PT	4.1146	0.882	0.0382	0.0433

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Respondents	Layers	$\lambda_{\max}$	RI	CI	CR
Port companies	Layer 2: PF	4.2135	0.882	0.0712	0.0807
	Layer 2: PM	4.2167	0.882	0.0722	0.0819
	Layer 1	4.2569	0.882	0.0856	0.0971
	Layer 2: PE	4.2586	0.882	0.0862	0.0977
	Layer 2: PT	4.2536	0.882	0.0845	0.0959
	Layer 2: PF	4.1917	0.882	0.0639	0.0725
	Layer 2: PM	4.1682	0.882	0.0561	0.0636

3.4.5 Global weight of PSFs

The PSFs' global weights in Layer 2 can be obtained by multiplying the local weight by their correlated construct weights in Layer 1. The results of PSFs' final weights for CCs are shown in the last field of Table 4. The results indicate that the CCs' respondents are most concerned with the construct of PF (28.99%), followed by PM (28.87%), PT (23.26%), and PE (21.88%). Further, in Layer 2, the CCs' respondents pay much attention to PF1(8.82%), PF2 (8.46%), and PE4 (8.28%).

Furthermore, based on the above steps 3.4.1~3.4.5, the PSFs' final weights for PCs' importance measures are found and shown in the last field of Table 5. The results indicate that the PCs' respondents are most concerned with the construct of PM (27.97%), followed by PE (26.99%), PT (23.08%), and PF (21.96%). Further, in Layer 2, the PCs' respondents pay more attention to PM2 (9.35%), PE3 (9.26%), and PM1 (8.86%) and PE2 (7.36%).

3.4.6 Demand gap analysis

To attract port calls from cruisers, port companies (PCs) need to meet the demand of cruiser carriers (CCs). In the current paper, DMG is developed to measure the differences of the perceived demands between PCs and CCs. From that, PC managers can make police lessen the gap. The fundamental concept of the DMG is that a PSF with a higher CCs' expected weight (called a CC weight) and a lower PCs' expected weight (called a PC weight) will be a higher demand gap with higher priorities for improving. In this paper, a PSF with the CC weight > the PC weight is defined as a "negative gap", meaning the PC managers should put in more effort to improve this PSF. On the contrary, a PSF with the CC weight < the PC weight is defined as a "negative gap", implying this PSF could be overinvested. Thence, scarce resources allocated to it should be employed elsewhere. Further, a PSF with the CC weight = the PC weight is defined as the "no gap". Obviously, the policy for PSF should "keep working with no changes".

According to the collected data, a two-dimensional matrix was constructed to evaluate the demand gap of PSFs. Then, the matrix is divided into two zones by the identity line (the 45-degree line). More specifically, PSFs in Zone I mean weights from PCs are greater than ones from CCs. Thence, they are evaluated as "positive gaps". By contrast, PSFs in Zone II indicate that weights from CCs are greater than ones from PCs. Therefore, they are assessed as "negative gaps."

For the empirical case of the VNCC, PSFs' demand gap indices are presented in the final column of Table 7, while their positions are displayed in Figure 3. Evidently, there are seven positive demand gaps in Zone I. Among which, the demand gap indexes for PE2, PM2, and PEE are managerially significant while the remaining ones are insignificant. Therefore, PMC managers should focus on improving high-gap PSFs, especially PE2. On the contrary, Quadrant II also has 7 positive gap PSFs. More specifically, the largest positive-gap PSFs include PF3 (-2.26), PE4 (-2.51), PF1 (-1.88), and PF2 (-1.43). It is noteworthy that the resources committed to PF3 should be re-allocated elsewhere. Broadly speaking, port managers had better transfer resources from PSFs in Quadrant II to ones in Quadrant I to improve port's operational capacities.

Furthermore, a gap value was introduced to evaluate the size of the demand gap. It was initiated by measuring the distance between a PSF's position to the 45-degree line, as mentioned in Figure 3. For instance, the coordinate of point PE2 is (7.36%, 3.74%); as a result, its demand gap is positive (3.62%), representing the distance between the point and the 45° lines. In the same way, PF3's demand gap has a negative value of -2.26%.

Table 7 The DGM of cruise PSFs

PSFs	PCs (%)	CCs (%)	Zone	DGM (%)
PE1	4.61	2.12	Zone I (Negative gaps)	+2.48
PE2	7.36	3.74		+3.62
PE3	9.26	7.74		+1.52
PT1	6.38	5.68		+0.70
PM1	8.86	7.88		+0.98
PM2	9.35	7.59		+1.77
PT3	6.09	5.78		+0.32
PF1	6.94	8.82		-1.88

PSFs	PCs (%)	CCs (%)	Zone	DGM (%)
PF2	7.03	8.46	Zone II (Negative gaps)	-1.43
PF3	3.08	5.70		-2.62
PF4	4.90	6.01		-1.10
PM3	5.05	4.80		0.25
PT2	6.10	6.98		-0.89
PM4	4.71	5.60		-0.89
PT4	4.51	4.82		-0.31
PE4	5.77	8.28		-2.51

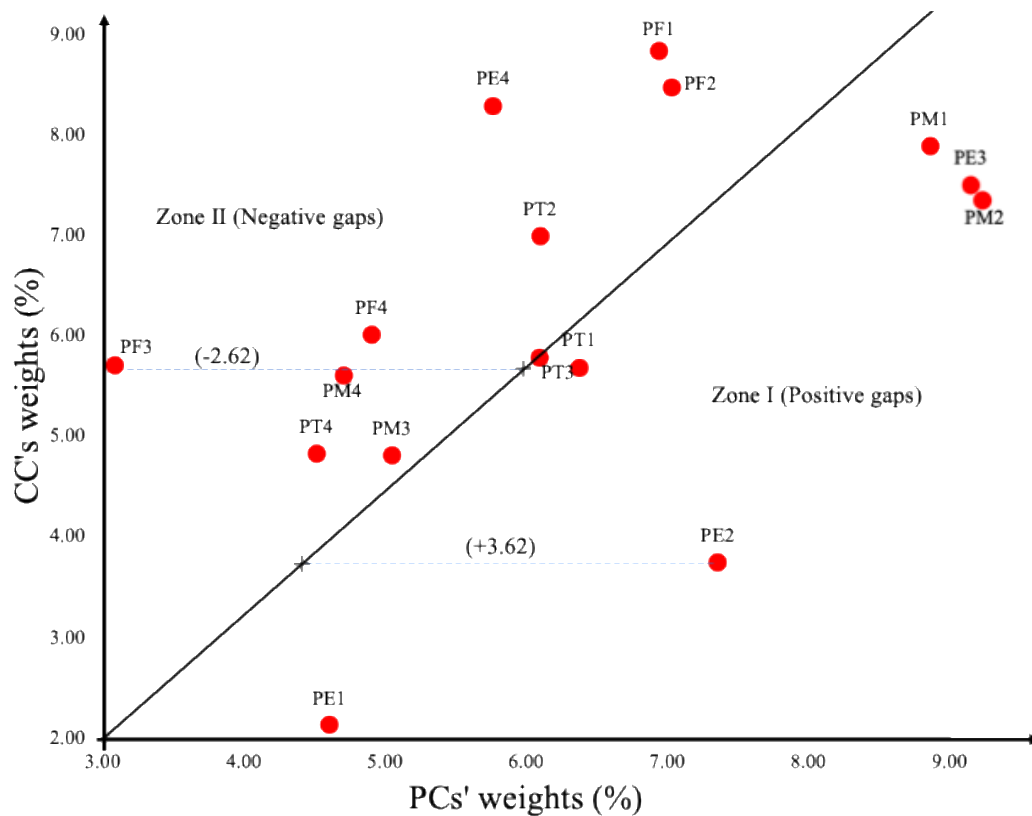


Figure 3 The gap values for PSFs

4 Results and discussions

4.1 The PSF's weight for the cruise company

Table 4 demonstrates that in Layer 1, the highest-weight PSFs are PF (port travel features) and PM (port management). And in Layer 2, PSFs receive more attention from CCs, including PF1, PF2, and PE4. Put succinctly, “variety of land-based tourism opportunities”, “availability of local historic landmarks”, and “political stability” play a crucial role in the port of call from CCs' perspective.

Prior studies also emphasized the land-based tourism opportunities in developing cruise tourism. For instance, Kodzi and Saeed [12] argued that a cruise port offering multiple types of experiences (i.e., cultural sites, shopping, nature, adventure, gastronomy, and relaxation) can satisfy first-time visitors and repeat cruisers. Moreover, it is widely admitted that for many cruise passengers, especially first-time visitors [7], history and heritage [15] are key motivations for going ashore. On top of that, political stability is essential for a cruise port of call. It is explained that political stability ensures passenger safety [25], operational reliability [14], positive destination image [6], and long-term viability within cruise itineraries [24]. In summary, from a practical perspective, these findings provide PCs with an actionable checklist of what CCs value most; thus, investment and marketing strategies can be prioritized accordingly. On top of that, these findings provide a decision framework and performance indicators for PCs to redesign services to attract cruise liners.

4.2 The demand gap

Results in Table 7 indicate that PE2 (health and sanitation conditions of the local population) is the most significant positive gap criterion (+3.62). This indicates that this criterion is highly important to cruise stakeholders, while its current

performance is perceived as weak. This implies that PMC executives may be underestimating or overlooking the role of local health and sanitation conditions in shaping the overall city image. From a cruise tourism perspective, passengers are highly sensitive to hygiene [4], cleanliness [2], and public health conditions [3]. Hence, poor sanitation or visible health issues can negatively affect the destination's image, even if port facilities themselves are adequate. From practical views, this finding gives PCs a basis for prioritizing investments to enhance health and sanitation conditions at terminal areas. If they do so, they can improve performance to cruise stakeholders and reduce perceived operational risk.

As shown in Table 6, PF3 (existence of modern tourist centers) has the most significant negative gap (-2.26), indicating that this PSF is over-invested. In practice, the modern tourist center, including 24-hour services, transportation, and visa-free services, encourages cruise companies to select the port of call [9]. However, in the context of the VNCC case, resources for PF3 should be employed elsewhere to improve the port's operations.

5 Conclusions

The main purpose of this paper is to examine the demand gap in PSFs between the CCs and PCs. First, based on relevant literature and CCs' features, a total of 16 PSFs for cruise operators were established and classified into 4 dimensions, namely "port environment", "port inland transportation", "port travel features", and "port operations management". Secondly, this study uses the fuzzy AHP method to determine the PSFs' weight. From that, the port company can formulate appropriate policies to develop the port and attract more cruise carriers. The empirical results indicate that two significant gaps are "health and sanitation conditions of the local population" (the positive gap), and "existence of modern tourist centers" (the negative gap). Based on empirical results, practical policies to attract CCs for the PMC were proposed.

To validate this model, we used 11 PCs and 17 CCs, as provided in the paper, for a survey. To improve the validity of the questionnaire, this study conducted interviews with experts to find the answers to the surveys. However, for more accurate empirical results, more samples are needed for further research. Furthermore, this paper uses the fuzzy AHP method to determine the weights of PSFs to improve the validity of data collected from experts. In principle, the fuzzy AHP method might enhance data verification in decision-making scenarios. Besides, the sample size is a research limitation. This study only surveys 17 CCs and 11 PCs. Future research should increase the number of respondents to inform better policies.

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