Research on Improving the Salary Structure of Port State Control Officers in Taiwan

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RESEARCH ARTICLE

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Abstract

The implementation of port state control (PSC) has been challenging in Taiwan due to lack of port state control officer (PSCO), foreign ships berthing at ports in Taiwan cannot be effectively inspected. PSCOs of Taiwan are subordinate to the public service system, and restrained by the number of personnel by Executive Yuan. Compared with the other similar work, their salaries are significantly different from those of the industry, making it unideal to recruit the PSCOs or retain existing human resources. Accordingly, this study improved the salary structure of PSCO by conducting field interviews with existing PSCO in Taiwan and using the Fuzzy-AHP method as an analysis model. According to the results of the analysis, priority has been given to improving the adjustment of the "profession allowance" for PSCOs. It is sought to provide shipping authorities as a reference for improving the remuneration structure of PSCO in order to achieve effective recruitment or retention of professionals.

Keywords: Port state control officer, Port state control, Fuzzy analytic hierarchy process, Salary structure, Profession allowance

1. Introduction

Since the International Maritime Organization (IMO) started to promote port state control (PSC), PSC has gradually become a management system for combating sub-standard ships, protecting the marine environment and improving the safety of crew work and life [1–3]. As a result, PSC promotes shipping navigation safety by inspecting and identifying deficiencies in the ships' equipment, crew training, or nonconformity of shipping regulations, thereby protecting life, goods, ships, and the environment. Taiwan is located in the Asia-Pacific region, so our competent authorities have signed the "Memorandum of Understanding on Maritime Systems and Technologies Cooperation Between the Ministry of Transportation and Communications in Taipei and The Canadian Trade Office in Taipei",

and also follow the regional PSC Memorandum of Understanding (PSC MoU) in the Asia-Pacific—Tokyo Memorandum of Understanding (Tokyo MoU) as the basis for implementation.

Taiwan is not a member of the IMO, but has agreed to abide by the international maritime conventions regulated by the IMO. Since 2000, the Canadian Office in Taiwan has assisted the Taiwan Ministry of Communications in the construction of PSC. At present, Taiwan can implement PSC, mainly through the "Memorandum of Understanding on Maritime Systems and Technologies Cooperation Between the Ministry of Transportation and Communications in Taipei and The Canadian Trade Office in Taipei" to successfully implement it.

Since the details of this memorandum have not been made public, this article summarizes the benefits of this memorandum for Taiwan based on

the content of the press release published by the Maritime and Port Bureau (MPB) and the research case commissioned by the Ministry of Communications. The results are summarized as follows: (1) Although Taiwan cannot join the IMO, Taiwan can also obtain the latest announcement information released by the IMO through this memorandum of cooperation; (2) Taiwan can plan PSCO training courses in accordance with the latest international conventions and the concentrated inspection campaigns (CICs) of each PSC MoU so as to synchronize the implementation of CICs with PSC MoUs around the world; (3) The information provided by this memorandum can effectively plan the training courses of PSCO, while also update the investigation knowledge of PSCO and maritime investigators; (4) Strengthen the situational dialogues that commonly seen during PSCO boarding inspections in Taiwan to simulate the content of maritime cases writing.

In the process of collecting the data from various maritime affairs centers (MACs) in Taiwan, this paper found that the port state control officer (PSCO) in Taiwan is currently facing a situation of serious shortage of manpower. After the investigation, except that the headquarters of the MPB hired a PSCO with captain qualifications, the staffing of the other MAC is almost the case where the center personnel is also a PSCO. In addition, after interviewing the supervisors of each MAC and PSCO, we learned that the current salary and allowance of PSCO is significantly different from that of the industry. This is the reason for the low number of people willing to work in PSCO and the high turnover rate. However, PSCO belongs to the system of public servants, namely that their salary or benefits cannot be changed arbitrarily. After the reform of the maritime and port system, the salaries of PSCOs were paid in accordance with the basic remuneration for civil servants. However, during 2015−2019, the proportion of foreign ships entering the port in Taiwan was as high as 73.66%. In order to strengthen the safety of Taiwan's navigational waters, it is necessary to prevent inbound sub-standard ships. Taiwan urgently needs PSCO personnel with highly professional and practical experience to board ships to check the seaworthiness of ships. Nevertheless, such personnel is hard to recruit. This study hopes that through the results of this study can be used as a recommendation to adjust the salary and benefits for PSCOs, so as to attract crew members with practical experience to serve.

Therefore, this article refers to the relevant literature on salary adjustment in Taiwan, as well as the "The Treatment of Military, Civil and Teaching Staff

directions", "The Performance Allowance for Civil Servant" and the internal regulations of the MPB. The study proposed to adopt the three parts of salary, performance incentives and professional ability incentives as the voucher for Taiwan PSCO salary adjustment research, and then through the fuzzy analytic hierarchy process (Fuzzy-AHP) as an analysis to explore the issue of improving the structure of PSCO's salary and allowance. To sum up, insufficiency of PSCOs in Taiwan have resulted in the inability of Taiwanese PSCOs to effectively increase their ship inspection rate during the PSC inspection. However, restrained by the Executive Yuan's organization and number of staff control, and the unattractive salary and allowances of PSCOs, it is difficult to recruit PSCOs and retain the existing PSCO manpower. Salary structure of PSCOs must be determined in accordance with the "The Treatment of Military, Civil and Teaching Staff directions", "The Performance Allowance for Civil Servant", and the internal regulations of the MPB, namely their salary structure cannot be adjusted arbitrarily. Therefore, the research suggestions given in this paper is mainly discussed in accordance with the "The Treatment of Military, Civil and Teaching Staff directions", "The Performance Allowance for Civil Servant", and the internal regulations of the MPB rather than construct a set of salaries specification for civil servants. The purpose of using Fuzzy-AHP is to evaluate or select an ideal solution in line with decision-making by using a reasonable mathematical analysis method to solve the problems generated by the interaction factors [4,5]. In addition, combining analytic hierarchy process (AHP) with fuzzy theory can effectively reduce the imprecise effect of AHP in comparative measurement evaluation [6−8].

AHP proposed by Saaty (1980) has been widely used to evaluate complex multi-standard alternatives in many fields [4]. It excels at ease of use, systematically constructing problems, and calculating standard weights and alternative priorities [6,8]. However, experts do not all have a clear basis or demarcation of boundaries in determining the importance of the assessment factors. Therefore, there is a characteristic of ambiguity when filling out the questionnaire. As a mainstream method of dealing with inaccuracies, Zadeh [9] proposed a fuzzy set combined with the analytic hierarchy method, that is, the fuzzy analytic hierarchy method. This integrated method maintains the advantages of the analytic hierarchy method and is widely used [10].

The paper is outlined as follows. In section 2, the history of establishing PSC in Taiwan and the performance of implementing PSC are reviewed. In addition, in this Section, the literature on the salary

structure of civil servants in Taiwan is also organized. Section 3 demonstrates the detailed steps of the proposed method. Section 4 reveals the analysis results arose from the proposed method, and section 5 presents conclusions and future applications.

2. Literature review

2.1. The history of establishing PSC in Taiwan

In 2002, Taiwan conducted the first phase of PSCO personnel training. Through this memorandum of cooperation, Taiwan appointed Canadian experts and scholars to assist PSCO in training, and Ministry of Communications issued a pass certificate and inspection certificate. At the same time, Taiwan also began to operate a trial of PSC, and officially implemented in 2003. But when the Ministry of Communications officially implements the PSC, it is often questioned about fairness. The reason is that the pre-reformed "Harbor Bureau" implemented PSC, which can simultaneously exercise public power and have the right to operate port undertakings. In order to increase the efficiency of port operations and enhance international competitiveness, Taiwan has referred to the port management system of "separation of government and business" of other advanced maritime countries.

In 2012, the four Harbor Bureaus, including Keelung, Taichung, Kaohsiung and Hualien were restructured into "MAC" and "Taiwan International Ports Corporation, Ltd. (TIPC)". The MAC is specialized in navigation administration and public power of the port, while TIPC is specialized in port management and operation. In addition, in order to cultivate and recruit new talents, the MPB applied to resume the advanced examinations (level 3) and general examinations for navigation technology and marine technology in 2014.

According to the 2019 annual report published by the Tokyo MoU, a total of 17,647 PSC inspections were conducted in the regional countries under the Tokyo MoU in 2019. In addition, according to the information provided by Lloyd's List Intelligence, there were 25,741 ships visiting the port of Tokyo MoU in 2019, and the PSC ship inspection rate was about 69% [11]. During 2019, a total of 5223 ships called at Taiwan ports, and Taiwan conducted PSC inspections on 838 of them. However, when Taiwan implemented PSC in 2019, its total ship inspection rate was only 16% [12]. The gap in inspection rates between the two, and what influencing factors exist, are worthy and urgently needed to be explored.

According to the public information of the MPB, the four MACs under the jurisdiction of the MPB have actually implemented the PSC in accordance with the policy plan. In terms of performance, the four MACs have achieved the number of ship inspections previously set every year. In addition, the number of target inspections set in each year has also increased year by year. This situation underscores the fact that the MPB is all-round the task of PSC.

PSCOs must has diverse aspects of ability. Good communication skill is essential. They also required to be capable of professional skills and knowledge's (navigation, marine engineer, international convention, health and safety). After passing specific training (MOU), then they would be qualified for this position. Depending on different type of ship, the working environment of PSCOs would change (including high temperature, noise, vibration, dust, wet, working at high space, hermetic space or even working at the place with dangerous goods. PSCOs are one of the public servants who has public power. Compare to normal public servant, the professional territory of knowledge and skills are much tougher to be qualified. Therefore, they deserve such high salary and willing to dedicate to work for our country.

2.2. Taiwan executive PSC performance

Maritime transportation plays a very important role in Taiwan's economic and social development [13,14]. However, during the voyage of the ship, it is inevitably be affected by many force majeure factors. Such as: weather, sea conditions, these will lead to problems in the seaworthiness of the ship, and extend to the occurrence of marine accidents [15,16]. Such a situation can adversely affect the ship, the crew and may even cause very serious damage to the port environment and the loading and unloading equipment on the shore [17]. In recent years, whether internationally or in Taiwan, the maritime regulations have been continuously revised and revised, but maritime accidents still continue to occur. Based on the maritime data collected by the MPB from 2015 to 2019, this research collated the occurrence of merchant shipwrecks in the waters under the jurisdiction of Taiwan, as shown in Table 1 below.

As mentioned earlier, most of the causes of shipwrecks are not having the seaworthiness of ships. Ships that are not seaworthy are generally substandard ships. As can be seen in Table 1, merchant ships of foreign nationality are in the majority in maritime accidents under Taiwan's jurisdiction. In order to explore whether this situation is due to the loose implementation of PSC inspection operations in Taiwan, this article summarizes the targeted and

Table 1. *Statistical table of maritime accidents of merchant ships in waters under the jurisdiction of Taiwan from 2015 to 2019.*

Title	2015	2016	2017	2018	2019	Total
Collision	14[a]/20[b]	21/37	12/18	16/13	7/16	70/104
Grounding	4/3	1/2	2/3	1/12	6/1	14/21
Fire	0/0	0/1	0/2	1/0	0/0	1/3
Explosion	0/0	0/0	0/0	0/0	0/0	0/0
Leakage	0/0	0/0	0/1	1/0	1/0	2/1
Overturned	0/0	0/0	0/0	0/0	0/0	0/0
Machine malfunction	8/3	5/3	6/3	0/3	3/1	22/13
Other	11/10	14/16	4/7	10/13	6/5	45/51
Total	37/36	41/59	24/34	29/41	23/23	154/193

Source: Maritime and Port Bureau (2019).
Note:
[a] Indicates the number of Taiwanese merchant ships involved in maritime accidents.
[b] Indicates the number of foreign merchant ships in maritime accidents.

Table 3. *Summary table of the number of PSCOs in Taiwan from 2015 to 2019.*

	2015	2016	2017	2018	2019
Bureau Headquarters	1	1	1	1	1
North Taiwan MAC	8	8	6	10	10
Central Taiwan MAC	4	4	4	4	4
South Taiwan MAC	4	4	4	10	10
East Taiwan MAC	3	2	2	4	4
Total	20	19	17	29	29

Source: Maritime and Port Bureau (2019).

the actual number of ships inspection by the four MACs from 2015 to 2019, as shown in Table 2 below.

According to Table 2, it can be known that all MACs have achieved their own target inspection number from 2015 to 2019. It also revealed that the actual number of inspections per year by the MAC exceeds the target number of inspections set for that year. In other words, it indicates that each MAC actively performs PSC inspections. In order to better understand Taiwan PSCO's implementation of PSC inspection, this article summarizes the number of PSCOs in each MAC in Taiwan from 2015 to 2019, as shown in Table 3 below. From Table 3, it is known that the number of PSCOs in Taiwan has not increased year by year, while the number of target inspection ships has been increased every year. Such a situation is likely to result in the inability to improve the inspection rate of Taiwan's PSC operations.

PSCO in Taiwan belongs to the civil servant system. This means that neither the salary situation nor the welfare package can be changed at will, and the adjustment of the salary package will involve the national budget expenditure. This greatly reduces the number of people who want to apply for PSCO, and its salary package of PSCO is also difficult to attract crew members like the rank of chief officers and chief engineers to apply for the job.

As mentioned by the examiners, Taiwan's international port is located on a busy shipping waterway. Implementing PSC requires highly professional PSCOs, and should pay an appropriate salary to them. Regarding the employment salary level of PSCOs, in the early days, the seniority system was adopted in 1990−2010 (except that the pension's calculation is the same as Civil Service

Table 2. *A summary of the target/actual number of ships inspected by each maritime affairs center in Taiwan from 2015 to 2019.*

		North Taiwan MAC	Central Taiwan MAC	South Taiwan MAC	East Taiwan MAC	Total
2015	Number of foreign ships calling at port	1405	2287	3438	220	7350
	Number of target checks	169	199	320	59	747
	Actual number of inspections	178	205	330	61	774
	Executive rate	12.67%	8.96%	9.60%	27.73%	10.53%
2016	Number of foreign ships calling at port	1245	2393	3431	242	7311
	Number of target checks	174	205	329	61	769
	Actual number of inspections	181	208	332	62	783
	Executive rate	14.54%	8.69%	9.68%	25.62%	10.71%
2017	Number of foreign ships calling at port	1281	1705	3571	192	6749
	Number of target checks	176	208	333	62	779
	Actual number of inspections	186	216	345	64	811
	Executive rate	14.52%	12.67%	9.66%	33.33%	12.02%
2018	Number of foreign ships calling at port	1313	2439	3511	185	7448
	Number of target checks	182	215	344	64	805
	Actual number of inspections	190	218	346	73	827
	Executive rate	14.47%	8.94%	9.85%	39.46%	11.10%
2019	Number of foreign ships calling at port	1339	2456	3507	201	7503
	Number of target checks	182	215	344	64	805
	Actual number of inspections	187	235	351	65	838
	Executive rate	13.97%	9.57%	10.01%	32.34%	11.17%

Source: Maritime and Port Bureau (2019).

Junior Examination and Level Three Senior Examination, during their tenure, the pay is 1.5−2.8 times, and the year-end bonus is 1−2 months, than personnel through Junior Examination and Level Three Senior Examination, but they cannot enjoy any subsidies), and this employment channel has been terminated due to the annuity reform. Secondly, the personnel employed through the high general examination are all part-time PSC business, and they may not all come from the disciplines of navigation, marine engineering, and shipbuilding. Chiu et al. [18] pointed out the current practice for PSCO to conduct their PSC task as a part-time job needs to be changed as soon as possible.

The Coast Guard Administration and Customs Administration of Taiwanese public service system recruit graduates of the Department of Aviation and Wheels to serve in maritime affairs through special examinations, and their salary benefits are better than those of the high general examination, and even the special examination salary is close to the early salary level of the seniority system. At present, the ship-background manpower of the Coast Guard Administration and the Customs Administration is transferred to the relevant grades of the Navigation and Port Bureau to serve as PSCO through open consultation, and finally they all give up applying due to the obvious gap in salary and pension level after the transfer.

At present, PSC business is to enforce public power, and there is no special contract to hire surveyors, pilots, captains and chief engineers to enforce PSC to prevent public power from being unfulfilled. Therefore, for PSCO personnel with special high professional public authority, in addition to adjusting the applicable salary structure, special examination can be used to recruit practical experience manpower with a background in shipping and sea service, so as to enrich and improve the manpower literacy and quantitative capacity of PSCO.

2.3. Literature discussion on salaru treatment of civil servants in Taiwan

Among the existing PSCO members, almost all of them are recruited through the Civil Service Junior Examination and Level Three Senior Examination, the salary level is according to the examination appointment level and the individual year-end performance appraisal and the new way of slightly, its salary level and the personnel of the seniority system, the maritime technology department of the shipping company (and the PSC affairs highly related departments) are difficult to compare, less

than five are hired personnel in the early seniority system, the salary level of the two is very different, and the difference in salary and allowance is explained as before previous section 2.2.

At present, most of the research directions on the issue of civil servants' salaries and treatment are discussed the pension mechanism, the phenomenon of hiring contract employees, and the recruitment of talents. However, there is few research on the topic of salary adjustment for Taiwanese civil servants. Therefore, after searching for relevant literature, the relevant literature related to the salary and treatment issues in this paper is compiled. The research results of many scholars abroad can be concluded that adjusting salary and treatment can effectively improve the operational performance of public servants [19,20]. Although Taiwan's economic growth has slowed in recent years and unemployment has risen, resulting in stagnation or even reduction in private sector wages, the impact on civil servants' salaries has been minimal [21]. However, Su [22] noted that Taiwan's centralized personnel management system for civil servants has long been criticized as extremely rigid and unified, making it impossible to cope with the accelerated pace of global change. The government often restricts salary adjustments for Taiwanese civil servants when planning its budgets [23]. This wage gap makes Taiwanese civil servants vulnerable to bribery by businessmen [24]. This paper mainly based on the research results of Taiwan experts and scholars because the object of this paper is the public servants in Taiwan. If the research results of foreign scholars are used, it is prone to inapplicable situations as well as conflicts with Taiwan's regulations.

Therefore, this study begins to study the adjustment of the salary structure of civil servants in Taiwan. Wu et al. [25] pointed out in their research that the salaries of teachers in public universities, middle schools, and elementary schools in Taiwan are currently based on the Ministry of Education's "Public School Teachers and Teaching Assistants Job Rating Table" and individual "Academic Research Fee Tables". Wu et al. estimated the net present value of a student who chose to be a university, middle school and primary school teacher through the "net present value method", and then established a monthly payment calculation model for only applicable to university professors.

Lin [26] pointed out that in the process of huge use of Taiwan's education personnel funds, the government mainly takes academic qualifications and seniority as evaluation considerations. According to this research results, professionalism and grades are used as the basis for salary evaluation. Leng [27]

Table 4. Summary table of the Performance Allowance for Civil Servant.

	Grade		
	Senior executive officer	Executive officer	Appointment
1st	NT$29,960~ NT$40,630	NT$20,790~ NT$25,770	NT$17,710~ NT$18,910
2nd	NT$32,895~ NT$42,755	NT$23,230~ NT$27,750	NT$19,280~ NT$20,385
3rd	NT$33,450~ NT$43,240	NT$23,735~ NT$28,575	NT$19,690~ NT$21,160
5th-1	NT$37,995~ NT$51,015	NT$26,515~ NT$33,180	NT$24,065
5th-2	NT$37,995~ NT$51,015	NT$26,515~ NT$33,180	NT$24,065
6th	NT$37,830~ NT$51,520	NT$25,540~ NT$32,880	NT$20,350~ NT$23,775
7th	NT$34,665~ NT$44,495	NT$24,900~ NT$28,925	NT$18,920~ NT$22,425
10th	NT$35,780~ NT$46,095	NT$24,610~ NT$29,410	NT$19,690~ NT$21,160
14th	NT$34,645~ NT$45,815	NT$24,150~ NT$29,370	NT$20,310~ NT$21,540
20th	NT$37,045~ NT$44,315	NT$26,930~ NT$31,850	NT$21,000~ NT$24,095
24th-1	NT$35,110~ NT$44,745	NT$25,610~ NT$30,410	NT$20,475~ NT$22,385

Source: Directorate General of Budget, Accounting and Statistics, Executive Yuan.

pointed out that the salary package of teachers is mainly composed of three parts: basic salary, additional bonuses and bonus. Among them, the basic salary, additional bonuses and bonus can be changed by means of further study or license. Chu et al. [28] pointed out that individual power has a positive and significant impact on basic salary, job bonus, and skill bonus. This means that the greater the individual authority, the higher the salary level may increase. Weng and Hsieh [29] pointed out that performance-based pay is a mechanism widely used in employee motivation. By combining compensation and performance, employees can be effectively motivated to improve performance and enhance organizational competitiveness. The results of the above-mentioned studies reveal some information. First of all, when measuring salary and treatment, it mainly considers three parts: the basic salary, job additional bonuses and professional allowance bonus. In addition, when civil servants are paid, there will be relevant laws and regulations to regulate their salaries.

However, it is possible to change the salary situation through acts such as grade promotion, follow-up study or license acquisition. Finally, the favorable situation of salary package will affect the attitude of employees towards work.

Based on the research results of the above scholars and experts, when discussing the issue of PSCO salary allowance, this article will mainly use basic salary, additional bonuses and bonus as the evaluation criteria for PSCO's salary adjustment

credentials. Therefore, the analysis of this article is finally necessary to follow the "The Treatment of Military, Civil and Teaching Staff directions", "The Performance Allowance for Civil Servant", and MPB regulations for study and discussion. The subsequent article summarizes the current situation of the "The Performance Allowance for Civil Servant", as shown in Table 4.

3. Research method

3.1. Constructing evaluation aspects and evaluation factors criteria

In Taiwan, the salary of PSCO is not attractive enough for candidates. It even causes the current PSCO to resign or transfer to other agencies. So this article proposes ways to improve and reduce this phenomenon. This article adopted three parts: of the basic salary, additional bonuses and bonus as proof of salary adjustment for Taiwan PSCO. Subsequently, the method of "guided interviews" was adopted by interviewing with experts and scholars in related fields. Included: supervisors and PSCOs of MPB and its MACs, thus designing the evaluation aspects and evaluation factors of the questionnaire. Guided interviews can be used as a basis for interviews through open research questions so as to achieve the purpose of guided interviews. This interview mode can make the interviewees recognize their feelings and present them in a more realistic way [30]. Several researchers have applied

Table 5. The evaluation aspects description.

Code	Evaluation aspects	Description
A_1	Basic salary	"The Treatment of Military, Civil and Teaching Staff directions" and "The Performance Allowance for Civil Servant" promulgated by the Executive Yuan are used as the basis for adjusting the salary.
A_2	Duty performance bonus	Based on work performance and on-duty performance, the incentives will be approved and issued.
A_3	Professional ability bonus	Incentives are determined and issued according to professional licenses, language certifications, and work service qualifications.

this interview model to the fields of medical treatment, psychological assessment and ideology, and their research results have also proved that this view is feasible [31,32].

After interviewing the supervisors and PSCOs who serve in the MAC, this article sets the basic salary, duty performance bonus and professional ability bonus as the evaluation criteria. For the description of the evaluation aspects/factors, the results are shown in Table 5 and Table 6.

There are still only 29 PSCO personnel in the country, so through the census questionnaire, we can understand why these current PSCOs cannot stay for a long time and transfer to other units. In addition, PSCO is a public employee, so in terms of salary and treatment, the salary of public employees paid by the government can be divided into three parts: basic salary, job addition bonuses, professional allowance bonus, etc., in order to improve the PSCO salary level, the salary structure components of Table 5 and Table 6 and their related reference indicators will be proposed, hoping to provide the government with reference to the corresponding salary level in the future.

3.2. Fuzzy analytic hierarchy process

With the development of systematic methods, many complex problems can be simplified by analytical methods. Most problems are composed of interacting elements, so it has become a trend to study the evaluation factors into a hierarchical manner. Hierarchical structures are used to explore research questions and help to provide a more comprehensive analysis of research events. However, decision making process is not only considered a single level, but also considered multiple levels. For policymakers, it can be used to select options based on some certain benchmarks so as to effectively obtain an appropriate solution [33,34].

AHP is widely adopted deal with complex decision-making problems, but there are still some shortcomings in this method. In the process of AHP analysis, individual subjective evaluations is prone to be mixed, resulting in serious discrepancies between evaluation results and practical problems [4,5,8]. Based on the fact that AHP cannot directly improve this situation, this paper adopts the Fuzzy AHP proposed by Van Laarhoven and Pedrycz [35] and Buckley [36] as the analysis method. Fuzzy-AHP is employed to decide the priority weights of estimate [37]. Gumus [38] are suggested to evaluate importance ratings in preference to the expected mathematical similarity method [39]. Thus, when an uncertain pairwise comparison environment exists, Fuzzy-AHP should be more appropriate and satisfactory than conformist AHP in practice [39,40]. This article is a field interview with PSCO in Taiwan to study the views and suggestions of each PSCO on salary benefits. If the traditional AHP is used as an analysis method, when the number of levels and assessment factors increases, it is easy for respondents to answer too many questions and cause confusion in their thoughts, resulting in reduced evaluation efficiency. This is also the purpose of the fuzzy hierarchical analysis method used in this study.

Van Laarhoven and Pedrycz [35] combined the concept of fuzzy theory with AHP, and further proposed to incorporate the fuzzy numerical value into the AHP analysis process. Buckley [36] adopted this pattern concept to fuzzify the pairwise comparison values in the AHP constructed by Saaty [41], and formally proposed Fuzzy AHP. Buckley adopted ordinal scales instead of numerical ratios to express the relative importance of elements, which reduced the overly individual subjective phenomenon in the analysis process [6,36]. Later, scholars also proved that the analysis results obtained by combining traditional AHP with the concept of fuzzy theory have better accuracy [4,8]. In this paper, Buckley's Fuzzy AHP is used as the research methodology. The operation process of this method is briefly described as follows:

Table 6. The evaluation factors description.

Code	Evaluation factors	Description
A_{11}	Salary amount change	Salary amount change is made according to the "The Treatment of Military, Civil and Teaching Staff directions" promulgated by the Executive Yuan.
A_{12}	Supervisor job bonus change	Supervisor job bonus change based on the "The Treatment of Military, Civil and Teaching Staff directions" promulgated by the Executive Yuan.
A_{13}	Professional bonus change	Professional bonus change according to "The Performance Allowance for Civil Servant" promulgated by the Executive Yuan.
A_{21}	Ship inspection rate	Incentives are awarded based on the circumstances in which the ship inspection is performed.
A_{22}	Substandard ship hit rate	Incentives are awarded on the basis of performance in performing ship inspections.
A_{23}	Operating hours	Incentives are awarded based on the hours worked to perform ship inspections.
A_{24}	Duty times	Incentives are awarded based on the number of jobs performed for ship inspections.
A_{31}	Professional license	Incentives are awarded based on having a certificate in navigation, engineering, shipbuilding or surveying.
A_{32}	Language test certificate	Rewards are issued based on the possession of language-related certifications.
A_{33}	Working years	Incentives are awarded based on seniority.

1. Establish a fuzzy pairwise comparison matrix

According to the results of the questionnaire survey, the fuzzy pairwise comparison matrix $\tilde{A}$ of the comparison is represented by a trapezoidal fuzzy number. Where $\tilde{A} = [\tilde{a}_{ij}]$, $\tilde{a}_{ij} = [a_{ij}, b_{ij}, c_{ij}, d_{ij}]$. Buckley [36] expressed the weight value as a trapezoidal fuzzy number, since the calculation was too complicated, this paper uses triangular fuzzy numbers to express the decision makers' views on the pairwise importance of factors. Based on this, a fuzzy pairwise comparison matrix is established, and the matrix is shown in the following Eq. (1).

$$\tilde{A}_{ij} = \begin{bmatrix} 1 & \tilde{a}_{12(U-R)} & \tilde{a}_{1n(U-R)} \\ \tilde{a}_{21(U-R)} & 1 & \tilde{a}_{2n(U-R)} \\ \vdots & \vdots & \vdots \\ \tilde{a}_{n1(U-R)} & \tilde{a}_{n2(U-R)} & 1 \end{bmatrix}, \tag{1}$$

where
$\tilde{A}_{ij} = [L_{ij}, M_{ij}, U_{ij}]$, $\tilde{A}_{ij} \cdot \tilde{A}_{ij} \approx 1$, $\forall_{ij} = 1, 2, ..., n$. L_{ij}: The minimum value of the scale interval value filled in by the assessor. M_{ij}: The average value of the scale interval value filled in by the assessor. U_{ij}: The maximum value of the scale interval value filled in by the assessor.

In addition, if the positive reciprocal matrix $A = [a_{ij}]$ is consistent, the fuzzy positive reciprocal matrix $\tilde{A} = [\tilde{a}_{ij}]$ is also consistent. During calculation, the consistency of this paired comparison matrix needs to be judged to determine the ratio of the matrix and estimate whether the logical relationship of the sample collection is close to a random collection. Therefore, the consistency index (C.I.) and consistency ratio (C.R.) are employed to test matrix consistency. Where n is the number of criteria and $\lambda_{\max}$ is the maximum eigenvalue. C.R. shows the ratio of the C.I. to the average consistency index, known as random index (R.I.), as follows Eqs. (2) and (3) shown. The R.I. data for the study were obtained from Saaty [41], as shown in Table 7.

$$C.I. = \frac{1}{n-1}(\lambda_{\max} - n), \tag{2}$$

$$C.R. = \frac{C.I.}{R.I.}. \tag{3}$$

Saaty [41] has suggested that when $C.R. \leq 0.1$, the consistency of the evaluation matrix will be guaranteed. If $C.R. \leq 0.1$, the degree of matrix

consistency will be considered satisfactory. If any of the matrices are inconsistent, the scholars' findings suggest that the corresponding pairwise comparisons should be modified until the desired consistency is achieved [12,42].

2. Weight of fuzzy positive reciprocal matrix

Buckley [36] adopted the concept of the geometric mean to consider the fuzzy weight of each criterion. If the fuzzy positive reciprocal matrix $\tilde{A} = [\tilde{a}_{ij}]$, the geometric mean r_i and the fuzzy weight value ω_i are as follows Eqs. (4) and (5) shown:

$$\tilde{r}_i = (\tilde{a}_{i1} * ... * \tilde{a}_{in})^{1/n}, \tag{4}$$

$$\tilde{\omega}_i = \tilde{r}_i * (\tilde{r}_i + ... + \tilde{r}_n)^{-1}. \tag{5}$$

3. Defuzzification

There are many ways of defuzzification, including: the center of gravity method, the centroid method, and the average maximum degree of membership method. This paper adopted the fuzzy arithmetical operations of triangular fuzzy numbers developed by Hsieh and Chen [43] for defuzzification, referring to Eqs. (6) and (7).

$$\tilde{A}_{ij} = [L_{ij}, M_{ij}, U_{ij}], \tag{6}$$

$$P(A_i) = \frac{L_{ij} + 4 * M_{ij} + U_{ij}}{6}. \tag{7}$$

This defuzzification proposed to choose the corresponding best linguistic data of both fuzzy average judgment values and fuzzy average ideal values [8,43,44]. This method of defuzzification has been verified by many scholars and has achieved remarkable results in an ambiguous analysis environment [44,45]. During the calculation process, most of the positive reciprocal matrices are non-uniform matrices. Therefore, this paper adopts the row vector mean normalization method to calculate, as shown in Eq. (8).

$$w_i = \frac{1}{n} \sum_{j=1}^{n} \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}}, i, j = 1, 2, ..., n. \tag{8}$$

4. Results and discussion

Harbor Bureau was divided into MPB and TIPC due to the separation of government administration and enterprise management. Later, MPB was divided into four maritime affairs centers owing to the different jurisdictions. In order to understand

Table 7. Summary of random index table.

Layers	1	2	3	4	5	6	7	8	9	10
R.I.	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Source: Staay [41].

Table 8. Summary table of single weight and rank of overall respondents.

Criteria	Weights (A)	Rank	Criteria	Weights (B)	Rank
A_1	0.3231	2	A_{11}	0.2482	2
			A_{12}	0.1363	3
			A_{13}	0.6155	1
A_2	0.2449	3	A_{21}	0.1454	4
			A_{22}	0.3882	1
			A_{23}	0.2113	3
			A_{24}	0.2552	2
A_3	0.4320	1	A_{31}	0.2781	3
			A_{32}	0.3016	2
			A_{33}	0.4203	1

the situation of each center, the results of the interviews of each center are also analyzed in this research and analysis.

The implementation of PSC requires a highly professional and practical attainments, not all personnel serving at Taiwan's maritime and port agencies can be assigned and transferred. Accordingly, this article will conduct a census interview with all current PSCOs in Taiwan. Aside from understanding the main factors of PSCO switch and resignation, we can study whether in different ways of remuneration for civil servants could affect the that factors above.

A total of 29 questionnaires were distributed in this paper, and the respondents were PSCOs of each MAC. The authors personally went to each MAC to conduct interviews and surveys. Therefore, if there are any doubts or mistakes in the process of filling out the questionnaire, the author will explain directly to the respondents. However, there are still 2 questionnaires that are invalid, and so the effective rate of questionnaire recovery in this study is 93.10%. The analyzed results are shown Table 8.

The *C.R.* of evaluation aspects of overall respondents was 0.0674, and the *C.R.* of evaluation factors was between 0.0469 and 0.0708. This means that the matrix consistency requirements are complied. This study continues to classify the locations of the MACs where the respondents serve. The analyzed results are shown in Table 9 to Table 12.

In Table 9, the *C.R.* of the evaluation aspects of the surveyed groups in the North Taiwan MAC was between 0.0023 and 0.0925, and the *C.R.* of the evaluation factors was between 0.0013 and 0.0988. This means that the matrix consistency requirements are complied. The respondents of North Taiwan MAC thought that A_1 is important, of which the weight is 48.68%, approximately half of the overall weights.

In Table 10, the *C.R.* of the evaluation aspects of the surveyed groups in the Central Taiwan MAC was between 0.0465 and 0.0821, and the *C.R.* of the evaluation factors was between 0.0029 and 0.0944. This means that the matrix consistency requirements are complied. The respondents of Central Taiwan MAC emphasized on A_1, of which the weight is 43.97%.

In Table 11, the *C.R.* of the evaluation aspects of the surveyed groups in the South Taiwan MAC was between 0.0251 and 0.0827, and the *C.R.* of the evaluation factors was between 0.0013 and 0.0957. This means that the matrix consistency requirements are complied. The respondents of South Taiwan MAC preferred A_3, of which the weight is 44.70%.

In Table 12, the *C.R.* of the evaluation aspects of the surveyed groups in the East Taiwan MAC was between 0.0048 and 0.0955, and the *C.R.* of the evaluation factors was between 0.0158 and 0.0959. This means that the matrix consistency requirements are complied. The respondents of East Taiwan MAC considered A_3 is very important, of which the weight is 62.87%, more than half of the overall weight.

The above Table 8 to Table 12 indicate weight and rank situation. This study presents the analysis results of each MACs and all respondents in the form of group weight and rank, as shown in Table 13. The data in Table 13, it can be known that when the respondents fill out the questionnaire, there are still some differences in the ranking of their group weights. First of all, under the consideration of all respondents, A_{13} in A_1 is the priority evaluation item.

Secondly, we found in the analysis that the priority of the evaluation items of each MAC exists difference, so it is necessary to study in accordance

Table 9. Summary table of single weight and rank of North Taiwan maritime affairs center.

Criteria	Weights (A)	Rank	Criteria	Weights (B)	Rank
A_1	0.4868	1	A_{11}	0.2891	2
			A_{12}	0.0914	3
			A_{13}	0.6195	1
A_2	0.1701	3	A_{21}	0.1714	4
			A_{22}	0.4091	1
			A_{23}	0.1819	3
			A_{24}	0.2376	2
A_3	0.3431	2	A_{31}	0.3421	2
			A_{32}	0.1389	3
			A_{33}	0.5190	1

Table 10. Summary table of single weight and rank of Central Taiwan maritime affairs center.

Criteria	Weights (A)	Rank	Criteria	Weights (B)	Rank
A_1	0.4397	1	A_{11}	0.3062	2
			A_{12}	0.1849	3
			A_{13}	0.5089	1
A_2	0.2510	3	A_{21}	0.1322	4
			A_{22}	0.4446	1
			A_{23}	0.2702	2
			A_{24}	0.1530	3
A_3	0.3093	2	A_{31}	0.2702	3
			A_{32}	0.3823	1
			A_{33}	0.3475	2

Table 11. Summary table of single weight and rank of South Taiwan maritime affairs center.

Criteria	Weights (A)	Rank	Criteria	Weights (B)	Rank
A_1	0.2158	3	A_{11}	0.1956	2
			A_{12}	0.1176	3
			A_{13}	0.6868	1
A_2	0.3372	2	A_{21}	0.1591	3
			A_{22}	0.3633	1
			A_{23}	0.1589	4
			A_{24}	0.3188	2
A_3	0.4470	1	A_{31}	0.3087	2
			A_{32}	0.2307	3
			A_{33}	0.4606	1

Table 12. Summary table of single weight and rank of East Taiwan maritime affairs center.

Criteria	Weights (A)	Rank	Criteria	Weights (B)	Rank
A_1	0.1500	3	A_{11}	0.2019	2
			A_{12}	0.1512	3
			A_{13}	0.6469	1
A_2	0.2213	2	A_{21}	0.1190	4
			A_{22}	0.3357	1
			A_{23}	0.2341	3
			A_{24}	0.3112	2
A_3	0.6287	1	A_{31}	0.1915	3
			A_{32}	0.4546	1
			A_{33}	0.3539	2

with the location of the MAC where the respondents serve. In addition, it can be found that almost all of the top three rankings overlap whether from the perspective of the whole or each MAC. For example, North Taiwan MAC's group rank 1 and group rank 2, Central Taiwan MAC's group rank 1 and group rank 3, and East Taiwan MAC's group rank 2, are in the same order as the overall respondents' group rank, but only the top three group rank of South Taiwan MAC is completely different from the top three group rank of overall respondents.

Finally, it can be seen from the responses of each MAC that the North Taiwan MAC and the Central Taiwan MAC tend to use the basic salary project to change the salary structure of the PSCOs. The South Taiwan MAC and the East Taiwan MAC tend to use the professional ability bonus project to change the salary structure of PSCOs.

5. Conclusions and suggestions

The current PSCO treatment in Taiwan is not attractive enough, resulting in the lack of PSCO numbers in our country so that the ship inspection rate cannot be greatly improved. Therefore, this paper intends to propose a solution to the issue of improving the salary structure and increase the salary and allowance of PSCO so as to attract professionals who are willing to engage in PSCO. Through the research results of scholars and experts in Taiwan as well as the salary regulations for public servants in Taiwan, we can find a suitable mode for adjusting the salary and allowances of PSCO. It is hoped that the results of the analysis in this article can be used as a reference for improving the salary and allowances of Taiwan PSCOs, and the vision of effective operation and sustainable development of Taiwan's PSC business can be achieved.

During the Harbor Bureau period, PSCO had paid NTD$ 71,230. However, after the separation of government administration and enterprise management., the PSCO's salary was down to NTD$49,500. Currently, the pay of PSCO in Taiwan is adopted the "The Performance Allowance for Civil Servant (1st)". However, PSCO is a type of technical inspectors whose work duty are similar to the personnel of "The Performance Allowance for Civil Servant (7th)". The author suggest that our government can take "The Performance Allowance for Civil Servant (7th)" as a reference instead of "The Performance Allowance for Civil Servant (1st)" when adjusting the remuneration package of PSCOs in the future.

This article referred to "The Performance Allowance for Civil Servant (1st) and (7th)", and aggregates both situations of professional allowance of civil servants as Appendix A. According to the results compiled in Appendix A, there are few

Table 13. Summary table of group weights and rank of overall respondents and each Taiwan maritime affairs center respondents.

Criteria		Overall respondents		North Taiwan MAC		Central Taiwan MAC		South Taiwan MAC		East Taiwan MAC	
		Weights (C)	Rank	Weights (C)	Rank	Weights (C)	Rank	Weights (C)	Rank	Weights (C)	Rank
A_1	A_{11}	0.0802	6	0.1407	3	0.1346	2	0.0422	9	0.0303	8
	A_{12}	0.0440	9	0.0445	7	0.0813	7	0.0254	10	0.0227	10
	A_{13}	0.1989	1	0.3016	1	0.2238	1	0.1482	2	0.0970	4
A_2	A_{21}	0.0356	10	0.0291	10	0.0332	10	0.0536	7	0.0263	9
	A_{22}	0.0951	5	0.0696	5	0.1116	4	0.1225	4	0.0743	5
	A_{23}	0.0517	8	0.0309	9	0.0678	8	0.0536	8	0.0518	7
	A_{24}	0.0625	7	0.0404	8	0.0384	9	0.1075	5	0.0689	6
A_3	A_{31}	0.1202	4	0.1174	4	0.0836	6	0.1380	3	0.1204	3
	A_{32}	0.1303	3	0.0476	6	0.1182	3	0.1031	6	0.2858	1
	A_{33}	0.1816	2	0.1781	2	0.1075	5	0.2059	1	0.2225	2

Note: Weights (C) = (A)*(B).

differences in monthly pay between both of them. Among them, the largest amount difference in monthly pay is rank 10 (the difference is NT$3805); the smallest amount difference is rank 1 (the difference is NT$670). Even though the amount of adjustment is not quite large, for PSCOs, it is not only a reward for their hard work, but also the government's affirmation of their contribution.

Secondly, the existing public service units of the relevant grades of shipping ships (Coast Guard Administration and Customs Administration) are hired and paid through the special method, and their salary level is not only close to the early public service seniority system, but also quite close to the relevant departments of shipping companies, these public service units not only have a stable human structure, but also perform a high degree of maritime professional services to further demonstrate the public power of the government.

Therefore, in terms of job additions for existing PSCOs, if we can refer to the addition of PSC business allowances of Appendix A (Appendix A) level 1—7, just as the personnel of Taiwanese Coast Guard Administration in terms of job additions, but also increase the maritime duties and dangerous duties, it will help the retention policy of professional functional manpower.

Although this article refers to the relevant literature of scholars on the adjustment of salary and treatment of civil servants in Taiwan, there are still some insufficient parts need to be solved. The authors suggested that inspired researchers can explore for such personnel whether to design a new salary structure table in accordance with the current salary system law of civil servants, so as to extensively and intensively discuss about the issue of adjusting PSCO's salary and treatment. Some topics for future study. For example, the work and business of Coast Guard Administration, Customs and PSCO in Taiwan are similar, the salary and benefits of these three can also be studied in the future.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Acknowledgments

Appendix A.

The PerformanceAllowance for Civil Servant (1st) and (7th) Monthly Payment Amount Consolidation Situation.

The Performance Allowance for Civil Servant (1st)			The Performance Allowance for Civil Servant (7th)		
Grade	Rank	Monthly payment amount	Grade	Rank	Monthly payment amount
Senior executive officer	14	NT$41,850	Senior executive officer	14	NT$44,495
	13	NT$38,980		13	NT$41,635
	12	NT$37,800		12	NT$40,620
	11	NT$33,630		11	NT$36,910
	10	NT$30,860		10	NT$34,665
Executive officer	9	NT$26,550	Executive officer	9	NT$28,925
	8	NT$25,450		8	NT$27,930
	7	NT$22,370		7	NT$25,770
	6	NT$21,420		6	NT$24,900
Appointment	5	NT$19,480	Appointment	5	NT$22,425
	4	NT$18,610		4	NT$21,440
	3	NT$18,370		3	NT$21,030
	2	NT$18,310		2	NT$19,340
	1	NT$18,250		1	NT$18,920

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