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Using Multiple Criteria Decision Making Application to Select Subpar Ships Accordance To Challenges of Modern Technology

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المستخلص

تهدف هذه الورقة إلى التحقيق في الابتكار التكنولوجي ، وأهمية استخدام قاعدة البيانات الرقمية ، في تسهيل مراقبة دولة الميناء PSC لتسهيل ورقمنه الاتفاقيات والمدونات الحالية ، بعد تعديلها لتتوافق مع الابتكار المستقل لتطوير نظام PSC للتفتيش علي السفن المطبقة لمعاهده SOLAS ودعم التكنولوجيا الجديدة القادمة للسفن الحديثة وتجنب أوجه القصور في الإطار الحالي ، وتوفر نموذجًا متكاملًا قادرًا على اختيار السفن دون المستوى القياسي ، ويعمل كإجراء مكمل لنظام PSC.

تم اختيار عملية التسلسل الهرمي التحليلي (AHP) وطريقة تفضيل الطلب بناءً على نماذج تشابه الحل المثالي (TOPSIS) لاتخاذ القرارات ، باستخدام طرق معايير متعددة. تم استخدام هذه الطرق لترتيب السفن البديلة التي سيتم فحصها وفقًا للمتغيرات المستهدفة المعتمدة. العناصر التالية هي جزء من نظام اختيار السفن للتفتيش المقترح في هذه الدراسة: العوامل التي يجب مراعاتها تشمل تاريخ البناء ، والسفينة المحددة ، وبلد التسجيل ، وعدد العيوب ، هيئه الاشراف التابعة لها السفينة ، وعدد أوجه القصور التي لم يتم حلها ، والفترة الزمنية منذ آخر تفتيش ، ومشغلي السفن ، والمستثمرين ، وكمية الضحايا والمخالفات.

يشكل شكل استراتيجية الاتفاقية تحديًا في استخدام هذا الشكل الجديد من التكنولوجيا. ويتجلى ذلك ، في ظل عدم وجود لوائح ، بذكر معدات السفن الحديثة ، وكذلك استراتيجية استخدام التكنولوجيا الجديدة ، من خلال PSC ، لإدارة وفحص عملية الشحن الآمن لتجنب الحوادث البحرية وحماية البيئة. تم الجمع بين التحليلات الكمية والنوعية لتحقيق الأهداف الرئيسية للدراسة.

الكلمات الرئيسية: مراقبة دوله الميناء وعملية التسلسل الهرمي التحليلي وطريقة تفضيل الطلب على أساس تشابه الحل المثالي.

Abstract

This paper aims to investigate the technological innovation, and the importance of using the digitalized database, in facilitating the Port State Control (PSC)asks and digitalizing the current conventions and codes, after being amended to cope with the autonomous innovation to develop a (PSC) pointed-SOLAS ships-for-inspection system and support the upcoming new technology **Modern s**hips which avoids the deficiencies of the existing framework, provides an integrated model capable to select the substandard ships, and acts as a complementary measure to PSC system.

The Analytic Hierarchy Process (AHP) and Method for Order Preference Based on Ideal Solution Similarity (TOPSIS) models for Making Decisions, Using Multiple Criteria methods were chosen. These methods were used to rank the alternative ships that would be examined in accordance with the adopted targeted variables. The following elements are part of the system for choosing ships for inspection that is proposed in this study: Factors to take into account include the Kell laid, the ship specific, the country of registry, the number of flaws, the overall number of claims, the classification society, the number of unresolved deficiencies, the interval since the last inspection, the ship operators, the investors, and the quantity of casualties and violations.

The form of the convention's strategy poses a challenge in using this new form of technology. This is apparent, in the absence of regulations, mentioning the Modern ships equipment, as well as, a strategy for using the new technology, through the PSC, to manage and inspect the safe shipping operation to avoid marine accidents and protect the environment .Quantitative and qualitative analyses were combined to achieve the main objectives of the study.

Keywords: Port State Control , Analytic Hierarchy Process and Method for Order Preference Based on Ideal Solution Similarity .

1. Bckground

Stakeholders with an interest in the shipping sector have support the goals and aspect for PSC role . Many of those parties have stated that the alliances between fleets and the modifications to market processes are the root causes of this issue. Numerous other factors, including the general inability of those developing nations to implement and adhere to the most recent and frequent technical amendments to International Maritime Organization (IMO) instruments, the use of tacit acceptance techniques to bring the technical amendments into force, and the widespread implementation of PSC around the globe, all significantly contributed to the decline in the global fleet.

The IMO has created a number of regulations , conventions and instruments to decrease the loss of life, shipping losses, and environmental disaster that are frequently linked to maritime casualties. Marine casualties have always been a major problems . Numerous strategies to prevent the conditions that cause accidents have been developed as a result of these international treaties. While some are used on land to promote navigation safety, others are implemented at sea to ameliorate the situation, and some are used on ships to assure operational effectiveness, casualties still happen with worrying regularity.

By putting the ships under some forms of control, further measures are thought necessary to guarantee the proper application of international conventions and treaties. Then, it has been acknowledged that ports may contribute to the promotion of maritime safety and environment protection to complete the safety system as nodes in the supply chain for seaborne trade. Flag State Control (FSC) and PSC are the two aspects of ship control, respectively PSC. The IMO has established the standards for putting into practice the appropriate processes for both by the administrations to eradicate the substandard ships.

2. Introduction

Modern ship technology, Robotics, Drones, and E-certificates are already used in marine sectors and approved by port authorities under regulatory framework. The legal concern is understandable given that the autonomous shipping market, which was estimated in 2018 to be worth USD 6.1 billion, is now projected by some to be worth a staggering $136 billion by 2030 (koscielecki, et al., 2019).

There are numerous autonomous features and benefits for maritime shipping, including not only the reduction or elimination of human errors and crew claims, but also the accuracy of using AHP-TOPSIS model for data analysis to achieve and determine corrective action.

The exciting development of a "smart ship" will transform the landscape of ship design and operations, but this revolution will be fraught with difficulties. This briefing defines autonomous ships while focusing on the International Conventions and Regulations that will need to be updated to accommodate this new technological revolution.

The integrated model, which is the primary contribution of this effort, attempts to improve the effectiveness of the ship-selection system, i.e. increasing both stability and efficiency, within the existing PSC framework, and solves the ship-selection problem associated with the three approaches used herein.

In the following sections, the structure of the integrated selecting-ship-for-inspection system is outlined. Then it is applied to the case study and results obtained are presented and analyzed.

Finally, the findings of this paper are that, booming of SOLAS ships and new Autonomous technology and the integration with the AHP-TOPSIS modeling, with the benefits of transparency and cost-efficiency, facing major problems in working at sea will be minimized, also, there will be a scheme to follow in the updated conventions & the PSC inspections, that will update the new effective standards, in the maritime industry, that will diminish marine accidents.

3. Method Use And Tools .

There are several different Multi-Criteria Decision Making (MCDM) strategies, each of which can be used to a variety of challenges in fields like education, the environment, risk assessment, and decision-making. Since each of the MCDM approaches has its own benefits and drawbacks, and because the choice of the best strategy largely depends on the problem being studied, it is difficult to determine which approach is the most efficient and appropriate.

In order to increase the effectiveness of the PSC programme, the current research introduced the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approach. This strategy has the advantage of successfully identifying the optimal alternative and addressing challenging decision-making issues. The TOPSIS approach makes the assumption that each factor has a tendency to monotonically increase or decrease utility, which makes it easy to define the ideal solutions that are both positive and negative. However, this approach needs to determine the weights of selected factors, and it does so by asking experts for their opinions. *[Lai, et al (1994); Deng, et al (2000); Opricovic and Tzeng (2004); Srdjevic, et al (2004); Haisha (2008); Hung and Chen (2009); Fouladgar, et al (2011) and El Syaed, et al (2014)]*.

It would be more acceptable to employ a strong and relevant technique such as Analytic Hierarchy Process to address the TOPSIS approach's weakness of the difficulty to weigh considerations and maintain consistency of judgement (AHP). The latter approach has many benefits, including the following: (a) it makes use of the preferences of the experts based on their knowledge and experiences; (b) it checks the consistency of the information before eliminating any inconsistent information accordingly, reducing uncertainties in the results; and (c) it derives the factor weights by using pair-wise comparisons in accordance with the preferences of the experts. *[McCaffrey (2005); Berrittella, et al (2007); Behzadian, et al (2012); Nasim, et al (2013); El Syaed, et al (2014) and Pangsri (2015)]*

These findings led to the conclusion that the TOPSIS and AHP techniques make up two solid options for the current study. It was sought to blend the two approaches in order to create a hybrid strategy that would lessen their weaknesses while combining their strengths. The challenges encountered when applying the TOPSIS and AHP techniques separately may be overcome by the hybrid approach. The weight of each individual element was initially determined using the AHP method. The study was then finished using TOPSIS until substitute ships were ranked.

4. Structure of The Proposed Selecting Ship For Inspection System

This section describes the detailed methodology which includes three steps to construct the integrated selecting-ships-for inspection system as follows:

Step 1: The expert's judgments are used to evaluate the eleven factors, (f_1, f_2, f_3, f_4, …., f_{11}), includes the following factors: Kell laid, ship specific, nationality of registry, a number of shortcomings, total number of claims, classification society, number of outstanding deficiencies, time since last inspection, ship operators, investors, and number of casualties and violations are all factors to consider.

Step 2: The AHP approach is used to check consistency of the experts' judgements, then assign weight to each factor, (w_1, w_2, w_3, w_4 ...., w_{11}), which represents the importance of the factor.

Step 3: The alternative vessels to be checked are marking using the TOPSIS method.

Figure (1) shows the structure of the proposed selecting-ship-for inspection system.

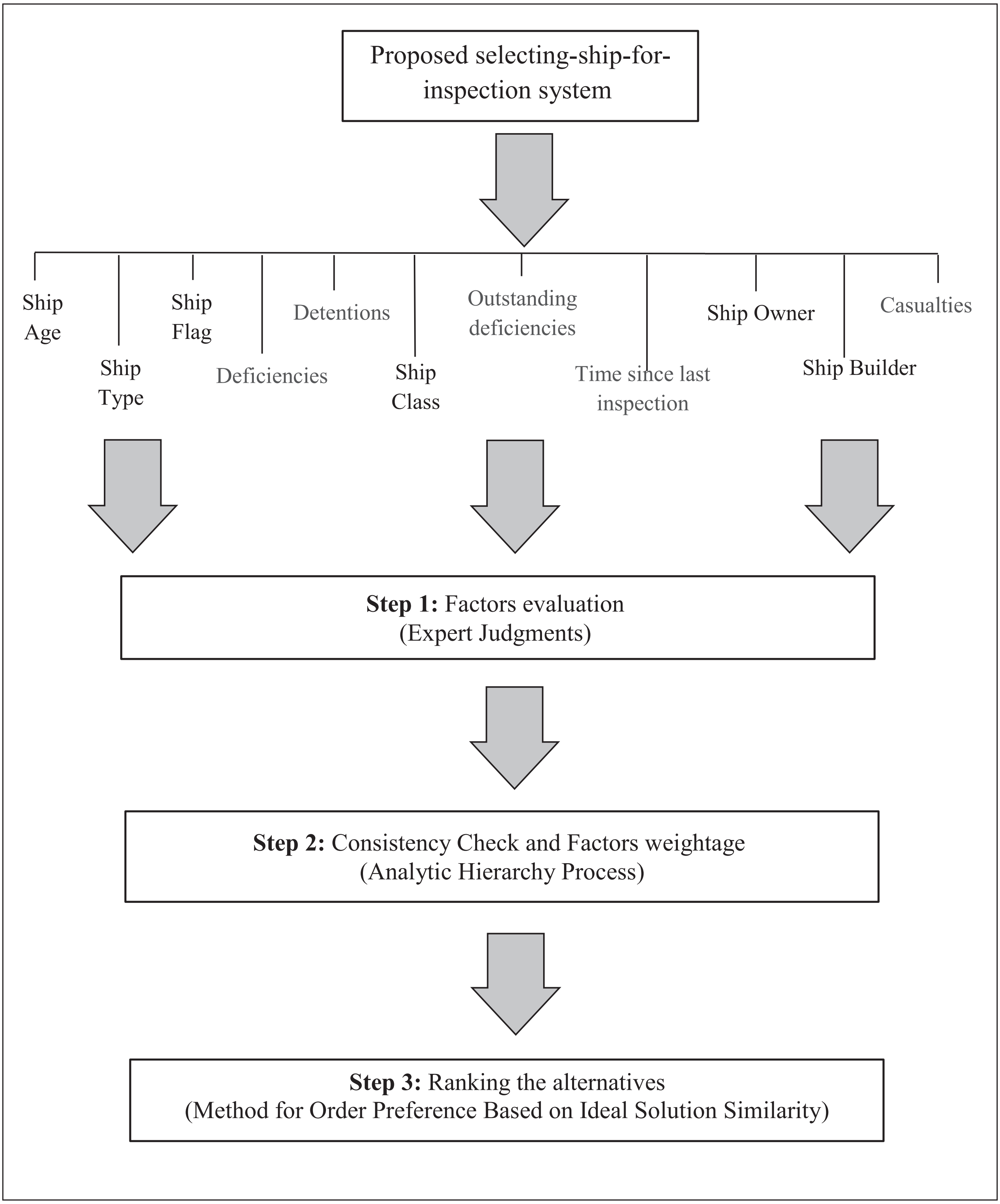

Figure (1) Structure of the proposed selecting-ship-for-inspection system

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5. Data Collection

The main tenet of the PSC order is that inspect foreign ships in their national ports to ensure that they are manned and operated in accordance with the relevant international laws and that their hull, machinery, and safety equipment comply with maritime regulations and conventions. The PSC has the authority to demand that flaws be fixed and, if necessary, to imprison ships for this purpose.

Ten ships are thought to be stopping at a fictitious port in the case study under discussion; for the sake of discussion, the ships will be coded S1, S2, S3,..., S10. Only four inspectors from the PSC office are in charge of conducting on-board inspections.

One ship may be inspected every day by each inspector. The challenge here is how to choose these 4 ships properly since there are 4 ships that need to be inspected out of the10 that need to be inspected. To achieve this, the Hybrid technique was used to rank the 10 ships.

6. Application of The Proposed Selecting Ship For Inspection System

One of the objectives of PSC is to set targeting factors to help identify what priority a particular foreign ship should be given for inspection in the region. The proposed structure of the selecting-ships-for-inspection model in this study includes the three main groups of factors as follows: firstly, the ship's characteristics such as ship age and ship type; secondly, the performance of the flag state, ship owner, classification society and ship builder; and thirdly, records from previous inspections such as number of detentions, number of deficiencies, number of outstanding deficiencies, number of casualties/violations, and time since last inspection.

As such, this study proposes an integrated AHP-TOPSIS model; AHP technique is concerned with the calculation of the weight of the selected factors, whereas TOPSIS technique is employed to rank the alternative ships based on their overall performance.

Figure (2) shows the flow of the processes of the proposed hybrid approach combining AHP and TOPSIS for the selecting-ships-for-inspection system.

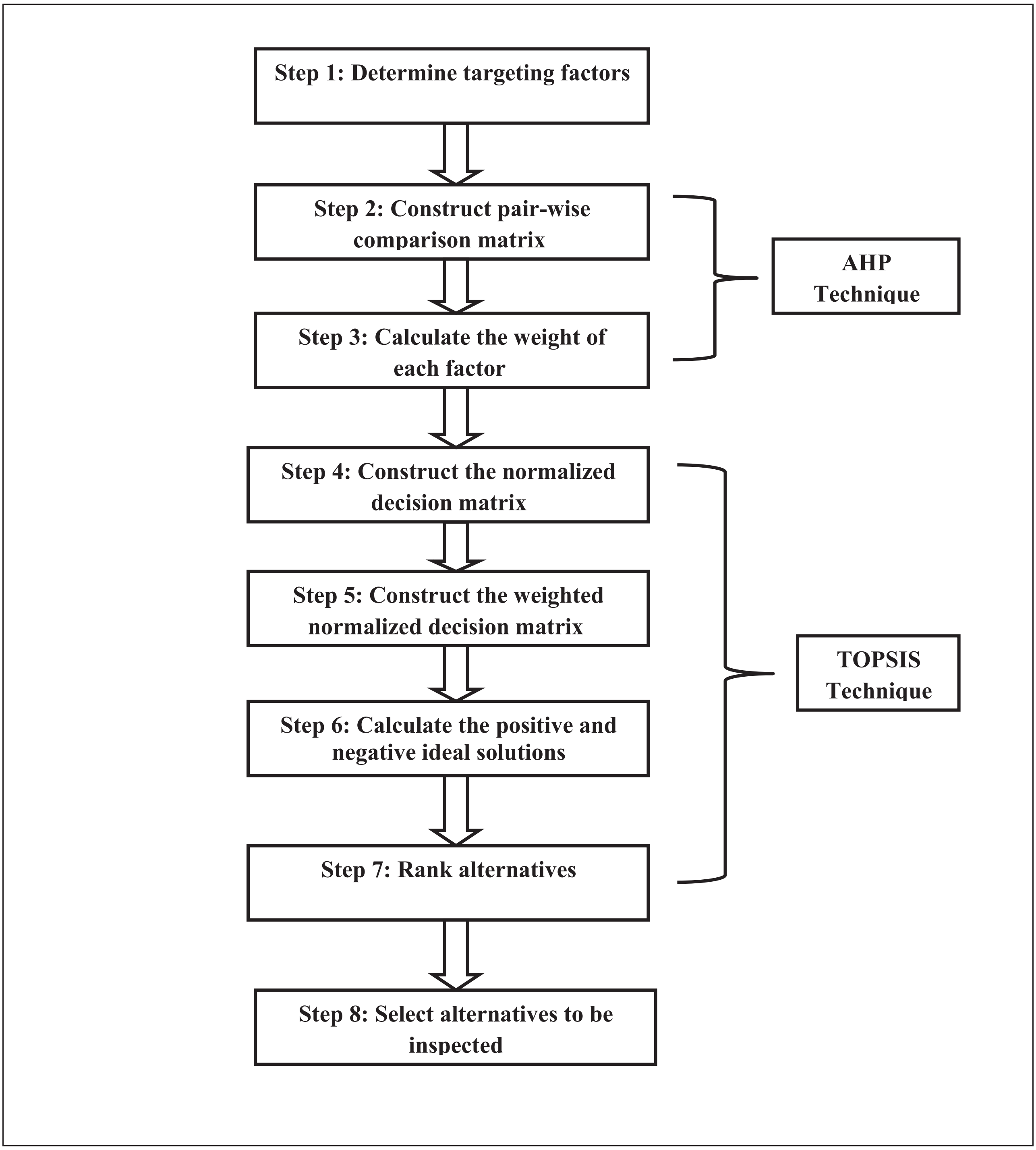

Figure (2) Research flowchart

The statistical technique (Excel sheet) has been used to calculate the variance and standard deviation for the eleven factors. The standard deviation results ranged from (0.0637) to (2.1088), and the variance from (0.0041) to (4.4470), as shown in Table. The relative importance of each factor indicated in Figure (3).

Table 1: Standard Deviation and Variance

Standard Deviation	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
F1	**0.0000**	0.7111	0.2351	1.2673	0.7638	0.5947	1.2792	1.5050	0.6536	0.8559	1.0104
F2	0.4624	**0.0000**	0.1187	0.6686	0.6495	0.2024	0.6030	1.1645	0.2406	0.5014	0.6696
F3	1.8320	1.6765	**0.0000**	1.6143	1.6214	1.3790	1.7495	2.1373	0.7217	1.3790	1.6214
F4	0.2209	0.2508	0.0637	**0.0000**	0.2344	0.2285	0.4330	0.5823	0.0981	0.1386	0.2709
F5	0.5810	1.0028	0.1454	0.9374	**0.0000**	0.1306	1.3371	1.4355	0.3026	0.2419	0.5365
F6	0.9415	1.0000	0.2941	1.6765	1.0445	**0.0000**	1.2401	1.8809	0.4866	0.8010	1.3671
F7	0.2258	0.2171	0.0663	0.3693	0.2706	0.1107	**0.0000**	0.5691	0.0996	0.1444	0.2828
F8	0.2369	0.2655	0.0637	0.4438	0.2679	0.1257	0.4330	**0.0000**	0.1050	0.1527	0.2937
F9	2.0835	1.9752	0.4576	1.6765	2.1088	1.0967	1.6765	2.1088	**0.0000**	0.9374	1.7838
F10	1.0208	1.2454	0.3087	1.7123	0.9653	1.0285	1.8320	1.8007	0.2983	**0.0000**	1.0731
F11	0.4891	1.0188	0.1222	0.8348	0.4981	1.0624	1.3484	1.5050	0.2396	0.2491	**0.0000**
Variance	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**	**F11**
F1	**0.0000**	0.5057	0.0553	1.6061	0.5833	0.3537	1.6364	2.2652	0.4272	0.7325	1.0208
F2	0.2138	**0.0000**	0.0141	0.4470	0.4219	0.0410	0.3636	1.3561	0.0579	0.2514	0.4484
F3	3.3561	2.8106	**0.0000**	2.6061	2.6288	1.9015	3.0606	4.5682	0.5208	1.9015	2.6288
F4	0.0488	0.0629	0.0041	**0.0000**	0.0549	0.0522	0.1875	0.3390	0.0096	0.0192	0.0734
F5	0.3375	1.0057	0.0211	0.8788	**0.0000**	0.0170	1.7879	2.0606	0.0915	0.0585	0.2879
F6	0.8864	1.0000	0.0865	2.8106	1.0909	**0.0000**	1.5379	3.5379	0.2367	0.6416	1.8688
F7	0.0510	0.0471	0.0044	0.1364	0.0732	0.0122	**0.0000**	0.3239	0.0099	0.0208	0.0800
F8	0.0561	0.0705	0.0041	0.1970	0.0718	0.0158	0.1875	**0.0000**	0.0110	0.0233	0.0863
F9	4.3409	3.9015	0.2094	2.8106	4.4470	1.2027	2.8106	4.4470	**0.0000**	0.8788	3.1818
F10	1.0421	1.5511	0.0953	2.9318	0.9318	1.0579	3.3561	3.2424	0.0890	**0.0000**	1.1515
F11	0.2392	1.0379	0.0149	0.6970	0.2481	1.1287	1.8182	2.2652	0.0574	0.0620	**0.0000**

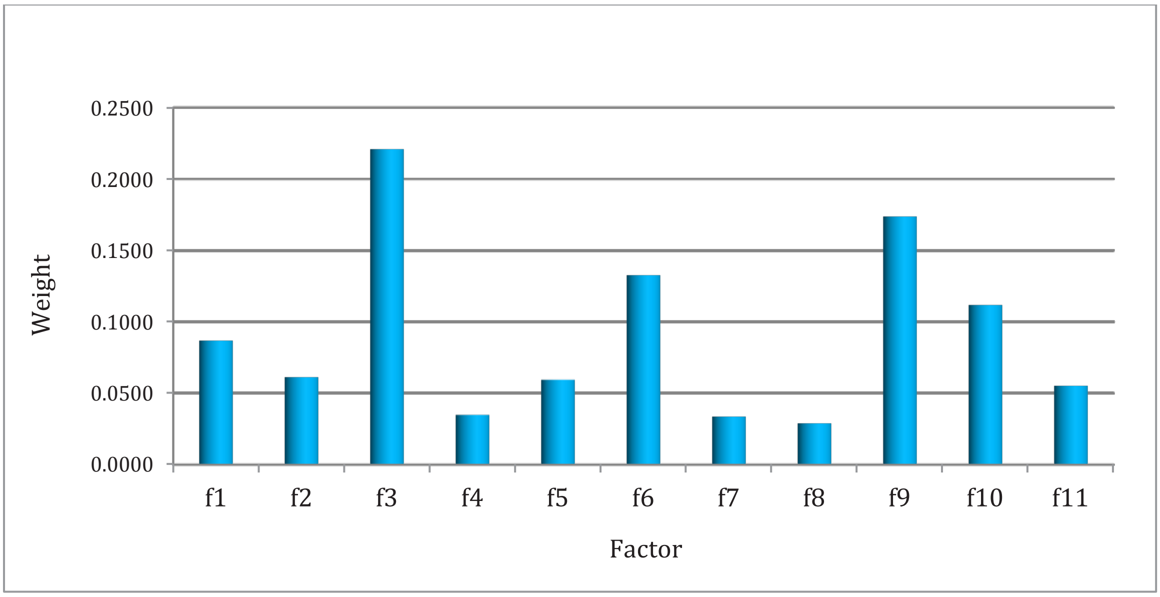

Figure (3) Weight of factors using AHP approach

Finally, the TOPSIS approach was applied in order to rank the ships. The weights of factors, which were calculated using AHP, were used as the input to TOPSIS. The proposed system was applied to rank the ten ships according to their targeting priority.

The results shown in Figure (4) indicate that ship S_5 has a rank of 1, while ship S_4 has a rank of 2. Ship S_2 and ship S_{10} possess ranks of 3 and 4, respectively. The results obtained from the proposed system reflected the importance of the factors weights and its impact on selection of the four ships.

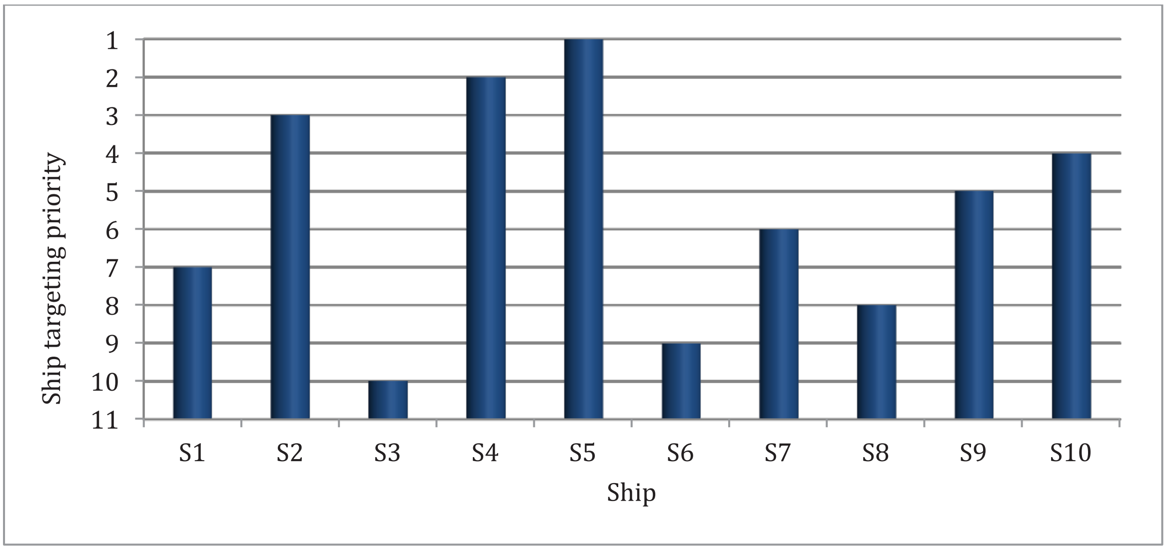

Figure (4) Ship targeting priorities based on the proposed system

According to the previously explained PSC strategy, the following can be deducted

- Using the AHP-TOPSIS Model contributes to managing and securing the PSC targeting evaluation through various cons. PSC inspectors can easily trace the history of any ship's data.
- Model is resistant to cyber-attacks and that would be helpful in preventing any access to PSC database especially by hackers.
- Model provides PSC numerous criteria of the data which can select.

7. Discussion

In recognition of PSC's importance in enforcing national and international ship safety standards, port states invest a great deal of time, effort, and resources to promote effectiveness in the implementation of their regional inspection regime. Assessments serve as a periodic review of the regime's purpose, an encouragement to its continued implementation, an instrument in identifying success and failure, as well as a tool to distinguish one from the other. In this regard, the current research offers a twofold contribution to PSC. Firstly, it gives a substantial contribution to the determination of new targeting factors that may lead to an enhanced implementation of PSC. Secondly, it presents a way to tackle the issue of the effectiveness of controls within a hybrid AHP-TOPSIS model, in order to enhance the effectiveness of the PSC inspections.

The TOPSIS technique was included in the recent study to increase the PSC program's efficacy. This strategy has the advantage of successfully identifying the optimal alternative and addressing challenging decision-making issues. The TOPSIS approach assumes that each factor tends to monotonically increase or decrease utility, which makes it easy to define the ideal solutions that are positive and negative. However, this approach needs to establish the weights of chosen factors, which it does by asking experts' opinions.

To overcome the TOPSIS approach shortcoming of the difficulty to weight factors and keep consistency of judgement, it would be more appropriate to use a powerful and suitable technique such as AHP. The latter approach has many advantages as follows: (a) it uses the experts' preferences depending on their knowledge and experiences; (b) it checks consistency of information then inconsistent information is eliminated accordingly, and uncertainties in results are diminished and (c) the factor weights are obtained by using pair-wise comparisons according to preferences of the experts.

8. Conclusion

The technological achievement brought the vision of fully autonomous shipping to life, while supporters of autonomous shipping are working hard to implement the technology as quickly as possible and put it into force. This paper has shown the importance of the AHP-TOPSIS Model in the maritime field currently , especially in the mechanism of PSC, to select data; this will result in changing the maritime conventions and codes. There are many marine entities, which have used this technology in different ways, which proved its success in marine ports and marine companies, and support the PSC to handle the select target with the upcoming technology .

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