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Declarations

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The authors declare that they have no obviously competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

2. Ethics approval
This article does not contain any studies with human participants or animals performed by any of the authors.

3. Authors’ contributions
Jing-Wei Liu: Writing-original draft, Conceptualization, Constructing experimental model and Methodology. Sheng-Hsiang Chen: Methodology, Validation, Writing-review & editing. Che-Hsiu Chen: Data Curation. Tsung-Han Huang: Project administration, Data Curation.
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Abstract
Taiwan’s rowing has achieved well performance in the Asian Games, but it has not in the Olympics. To get good results, in addition to the hard work and solid and effective training on weekdays, the qualification of the players is one of the key factors. Therefore, this research attempts to construct an artificial intelligence (AI) evaluation algorithm for rowing athletes to obtain advantages in the sports field, and can start from the athletes. The AI algorithm involves the hierarchical analysis method (AHP) is adopted to invite experts and scholars in the rowing field to answer the expert questionnaire. The TOPSIS (technique for order performance by similarity to ideal solution) method is then applied to calculate the ranking of material selection indicators, aiming to construct an evaluation model for rowers. The main research result shows that physicality is considered as the highest priority among the four main criteria of talent identification, following in a descending order by specialism, reaction and psychological elements. The propose model established by the most beneficial decision model for identification of talented rowers in the future.

Keywords: AI Intelligent Strategy Algorithm, AHP, TOPSIS, Rowing

1. INTRODUCTION
The rowing athletes of Taiwan have achieved well performance in the rowing of the Asian Games. However, such a scenario is very different from that in the Olympic Games. Indeed, although the Taiwanese rowers were successively qualified into the last four Olympics, they were all unable to win the medals. The fact that Jiang Qianru was ranked 17th in the women’s single scull competition in the 2004 Athens Olympics and Wang Minghui was ranked 23rd in men’s single scull in the 2008 Beijing Olympics remains the best women’s and men’s rowing performance for Taiwan in Olympics. Comparing with weightlifting, taekwondo, and archery that have the Olympic strong medal-winning ability for Taiwan, as Tang (1996) noted, rowing in Taiwan still has a lot of room for improvement.

Different sports require different body shapes and athletic abilities to achieve well performance. Therefore, understanding the physique requirements of rowing athletes can optimize the process of selecting and/or identifying potential rowers. In recent years, many scholars have extended researches to athlete selection in numerous sports through various methods. Zheng (2017) used the physical fitness differences of excellent male college football players in different positions in China to conduct tests of specific physical fitness tests in different positions to construct a material selection model. Yuan (2017) investigated the body shape and palm dermatoglyphics of the women’s volleyball open group in the southern region of Taiwan. The research results were compared with the relevant studies of other scholars, using for the selection of female volleyball players in the future. A baseball coach adopted the Delphi method to construct the basis for the selection of baseball pitchers at the junior high school (Shen 2017). Cao, Zhang, and Gao (2013) referred to the relevant literature on basketball talent selection and collected the recommendations of basketball experts and scholars to establish the professional ability assessment of basketball players. The model provides...
selection of basketball players. Salimi et al. (2012) used AHP (analytic hierarchy process) and TOPSIS (technique for order performance by similarity to ideal solution) to construct a decision-making model for sports venues selection, including nine weighted criteria. Indeed, Mavi, Mavi, and Kiani (2012) combined AHP and TOPSIS algorithms to measure and evaluate the performance of the national football team players. Moreover, Chen, Lee, and Tsai (2014) developed a decision-making model for the coaching team to choose a starting pitcher scheduling strategy by applying AHP and TOPSIS. Furthermore, Nurjaya et al. (2020) adopted AHP to value some main criteria that help to identify talented rowers.

The literatures above indicate that the criteria for sports talent identification are primarily formed through the relevant literature review and the experience of sports experts and scholars. Also, the body shape and special physical fitness requirements are the two main criteria included in most studies of sports talent identification. Current researches in Taiwan on the identification of rowing athletes are also based on the data of the body shape of excellent male and female rowers, and are further compared the data with that of other international excellent rowers. These researches are used AI intelligent strategy algorithm to discover potential rowing talents, but they rarely put focus on the quality of various special abilities of rowing (Gong et al. 201; Huang et al. 2013). Therefore, this research not only refers to the literature in relation to rowing, but also includes the special abilities required by rowers into consideration. In addition, based on the AI evaluation algorithm of AHP and TOPSIS, the model of identifying potential rowers is constructed.

2. AI INTELLIGENT STRATEGY ALGORITHM

Saaty (1980) proposed the AHP model to solve complex decision problems. The AHP is also a measurement theory that prioritizes the hierarchy and consistency of judgment data provided by a group of decision makers. TOPSIS was first proposed by Hwang and Yoon (1981). The underlying logic of TOPSIS is to define the ideal and negative ideal solutions. The ideal solution is the solution that maximizes the benefit criteria and minimizes the cost criteria; whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria. In this stage, we construct an AI intelligent strategy algorithm for evaluation international excellent rowers, the AI intelligent strategy algorithm are:

Step 1: Establish a Hierarchy of Experts

The AHP incorporates the evaluations of all decision makers into a final decision, without having to elicit their utility functions on subjective and objective criteria, by pairwise comparisons of the alternatives (Saaty 1990). The AHP applied to a diverse array of problems, using the following calculation procedure (Xitzlali et al. 2010; Zhang et al. 2010).

Step 2: Development of an Expert Questionnaire for Evaluating Rowers

Establish a pairwise comparison matrix A. Let $C_i$, $C_2, \ldots, C_n$ denote the set of criteria, while $a_{ij}$ represents a quantified judgment on a pair of elements $C_i$, $C_j$. The relative importance of the two criteria is rated using a scale with the values 1, 3, 5, 7, and 9, where 1 refers to “equally important”, 3 denotes “slightly more important”, 5 equals “strongly more important”, 7 represents “demonstrably more important” and 9 denotes “absolutely more important.” This yields an $n$-by-$n$ matrix $A$ as follows:
\[
A = \begin{bmatrix}
    1 & a_{12} & L & a_{1n} \\
    a_{21} & 1 & L & a_{2n} \\
    M & M & M & M \\
    a_{n1} & \frac{1}{a_{2n}} & L & 1
\end{bmatrix}
\]

Where \(a_{ij} = 1\) and \(a_{ij} = \frac{1}{a_{ij}}, i,j = 1, 2, \ldots, n.\)

Step 3: Calculate the Weights of the Criteria and Sub-criteria

In matrix \(A\), the problem becomes one of assigning to the \(n\) criteria \(C_1, C_2, \ldots, C_n\) a set of numerical weights \(W_1, W_2, L, W_n\) that reflect the recorded judgments. If \(A\) is a consistency matrix, the relations between weights \(W_i\) and judgments \(a_{ij}\) are simply given by \(W_i = a_{ij}\) (for \(i, j = 1, 2, \ldots, n\)). Saaty (1990) suggested that the largest eigenvalue \(\lambda_{\text{max}}\) would be

\[
\lambda_{\text{max}} = \sum_{j=1}^{n} W_j a_{ij} / W_i.
\]

If \(A\) is a consistency matrix, eigenvector \(X\) can be calculated by

\[
(A - \lambda_{\text{max}} I)X = 0.
\]

Saaty proposed utilizing the consistency index (C.I.) and the consistency ratio (C.R.) to verify the consistency of the comparison matrix. C.I. and R.I. are defined as follows:

\[
C.I. = \frac{\lambda_{\text{max}} - n}{n-1},
\]

\[
C.R. = \frac{C.I.}{R.I.}
\]

Where R.I. represents the average consistency index over numerous random entries of same order reciprocal matrices. If \(C.R \leq 0.1\), the estimate is accepted; otherwise, a new comparison matrix is solicited until \(C.R \leq 0.1.\)

Step 4: Calculation TOPSIS Decision Matrix

The ranking of alternatives in TOPSIS is based on the relative similarity to the ideal solution, which avoids the situation of both ideal and negative ideal solutions being similar. The calculation processes of the method are as follows:

\[
D = \begin{bmatrix}
A_1 & X_{11} & X_{12} & L & L & X_{1j} & X_{1n} \\
A_2 & X_{21} & X_{22} & L & L & X_{2j} & X_{2n} \\
& M & M & L & M & M \\
A & X_{n1} & X_{n2} & M & M & X_{nj} & X_{nn} \\
& M & M & L & M & M \\
A & X_{m1} & X_{m2} & L & L & X_{mj} & X_{mn}
\end{bmatrix}
\]

where \(A_i\) denotes the possible rowers, \(i = 1, \ldots, m; X_j\) represents criteria related to alternative performance, \(j = 1, \ldots, n;\) and \(X_{ij}\) is a crisp value indicating the performance rating of each rower \(A_i\) with respect to each criterion \(X_j.\)
Calculate the normalized decision matrix $R (= [r_{ij}])$. The normalized value $r_{ij}$ is calculated in equation (7):

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{n} x_{ij}^2}}, \ j = 1, \ldots, n; \ i = 1, \ldots, m.$$  

(7)

A set of weights $w = (w_1, w_2, \ldots, w_n)$, $\sum_{j=1}^{n} w_j = 1$ from AHP is the accommodated weight.

This matrix can be calculated by multiplying each column of $R$ with its associated weight $w_j$. Therefore, the weighted normalized decision matrix $V$ is equal to equation (8).

$$V = \begin{bmatrix} V_{i1} & V_{i2} & L & V_{ij} & L & V_{in} \\ M & M & M & M & M & M \\ V_{i1} & V_{i2} & L & V_{ij} & L & V_{in} \\ M & M & M & M & M & M \\ M & M & M & M & M & M \\ V_{in} & V_{in2} & L & V_{ijn} & L & V_{in} \end{bmatrix} = \begin{bmatrix} w_{1j} & w_{2j} & L & w_{ij} & L & w_{nj} \\ M & M & M & M & M & M \\ w_{1j} & w_{2j} & L & w_{ij} & L & w_{nj} \\ M & M & M & M & M & M \\ M & M & M & M & M & M \\ w_{nj} & w_{nj2} & L & w_{ijn} & L & w_{nj} \end{bmatrix}$$  

(8)

Step 5: Calculate the Most Ideal Solution and the Negative Ideal Solution

The ideal solution is computed based on the following equations (9) and (10):

$$A^* = \{(\max V_{ij} \mid j \in J), (\min V_{ij} \mid j \in J^*), i = 1, 2, \ldots, m\},$$  

(9)

$$A^- = \{(\min V_{ij} \mid j \in J), (\max V_{ij} \mid j \in J^*), i = 1, 2, \ldots, m\},$$  

(10)

where

$$j = \{j = 1, 2, \ldots, n \mid j \text{ belongs to benefit criteria}\},$$

$$j^* = \{j = 1, 2, \ldots, n \mid j \text{ belongs to cost criteria}\}.$$

Calculate the distance between the ideal and negative ideal solutions for each rower, see equations (11) and (12):

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_i^*)^2} \quad i = 1, 2, \ldots, m,$$  

(11)

$$S_i^- = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_i^*)^2} \quad i = 1, 2, \ldots, m,$$  

(12)

Step 6: Calculate the Comprehensive Evaluation Value of Each Player

Calculate the relative closeness to the ideal solution of each rower,

$$C_i^* = \frac{S_i^-}{S_i^+ + S_i^*} \quad i = 1, 2, \ldots, m,$$  

(13)

where $0 \leq C_i^* \leq 1$, that is, a rower $i$ is closer to $A^*$ as $C_i^*$ approaches 1.

A set of rowers can be preference ranked according to the descending order of $C_i^*$. 

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3. RESULTS

In this study, eight best rowers are selected from twelve rowers. According to Saaty (1980), it is best not to exceed seven, so as not to affect the consistency of the hierarchy. Therefore, when there are not too many elements in the rowing level, AHP can only achieve the weight value of each criterion and sub-criteria, and then use the TOPSIS method to conduct comprehensive evaluation and ranking of players. This study based on AHP and TOPSIS to construct the rowing player AI evaluation algorithm as shown in Figure 1. First, then, measure the data of the rower ’s sub-criteria, and then multiply the weights calculated by the AHP by the rower’s sub-criteria. Finally, the TOPSIS calculation process is used to calculate the ranking of the rowers, and the rowers are selected by the ranking. The evaluation steps are as follows:

Step 1: Establish a Hierarchy of Experts to select rowers

Xu pointed out that the selection of sports science is actually a combination of many sports-related disciplines, including anatomy-related body shapes and physiques; physiological functions and physical fitness elements covered by sports physiology; sports ability included in sports biomechanics technology and movement; and mental intelligence and various psychological related qualities in the field of psychology can be used as an effective assessment of whether athletes have high-level performance, and genetics is closely related to these sports science related disciplines (Xu 2006). The key factors that influence the selection of rowers through the literature are several important analysis aspects, which are the four analysis aspects of body, response, special and psychological elements, 16 evaluation criteria, four aspects and criteria The following are: body elements (body mass composition, muscle composition, sitting posture and shoulder width), reaction elements (explosive force, coordination, speed, and muscle endurance), special elements (flexibility, rhythm, pull strength, kick strength) , Psychological factors (stress resistance, concentration, self-confidence and goal setting). According to the literature, the four facets and 18 selection criteria for evaluating the selection of rowers 'materials were sorted out, and the four facets and 18 selection criteria for the selection of rowers’ materials were analysed using the AHP method. The method is divided into three levels, the selection of the first layer of rowers' material selection, the second layer is the four facets of the rower's material selection, and the third layer is the 18 criteria and mathematical code (Huang 2019), see Table 1, AHP architecture diagram, see Figure 2.
Table 1 Criteria and Sub-Criteria for Evaluating Rowers

| Criteria          | Criteria Code | Sub-Criteria                          | Sub-Criteria Code |
|-------------------|---------------|---------------------------------------|-------------------|
| Body              | C1            | Body Mass Composition (BMC)           | C11               |
|                   |               | Muscle Composition (MC)               | C12               |
|                   |               | Sitting Height (SH)                   | C13               |
|                   |               | Shoulder Width (SW)                   | C14               |
|                   |               | Upper Limb Length (ULL)               | C15               |
|                   |               | Explosive Force                       | C21               |
|                   |               | Coordination                          | C22               |
|                   |               | Speed                                 | C23               |
|                   |               | Muscular Endurance (ME)               | C24               |
|                   |               | Flexibility                           | C31               |
| Reaction          | C2            |                                       |                   |
| Profession Item   | C3            | Pulling Force (PF)                    | C32               |
|                   |               | Kick Strength                         | C33               |
|                   |               | Dynamometer Results (DR)              | C34               |
|                   |               | Compression Resistance                | C41               |
| Psychological     | C4            | Concentration                         | C42               |
|                   |               | Self-confidence                       | C43               |
|                   |               | Target Setting (TS)                   | C44               |

Figure 1: Construction of the AI Evaluation algorithm for Rowers
Step 2: Development of an Expert Questionnaire for Evaluating Rowers

According to step 1, a pairwise comparison is developed, and an expert questionnaire is developed to evaluate the main and sub-criteria. Taking the evaluation criterion as an example, the questionnaire of the expert pairwise comparison, see Table 2.

Table 2: Expert Questionnaire for Evaluating Rowers

| Assessment Scale | Absolutely Important | Quite Important | Equally Important | Quite Important | Absolutely Important |
|------------------|----------------------|-----------------|-------------------|-----------------|---------------------|
| Body             | 9                    | 8               | 7                 | 6               | 5                   | 4                   | 3 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Body             |                       |                 |                   |                 |                     |                     |               |   |   |   |   |   |   |   |   |   |   |   |
| Body             |                       |                 |                   |                 |                     |                     |               |   |   |   |   |   |   |   |   |   |   |   |
| Reaction         |                       |                 |                   |                 |                     |                     |               |   |   |   |   |   |   |   |   |   |   |   |
| Psychological    |                       |                 |                   |                 |                     |                     |               |   |   |   |   |   |   |   |   |   |   |   |

Step 3: Calculate the Weights of the Criteria and Sub-criteria

Use formulas (2) and (3) to calculate the weights of the criteria and sub-criteria, see Table 3.
Table 3 Expert Weights

| Criteria | Weight | Sub-criteria       | Weight |
|----------|--------|--------------------|--------|
| C1       | 0.401  | C11                | 0.452  |
|          |        | C12                | 0.282  |
|          |        | C13                | 0.147  |
|          |        | C14                | 0.085  |
|          |        | C15                | 0.034  |
| C2       | 0.211  | C21                | 0.083  |
|          |        | C22                | 0.315  |
|          |        | C23                | 0.143  |
|          |        | C24                | 0.459  |
| C3       | 0.311  | C31                | 0.127  |
|          |        | C32                | 0.147  |
|          |        | C33                | 0.163  |
|          |        | C34                | 0.466  |
|          |        | C35                | 0.097  |
| C4       | 0.077  | C41                | 0.471  |
|          |        | C42                | 0.292  |
|          |        | C43                | 0.143  |
|          |        | C44                | 0.094  |

Step 4: Calculation TOPSIS Decision Matrix

Using formula (6) to formula (8), multiply the weight value of the criteria and sub-criteria by the measurement value of each rower, which is the weighted measurement value of each player, and use this value as the initial calculated value of TOPSIS’s decision matrix, see Table 4.

Table 4 Weighted Normalization Rower Players Matrix

|     | C1    | C2    | C3    | C4    |
|-----|-------|-------|-------|-------|
|     | C11   | C12   | C13   | C14   |
| R1  | 0.449 | 0.434 | 0.453 | 0.602 |
| R2  | 0.416 | 0.424 | 0.448 | 0.577 |
| R3  | 0.444 | 0.516 | 0.462 | 0.552 |
| R4  | 0.431 | 0.436 | 0.448 | 0.539 |
| R5  | 0.492 | 0.410 | 0.424 | 0.577 |
|     | C21   | C22   | C23   | C24   |
|     | 0.418 | 0.459 | 0.583 | 0.380 |
|     | 0.511 | 0.438 | 0.557 | 0.498 |
|     | 0.418 | 0.469 | 0.591 | 0.380 |
|     | 0.418 | 0.426 | 0.569 | 0.552 |
|     | 0.463 | 0.443 | 0.560 | 0.398 |
|     | C31   | C32   | C33   | C34   |
|     | 0.247 | 0.640 | 0.415 | 0.429 |
|     | 0.052 | 0.483 | 0.481 | 0.471 |
|     | 0.461 | 0.598 | 0.492 | 0.440 |
|     | 0.741 | 0.588 | 0.464 | 0.443 |
|     | 0.412 | 0.548 | 0.373 | 0.452 |
|     | C41   | C42   | C43   | C44   |
|     | 0.328 | 0.681 | 0.488 | 0.456 |
|     | 0.199 | 0.363 | 0.317 | 0.438 |
|     | 0.473 | 0.636 | 0.561 | 0.399 |
|     | 0.598 | 0.787 | 0.439 | 0.478 |
|     | 0.523 | 0.772 | 0.391 | 0.456 |

Step 5: Calculate the Most Ideal Solution and the Negative Ideal Solution

Use formula (9) to formula (12) to calculate and calculate the most ideal solution and the negative ideal solution, see Tables 5 and 6.

Table 5 The distance between the ideal solution

|     | C1    | C2    | C3    | C4    |
|-----|-------|-------|-------|-------|
|     | C11   | C12   | C13   | C14   |
| R1  | 0.000 | 0.023 | 0.001 | 0.000 |
| R2  | 0.015 | 0.026 | 0.002 | 0.001 |
| R3  | 0.003 | 0.000 | 0.004 | 0.000 |
| R4  | 0.008 | 0.023 | 0.002 | 0.001 |
|     | C21   | C22   | C23   | C24   |
|     | 0.008 | 0.003 | 0.001 | 0.084 |
|     | 0.008 | 0.010 | 0.005 | 0.000 |
|     | 0.000 | 0.010 | 0.000 | 0.000 |
|     | 0.000 | 0.013 | 0.000 | 0.003 |
|     | 0.008 | 0.013 | 0.000 | 0.000 |
|     | 0.008 | 0.016 | 0.013 | 0.003 |
|     | 0.000 | 0.013 | 0.000 | 0.000 |
|     | 0.000 | 0.017 | 0.000 | 0.002 |

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Step 6: Calculate the Comprehensive Evaluation Value of Each Player

Use formula (13) to calculate the comprehensive evaluation value of each rower, see Table 6. R3 = 0.749 is the best rower player.

Table 6 Outcome of the Rank of Rower Players

| Rower Players |  \(d^+\) |  \(d^-\) | TOPSIS \(A_i^*\) | Rank |
|---------------|-------|-------|----------------|------|
| R1            | 0.103 | 0.126 | 0.549          | 4    |
| R2            | 0.180 | 0.063 | 0.259          | 5    |
| R3            | 0.058 | 0.173 | 0.749          | 1    |
| R4            | 0.084 | 0.248 | 0.746          | 2    |
| R5            | 0.096 | 0.204 | 0.680          | 3    |

4. CONCLUSION AND DISCUSSION

This research mainly contributes to the establishment of an AI Intelligent Strategy Algorithm for selecting rowers. First, the study assembled four main criteria and seventeen sub-criteria by using the AHP to collect the recommendations of experts. The weights and importance of the main criteria and sub-criteria are then evaluated. When the TOPSIS selects rowers for the second stage, it will be used as the evaluation index for rowers. In the future, the empirical analysis will be used to verify the availability of the model for selecting rowers.

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Figures

AHP Calculation Processes

Step 1
Establish a Hierarchy of Experts to select rowers

Step 2
Development of an Expert Questionnaire for Evaluating Rowers

Step 3
Calculate the Weights of the Criteria and Sub-Criteria

TOPSIS Calculation Processes

Step 4
Calculation TOPSIS Decision Matrix

Step 5
Calculate the Most Ideal Solution and the Negative Ideal Solution

Step 6
Calculate the Comprehensive Evaluation Value of Each Player

Figure 1

Construction of the AI Evaluation algorithm for Rowers
Figure 2

Evaluation Rower Players Architecture