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RESEARCH ON USING FAHP AND TOPSIS TO ESTABLISH NATIONAL ARMY RECRUITMENT SERVICE QUALITY INDICATORS: TAKE VOCATIONAL SCHOOLS FROM YILAN COUNTY AS AN EXAMPLE

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Abstract

This study implements an expert questionnaire survey and adopts the fuzzy analytic hierarchy process (FAHP) to determine the weight of recruitment service quality in order to explore the status quo of military recruitment in Yilan County, Taiwan. Afterwards, the TOPSIS analysis method was used to sort out various indicators of service quality, analyze service quality, and provide a future reference for national army recruitment. Afterwards, the TOPSIS analysis method is employed to organize various metrics of service quality, analyze service quality, and provide future references for national army recruitment. The research subjects are students from 16 vocational high schools in Yilan County. The research discovered that the most important factor affecting the quality of military recruiting services is "empathy" rather than "tangibility" which the military spends great efforts to pursue. Empathy ranked highest among all factors with a weight of 0.49, Assurance and Reliability both ranked second with a weight of 0.20, followed by Responsiveness with a weight of 0.08. Further analysis revealed that among the factors related to Empathy, "the recruiter will prioritize students' rights" is the most important factor, with a weight of 0.25. Finally, this study can provide a reference for the service quality of national army recruiters, and improve recruitment performance by improving recruitment service quality parameters.

Keywords: Military recruitment, service quality, fuzzy analytic hierarchy process (FAHP), technique for order of preference by similarity to ideal solution (TOPSIS)

Introduction

For a long time, Taiwan's national army has leveraged promotional methods such as advertising, media, and boot camps to reach the public, encouraging people to understand the National Army and attracting people to join the ranks of volunteer service. This research adopted fuzzy hierarchy analysis (FHA) for paired comparison and discovered that among the five factors of service quality, the "empathy" aspect in the service quality model has the highest weight, accounting for 0.49. It can be seen that for vocational high school students, personal feelings are critical; assurance and reliability come second, with a weight of 0.20. These findings have important implications for national army recruitment and could help improve personal feelings and trust among school students. If the recruitment center does not provide timely care to students after the promotional activities, it will be difficult to make progress in recruitment.

The TOPSIS analysis showed that in terms of empathy, the principle of "recruiters prioritize students' rights" ranked highest, indicating that this is the top priority for students. Therefore, recruiters must prioritize students' rights during recruiting process.

Literature Review

Service Quality

In today's society, the public pays more and more attention to the demand for "service" and constantly pursues upgraded "service experience". Taking campus as an example, students' employment options are also more diversified. The following explains how Taiwan's national army attracts students to join the military through campus recruitment to strengthen national army manpower: In the past, the national army would conduct recruitment activities through recruitment centers and recruitment groups in various regions, including holding promotional activities in vocational high school campuses, amplifying promotional effects through traditional media such as television, newspapers, and magazines, and organizing summer camps and other activities for students to visit in order to attract them to experience the various military camps. This study analyzes service quality from five aspects: tangibility, reliability, responsiveness, assurance, and empathy, and provides a reference for national army recruitment services.

Tangibility: Taiwan's national army has been working hard to utilize positive news to change the public's perception of the national army through media propaganda and enhance the image of the national army (Chu & Lee, 2021), thereby increasing the willingness of young people to join the army. Similarly, Wang & Tsai (2018) proposed to strengthen educational publicity and marketing strategies to enhance the effectiveness of recruitment. The national army headquarters, combined forces brigade and other units will also regularly visit high schools and vocational high schools to provide explanations to students who want to apply for military services. Moreover, they also cooperate with

educational institutions to hold college fairs and explain to parents and applicants in person. However, these recruitment methods were not as effective as expected in increasing students' interest in volunteering for the National Army. We can learn from many recruitment advertisements that the social distance of the target audience in recruitment advertisements can have a significant impact on potential applicants with different regulatory focus (Fu & Huang, 2021). During the recruitment process, applicants will first understand whether the characteristics of the organization and the job vacancies meet their expectations to determine whether the position meets their needs (Hong et al., 2016). Therefore, when recruiting people on campus, recruitment goals must first be established. If we can take advantage of the important channel of the mentorship system, it will not only ensure the continued development of the national military campus recruiters but also enhance the sensitivity of the recruiters to the needs of each student. If you can make good advantage of the important channel of mentoring system, it will not only ensure the continued development of the national army recruiting personnel on campus, but also enhance the sensitivity of recruiters to the needs of each student. In addition, when introducing the internal environment and weapons of the military camp, as well as the equipment required by soldiers, it is necessary to start from the perspective of students. Various methods are utilized to promote the national army, so students can understand the characteristics of the national army and the conditions for joining the army, and then let students understand whether joining the army meets their needs.

Reliability: As we all know, "salary", "military competitiveness" and "future development" are important factors that affect whether vocational high school graduates are willing to join the military (Hsu, 2016). Apart from providing a detailed introduction, reliability can be increased if seniors who have already served in the military and graduated from the same school can personally explain the real situation of the military and their vision for the future. As pointed out by the signaling theory, recruiters from the vacancy department are more likely to provide actual information about job vacancies and work environments, which can help applicants understand the work situations they may confront in the future within a limited time (Huang & Lee, 2021). If students can be influenced by their close friends and relatives, then the best recruiters may be their relatives, friends, and elders. Therefore, if the National Army can adopt marketing methods such as recommendations from relatives and friends, promotion of school staff and graduates, and campus fairs, it can improve the marketing effects in vocational high schools (Wang & Tsai, 2018). These approaches can help recruiters increase student satisfaction with recruiting events or trust in the nation's military.

Responsiveness: Among the service quality indicators, responsiveness refers to the prompt response of recruiters to questions raised by students. When students are confused about recruiting information, recruiters can quickly answer students' questions. Before new employees join the organization, if the organization can provide clear and complete information during the recruitment process, it will help them establish an understanding of the new workplace more effectively. If credible information can be completely deliv-

ered during the recruitment process, it will help new employees adapt and integrate into the new work environment, while reducing their uncertainty and anxiety about the new environment (Yang, 2019). To this end, OOO should require recruiters to leverage currently popular Internet technologies and authorize them to contact users in the information age, use their common language usage, get involved in their fields, and provide services to students promptly in order to recruit more high-intent and outstanding young people by reformulating promotion policies (Lee, 2014).

Guarantee: Use multiple recruiting channels to gain students' trust. For example, the U.S. army targets American citizens with recruiting ads to encourage potential volunteer candidates. These ads can influence potential candidates' perceptions of the national army and make them have a positive attitude toward joining the military, thereby increasing their willingness to join the military. In U.S. Army recruitment ads, praising and promoting heroic images is one of the most commonly used persuasion strategies (Fu, 2016). When organizational members feel that the organization can provide practical welfare policies, they may have cognitions and feelings that they want to support the organization (Chang et al., 2016). Thus, in terms of policy formulation, some scholars believe that factors such as salary, benefits, and retirement system for volunteer military service should be paid attention to and adjusted (Tsai, 2020) to ensure that the rights and interests of military school students are protected. Some scholars also believe that the stable and generous employment security, salary and benefits provided by Taiwan’s national military are one of the main motivations for high school students to apply for military academies (Lin, 2016). In addition, the National Army not only advocates the "Three Security Policy" (that is, providing a safe and reassuring workplace environment and employment model for the troops, military personnel and military relatives), but is also committed to formulating a sound leave system to win public approval (Hsin, 2017). Under the current system, the national military provides a fair workplace. As long as students have goals they want to pursue, they will be motivated to apply to join the national military.

Empathy: Services can function from two dimensions: On the one hand, service providers can detect potential problems in advance. On the other hand, they can make customers feel considered by service providers and reduce their feelings of alienation (Liu et al., 2016). The recruitment process should focus on students' feelings because experiential marketing can have a positive impact on customer loyalty (Ho & Chiu, 2019). Arrange visits to military camps at an appropriate time and organize a series of diversified national defense training activities to provide young students with opportunities to experience and observe the military and reduce their sense of alienation and doubts about the military (Tsai, 2020). Moreover, establishing long-term relationships with students is a form of advocacy and service. In addition to sharing experiences and guiding understanding, it can also help students clarify their needs.

Fuzzy Hierarchical Analysis

This study draws on the evaluation and statistical fuzzy multi-criteria decision-making proposed by Chang (2018). As far as evaluation criteria are concerned, Burkley (2001) believes that hierarchical analysis cannot appropriately represent the subjective cognition and judgment of the evaluator. In view of this, he proposed the fuzzy analytical hierarchy process (FAHP), which considers the consistency concept of fuzzy matrices to verify credibility and reflect real environmental results. The steps are as follows:

FAHP algorithm

Step 1: Calculate the eigenvector $\widetilde{W}_i$, which is the weight value $\widetilde{W}_i$ of each column *i* in the pairwise comparison matrix $\tilde{A}$

Let $\tilde{Z}_i=\sqrt[n]{\tilde{a}_{i1} \oplus \tilde{a}_{i2} \oplus \cdots \oplus \tilde{a}_{in}}$, *n* is the number of criteria

then $\widetilde{W}_i=\frac{\tilde{z}_i}{\tilde{a}_{i1} \oplus \tilde{a}_{i2} \oplus \cdots \oplus \tilde{a}_{in}}$ (Equation 1)

Step 2: Solve the fuzzy $\widetilde{W}_i$ and $\tilde{A}$

$\widetilde{W}_i$=Defuzzy($\widetilde{W}_i$), the center of area method can be used to find DF

a_{ij}=*Defuzzy*($\tilde{a}_{ij}$), where A=$[a_{ij}]_{mxn}$ and $\tilde{A}$=$[a_{ij}]$

Step 3: Calculate relative weight W_i

$W_i=\frac{\widetilde{W}_i}{\sum_{i=1}^{n} \widetilde{W}}$ (Equation 2)

FAHP validity test

Step 1: Substitute into the formula "AW=λW" to obtain the eigenvector $\widetilde{W}_i$ which represents the weight.

Let AW on the left side be W'_i, then AW=λW becomes W'_i=λW.

$$\begin{bmatrix} W'_1 \\ W'_2 \\ \vdots \\ W'_n \end{bmatrix} = A \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{bmatrix} \quad \text{(Equation 3)}$$

Step 2: Now that A and B are known, substitute into the formula "AW=λW" to obtain the maximum eigenvector λ_{max}

$\lambda_{max}=\frac{1}{n}\left[\frac{W'_1}{W_1}+\frac{W'_2}{W_2}+\cdots+\frac{W'_n}{W_n}\right]$ (Equation 4)

Step 3: Now that λ_{max} is known,

then calculate to obtain CI (consistency index)

$$CI=\frac{\lambda_{max}-n}{n-1} \quad \text{(Equation 5)}$$

Table 1. The obtained RI in matrix order

Number of criteria (n)	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49

Source: Chang, S.X. (2018)

Step 4: Now that CI is known, then calculate RI

CR=CI/CR, where the critical value RI changes with the size of *n*, so a lookup table is utilized.

Step 5: Consistency check

Case (1): If CR≤0.1 (the pairwise comparison data $\tilde{A}$ is within a reasonable range of consistency), then the relative weight output result is $W_i(1\leq i\leq n)$.
Case (2): If CR ≥ 0.1 (pairwise comparison data is inconsistent), the pairwise comparison verification needs to be performed again.
Step 6: Triangle fuzzy number centroid method

Generally, the more commonly used fuzzy number sorting methods include the mean of maximal, the center of area method (COA) and the □-cut method, and the simplest and practical method is COA. This method is adopted to obtain the optimal non-fuzzy value DF_i of the fuzzy number R_i, and the triangular fuzzy number (TFN) is represented as $\tilde{A}$(L，M，U). When the parameter is M, the TFN has the maximum membership grade, indicating the most possible value of the evaluation data. L and U represent the lower limit and upper limit of the evaluation data respectively.

The equation is as follows:

$$DF=\frac{(M-L)+(U-L)}{3}+L \quad \text{(Equation 6)}$$

TOPSIS analysis method

The TOPSIS analysis method aims to find solutions that satisfy both the positive-ideal solution and the negative-ideal solution. When determining the optimal solution, the

priority should be given to the solution that is closest to the positive ideal solution and farthest from the negative ideal solution.

Step 1: Convert the decision-making problem into matrix A
The decision-making process has *m* options and *n* evaluation items (criteria), and its multi-criteria decision matrix A represents the priority order between options:

$$A=[a_{ij}]_{mn}=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}$$

Step 2: Normalize the original matrix (convert the data to between 0 and 1)

$$r_{ij}=\frac{a_{ij}}{\sqrt{\sum_{j=1}^{m} {a_{ij}}^2}} \qquad \text{(Equation 7)}$$

r_{ij}= normalized criterion value

Step 3: Determine the weight
Experts can "subjectively" specify the weight W=[w_1 w_2 w_3 $\cdots$ w_n], and they can also use standard deviation "objectively" ($w_1 = \frac{\sigma_j}{\sum_{j=1}^{m}\sigma_{ij}}$, j=1,2,$\cdots$,$m$)

$V_{IJ}=w_j \times r_{ij}$, j=1,2,$\cdots$,n
where $\sum_{j=1}^{n} w_j = 1$, $w_j$is the weight of the j[th] criterion (Equation 8)

Step 4: Find the ideal solution V^* and the negative ideal solution V^-

$$A^* \equiv \left\{ {}^{max}_{i} V_{ij}/j \in J \right\} \text{ or } \left\{ {}^{mix}_{i} V_{ij}/j \in J' \right\} \text{i=1,2,}\cdots,m=\{{V^*}_1, {V^*}_2, \cdots, {V^*}_i, \cdots {V^*}_n\}$$

$$A^- \equiv \left\{ {}^{mix}_{i} V_{ij}/j \in J \right\} \text{ or } \left\{ {}^{max}_{i} V_{ij}/j \in J' \right\} \text{i=1,2,}\cdots,m=\{{V^-}_1, {V^-}_2, \cdots, {V^-}_i, \cdots {V^-}_n\}$$

Step 5: Calculate the separation measure
${S^*}_1$= : Calculate the separation measure

Step 6: Calculate the separation measure

$${S^*}_1=\sqrt{\sum_{J=1}^{n}\left(V_{ij}-{V^*}_i\right)^2} \quad {S^-}_1 = \sqrt{\sum_{J=1}^{n}\left(V_{ij}-{V^-}_i\right)^2} \qquad \text{(Equation 9)}$$

Step 7: Calculate the relative closeness to the ideal solution

$$C_i^*=\frac{S_i^-}{S_i^+ + S_i^-}$$

The one farthest from the negative ideal solution is the best solution (Equation 10)

Step 8: Sort the obtained C_i^* according to size and select the best one

The relative proximity C_i^* of each evaluation sample is sorted by size and presented in relative priority order.

The closer the value of C_i^* is to 1, the closer it is to the ideal solution. Compared with other evaluation samples, C_i^** is the best evaluation sample.

Research Design

This research aims to help recruiters improve their service quality. The research subjects are vocational high school students from Yilan County recruited by national army recruiters to join the army. This study adopts the PZB service quality model and combines the evaluation indicators proposed by Lin *et al.* (2015), to construct a set of evaluation standards containing 5 dimensions and 22 indicators (See Figure 1).

Adopt the FHAP Analysis to Obtain Weights

Obtain the weight of each dimension

Step1: Obtain the weight of primary dimensions

$$A=\begin{bmatrix}1.00 & 0.14 & 0.20 & 0.14 & 0.11\\ 7.00 & 1.00 & 3.00 & 1.00 & 0.33\\ 5.00 & 0.33 & 1.00 & 0.33 & 0.20\\ 7.00 & 1.00 & 3.00 & 1.00 & 0.33\\ 9.00 & 3.00 & 5.00 & 3.00 & 1.00\end{bmatrix}$$ Multiply to obtain the 5th root $\sqrt[5]{\prod_{j=1}^{5} a_{ij}}$ $\begin{bmatrix}0.21\\ 1.48\\ 0.60\\ 1.48\\ 3.55\end{bmatrix}$ / 7.32 (Equation 1)

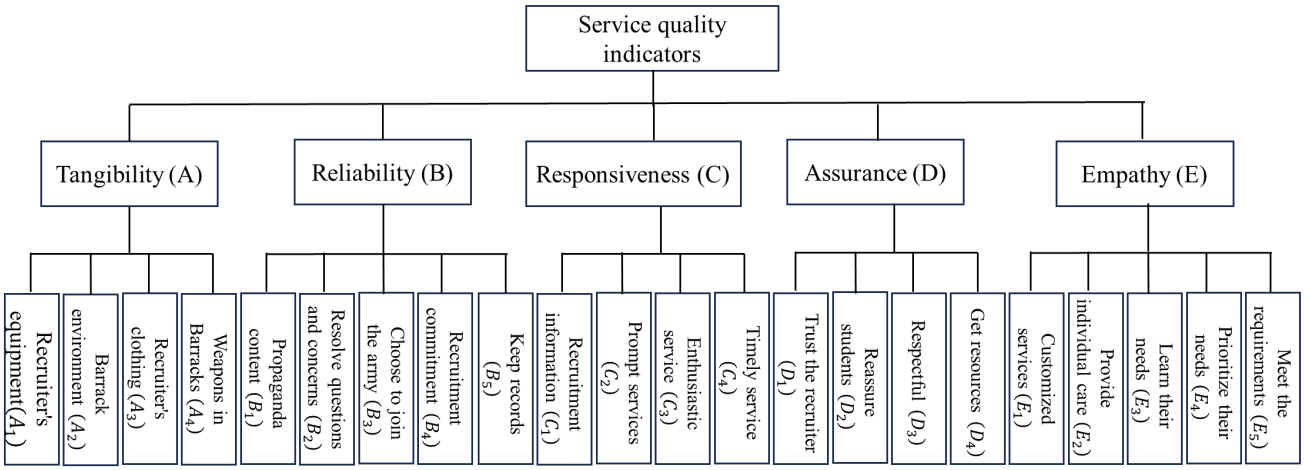

Figure 1. Service quality indicator architecture diagram

$$W=\frac{\sqrt[5]{\prod_{j=1}^{5} a_{ij}}}{\sum_{i=1}^{5}\sqrt[5]{\prod_{j=1}^{5} a_{ij}}} \Rightarrow \begin{bmatrix} 0.21 \\ \hline 7.32 \\ 1.48 \\ \hline 7.32 \\ 0.60 \\ \hline 7.32 \\ 1.48 \\ \hline 7.32 \\ 3.55 \\ \hline 7.32 \end{bmatrix} \Rightarrow$$

Normalized weight	
Criteria	Weight
A	**0.029286**
B	**0.201541**
C	**0.082275**
D	**0.201541**
E	**0.485356**
Total	**1.00**

(Equation 2)

Step 2: Perform consistency test
Because the formula is AW=λ-max W, multiply the normalized weight by the original matrix.

$$\begin{bmatrix} 1.00 & 0.14 & 0.20 & 0.14 & 0.11 \\ 7.00 & 1.00 & 3.00 & 1.00 & 0.33 \\ 5.00 & 0.33 & 1.00 & 0.33 & 0.20 \\ 7.00 & 1.00 & 3.00 & 1.00 & 0.33 \\ 9.00 & 3.00 & 5.00 & 3.00 & 1.00 \end{bmatrix} X \begin{bmatrix} 0.29286 \\ 0.201541 \\ 0.082275 \\ 0.201541 \\ 0.485356 \end{bmatrix} = \begin{bmatrix} 0.16 \\ 1.02 \\ 0.43 \\ 1.02 \\ 2.53 \end{bmatrix}$$ (Equation 3)

$$\lambda\text{-max}=(w'/w)/5$$

so λ-max =(0.16/**0.029286**+1.02/**0.201541**+0.43/**0.082275**+
1.02/**0.201541**+2.53/**0.485356**)/**5**=5.187089 (Equation 4)

$$C.I=\frac{\lambda max-n}{n-1}\ ,\ \frac{5.187089-4}{4}=0.05,\ C.I<0.1$$

and thus meets the consistency test (Equation 5)

$C.R=\frac{0.05}{1.12}$ =0.04, C.R<0.1, so it passes consistency test.
All experts agree that the primary dimensions of evaluation results are: E>B=D>C>A

The method for calculating the weight of criteria is the same as that of the main rule. But it must be multiplied by the weight of the dimension to obtain the complex weight:

First, calculate the sub-criteria of A and obtain A1, A2, A3, A4

Step 1: Normalize the matrix

$$\begin{bmatrix} 1.00 & 3.00 & 0.33 & 5.00 \\ 0.33 & 1.00 & 0.20 & 3.00 \\ 3.00 & 5.00 & 1.00 & 7.00 \\ 0.20 & 0.33 & 0.14 & 1.00 \end{bmatrix}$$ Multiply columns to obtain the 4th root $\sqrt[4]{\prod_{j=1}^{4} a_{ij}}$ $\begin{bmatrix} 1.50 \\ 0.67 \\ 3.20 \\ 0.32 \end{bmatrix}$

5.68

Step2: Calculate the weight and complex weight

$$W=\frac{\sqrt[4]{\prod_{j=1}^{4} a_{ij}}}{\sum_{i=1}^{4}\sqrt[4]{\prod_{j=1}^{4} a_{ij}}} \Rightarrow \begin{bmatrix} \frac{1.50}{5.68} \\ \frac{0.67}{5.68} \\ \frac{3.20}{5.68} \\ \frac{0.32}{5.68} \end{bmatrix} \Rightarrow$$

Normalized weight		
Criteria	Weight	Complex weight
A1	**0.26**	**0.01**
A2	**0.12**	**0.0035**
A3	**0.56**	**0.02**
A4	**0.055022**	**0.0016114**
Total	**1.00**	

Step 3: Perform the test

Multiply the original matrix by the complex weight to obtain W'

$$\begin{bmatrix} 1.00 & 3.00 & 0.33 & 5.00 \\ 0.33 & 1.00 & 0.20 & 3.00 \\ 3.00 & 5.00 & 1.00 & 7.00 \\ 0.20 & 0.33 & 0.14 & 1.00 \end{bmatrix} X \begin{bmatrix} 0.01 \\ 0.0035 \\ 0.02 \\ 0.0016114 \end{bmatrix} = \begin{bmatrix} 0.03 \\ 0.01 \\ 0.07 \\ 0.006663 \end{bmatrix} = W'$$

so λ-max=(0.03/**0.01**+0.01/**0.0035**+0.07/**0.02**+0.006663/**0.0016114**)/4
=4.117782

C.I=$\frac{4.117782-4}{3}$ =0.04, C.I<0.01, and thus meets the consistency test

C.R=$\frac{0.04}{0.9}$ =0.04, C.R<0.1, indicating that experts all agree.

The method for calculating the weights of criteria B, C, D, and E is the same as that of the main criteria. The weight of each criterion is obtained as show in Table 2.

Table 2. Complex weights of criteria B, C, D, and E

Normalized weight B			Normalized weight C			Normalized weight D			Normalized weight E		
Criteria	Weight	Complex weight	Criteria	Weight	Complex weight	Criteria	Weight	Complex weight	Criteria	Weight	Complex weight
B1	0.200	0.040	C1	0.160	0.010	D1	0.280	0.060	E1	0.200	0.040
B2	0.470	0.090	C2	0.400	0.030	D2	0.520	0.110	E2	0.470	0.090
B3	0.040	0.010	C3	0.400	0.030	D3	0.140	0.030	E3	0.040	0.010
B4	0.203	0.041	C4	0.047	0.039	D4	0.058	0.012	E4	0.203	0.041
B5	0.086	0.017							E5	0.086	0.017

After obtaining the weights and complex weights of the 16 experts, the results are presented in Table 3.

Table 3. Weight values of each evaluation sub-criteria given by experts

Weight values of each evaluation sub-criteria given by experts																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
A1	0.01	0.003	0.003	0.009	0.009	0.001	0.003	0.012	0.003	0.006	0.084	0.003	0.023	0.020	0.003	0.020
A2	0.00	0.002	0.002	0.004	0.019	0.004	0.002	0.006	0.002	0.003	0.008	0.002	0.005	0.004	0.002	0.009
A3	0.02	0.021	0.021	0.019	0.002	0.009	0.021	0.080	0.021	0.038	0.039	0.020	0.011	0.009	0.021	0.004
A4	0.002	0.010	0.010	0.001	0.004	0.019	0.010	0.036	0.010	0.017	0.017	0.009	0.002	0.002	0.010	0.002
B1	0.041	0.063	0.063	0.038	0.037	0.014	0.039	0.072	0.122	0.135	0.051	0.069	0.103	0.150	0.122	0.021
B2	0.094	0.188	0.188	0.009	0.095	0.068	0.117	0.139	0.236	0.260	0.064	0.208	0.200	0.290	0.236	0.332
B3	0.008	0.020	0.020	0.005	0.016	0.135	0.012	0.009	0.015	0.017	0.006	0.022	0.013	0.019	0.015	0.041
B4	0.041	0.104	0.104	0.056	0.295	0.032	0.065	0.035	0.060	0.066	0.025	0.115	0.051	0.074	0.060	0.090
B5	0.017	0.087	0.087	0.021	0.068	0.014	0.054	0.017	0.029	0.032	0.012	0.096	0.025	0.036	0.029	0.084
C1	0.013	0.004	0.004	0.149	0.003	0.004	0.003	0.002	0.004	0.002	0.002	0.007	0.021	0.008	0.010	0.015
C2	0.033	0.021	0.021	0.069	0.016	0.036	0.018	0.009	0.021	0.008	0.010	0.017	0.046	0.040	0.046	0.037
C3	0.033	0.047	0.047	0.031	0.037	0.017	0.040	0.020	0.047	0.019	0.022	0.036	0.010	0.019	0.021	0.015
C4	0.004	0.009	0.009	0.015	0.007	0.007	0.008	0.004	0.009	0.004	0.004	0.004	0.004	0.004	0.004	0.004
D1	0.056	0.176	0.176	0.317	0.080	0.316	0.272	0.292	0.167	0.013	0.029	0.031	0.037	0.043	0.075	0.033
D2	0.105	0.047	0.047	0.082	0.022	0.085	0.136	0.128	0.073	0.067	0.149	0.149	0.177	0.092	0.160	0.074
D3	0.028	0.047	0.047	0.086	0.022	0.085	0.040	0.055	0.032	0.153	0.339	0.069	0.083	0.019	0.033	0.041
D4	0.012	0.013	0.013	0.025	0.006	0.023	0.020	0.019	0.011	0.030	0.066	0.015	0.017	0.009	0.016	0.015
E1	0.063	0.036	0.036	0.002	0.009	0.017	0.021	0.010	0.021	0.019	0.011	0.019	0.028	0.021	0.018	0.005
E2	0.031	0.036	0.036	0.008	0.135	0.008	0.010	0.005	0.010	0.009	0.005	0.009	0.012	0.010	0.009	0.010
E3	0.016	0.024	0.024	0.004	0.070	0.004	0.005	0.002	0.005	0.005	0.003	0.005	0.006	0.005	0.005	0.021
E4	0.248	0.036	0.036	0.032	0.017	0.066	0.082	0.038	0.081	0.076	0.042	0.076	0.097	0.083	0.071	0.083
E5	0.128	0.008	0.008	0.017	0.034	0.034	0.022	0.010	0.022	0.021	0.012	0.021	0.028	0.043	0.037	0.043

Find the Optimal Non-fuzzy Value

Based on Table 3, the fuzzy weight values of each sub-criteria are as shown in Table 4.

Table 4. Fuzzy weight values of each evaluation criterion

Fuzzy weight values of each evaluation criterion							
Criteria	L(Min)	U(Avg)	M(Max)	Criteria	L(Min)	U(Avg)	M(Max)
A 1	0.001	0.007	0.084	C 3	0.010	0.026	0.047
A 2	0.002	0.004	0.019	C 4	0.004	0.006	0.015
A 3	0.002	0.016	0.080	D 1	0.013	0.086	0.317
A 4	0.001	0.007	0.036	D 2	0.022	0.088	0.177
B 1	0.014	0.059	0.150	D 3	0.019	0.054	0.339
B 2	0.009	0.135	0.332	D 4	0.006	0.016	0.066
B 3	0.005	0.016	0.135	E 1	0.002	0.016	0.063
B 4	0.025	0.066	0.295	E 2	0.005	0.013	0.135
B 5	0.012	0.035	0.096	E 3	0.002	0.008	0.070
C 1	0.002	0.006	0.149	E 4	0.017	0.061	0.248
C 2	0.008	0.023	0.069	E 5	0.008	0.023	0.128

Adopt the center of area method to obtain the numerical values and order of non-fuzzy values

$$A1=\frac{(M_i)-(L_i)+(U_i)-(L_i)}{3}+L_i,\ \frac{0.084-0.001+0.007-0.001}{3}+0.001=0.031 \quad \text{Equation 6}$$

Then, calculate the values for A2, A3, A4...E5 in the same way.

Obtain values and sort (see Table 5 and Table 6)

Employ TOPSIS Analysis to Rank Each Criterion

Step 1: Convert the decision problem into a matrix

$$\begin{matrix} A1 \\ A2 \\ A3 \\ A4 \end{matrix}\begin{bmatrix} 4.00 & 3.00 & \dots\dots & 4.00 \\ 4.00 & 3.00 & \dots\dots & 4.00 \\ 5.00 & 3.00 & \dots\dots & 4.00 \\ 3.00 & 5.00 & \dots\dots & 4.00 \end{bmatrix}$$

Table 5. Non-fuzzy values

Non-fuzzy Values			
A1	0.031	C3	0.034
A2	0.008	C4	0.028
A3	0.032	D1	0.008
A4	0.015	D2	0.139
B1	0.074	D3	0.096
B2	0.159	D4	0.137
B3	0.052	E1	0.030
B4	0.129	E2	0.027
B5	0.031	E3	0.051
C1	0.048	E4	0.027
C2	0.052	E5	0.108

Table 6. Ranking of weights of each criterion

Rank-ing	Criteria	Value	Rank-ing	Criteria	Value
1	B2	0159	12	C3	0.034
2	D2	0.139	13	A3	0.032
3	D4	0.137	14	A1	0.031
4	B4	0.129	15	B5	0.031
5	E5	0.108	16	E1	0.030
6	D3	0.096	17	C4	0.028
7	B1	0.074	18	E2	0.027
8	C2	0.052	19	E4	0.027
9	B3	0.052	20	A4	0.015
10	E3	0.051	21	A2	0.008
11	C1	0.048	22	D1	0.008

Step 2: Normalize the original matrix

$$\begin{bmatrix} \frac{4}{\sqrt{4^2+4^2+5^2+3^2}} & \frac{3}{\sqrt{3^2+3^2+3^2+5^2}} & \cdots\cdots & \frac{4}{\sqrt{4^2+4^2+4^2+4^2}} \\ \frac{4}{\sqrt{4^2+4^2+5^2+3^2}} & \frac{3}{\sqrt{3^2+3^2+3^2+5^2}} & \cdots\cdots & \frac{4}{\sqrt{4^2+4^2+4^2+4^2}} \\ \frac{5}{\sqrt{4^2+4^2+5^2+3^2}} & \frac{3}{\sqrt{3^2+3^2+3^2+5^2}} & \cdots\cdots & \frac{4}{\sqrt{4^2+4^2+4^2+4^2}} \\ \frac{3}{\sqrt{4^2+4^2+5^2+3^2}} & \frac{5}{\sqrt{3^2+3^2+3^2+5^2}} & \cdots\cdots & \frac{4}{\sqrt{4^2+4^2+4^2+4^2}} \end{bmatrix} = \begin{bmatrix} 0.49 & 0.42 & \cdots\cdots & 0.50 \\ 0.49 & 0.42 & \cdots\cdots & 0.50 \\ 0.62 & 0.42 & \cdots\cdots & 0.50 \\ 0.37 & 0.69 & \cdots\cdots & 0.50 \end{bmatrix}$$ Equation 7

$$\begin{bmatrix} 0.49*0.031 & 0.42*0.031 & \cdots\cdots & 0.50*0.031 \\ 0.49*0.008 & 0.42*0.008 & \cdots\cdots & 0.50*0.008 \\ 0.62*0.032 & 0.42*0.032 & \cdots\cdots & 0.50*0.032 \\ 0.37*0.015 & 0.69*0.015 & \cdots\cdots & 0.50*0.015 \end{bmatrix} = \begin{bmatrix} 0.02 & 0.01 & \cdots\cdots & 0.02 \\ 0.01 & 0.01 & \cdots\cdots & 0.01 \\ 0.02 & 0.01 & \cdots\cdots & 0.02 \\ 0.01 & 0.01 & \cdots\cdots & 0.01 \end{bmatrix}$$ Equation 8

A1: $S^*_1=\sqrt{(0.49-0.49)^2+(0.49-0.49)^2\cdots(0.37-0.49)^2}=0.02$

$S^-_1=\sqrt{(0.49-0.37)^2+(0.49-0.37)^2\cdots(0.37-0.37)^2}=0.01$ Equation 9

$$C_i^*=\frac{4.55}{4.55+4.46}=0.51$$ Equation 10

Calculate the values for A2, A3 and A4 in the same way. By adopting the TOPSIS analysis method, we can know that A1=0.51, A2=0.48, A3=0.51, A4=0.50

The numerical ordering calculations of the remaining B1, B2,..., E4, and E5 are the same.

Table 7. Weights and rankings of recruitment service quality indicators for 16 (vocational) high schools in Yilan County

Positive and negative ideal solutions														
	A1	A2	A3	A4		A1	A2	A3	A4		A1	A2	A3	A4
Positive	4.46	5.16	4.46	4.53	Negative	4.55	4.68	4.58	4.46	C_i^*	0.51	0.48	0.51	0.50

Table 8. Weights and rankings of recruitment service quality indicators for 16 (vocational) high schools in Yilan County

Dimensions Weight/ranking	No.	Indicator description	FAHP Weight/ranking	TOPSIS relative closeness /ranking
Tangibility (A) 0.03(4)	A1	Equipment and gear prepared by recruiters	0.01 (2)	0.51(1)
	A2	The living facilities and environment in the military camp are attractive	0.004(3)	0.48(3)
	A3	The recruiter's clothing and appearance are appropriate	0.02 (1)	0.51(1)
	A4	Interested in the armor, cannons and weapons in the military camp	0.002(4)	0.50(2)
Reliability (B) 0.20(2)	B1	The content promoted and promised by recruiters is convinc-ing	0.04 (3)	0.7281(1)
	B2	Provide timely assistance when students have questions or difficulties	0.09 (1)	0.5336(2)
	B3	Choosing to join the military is the right choice	0.01 (5)	0.5041(5)
	B4	Recruiters can deliver promised services in a timely manner	0.041(2)	0.5142(3)
	B5	Properly record and maintain student-related service records	0.0173(4)	0.5083(4)
Responsive-ness (C) 0.08(3)	C1	Recruiters leverage various channels so that students know clearly when they can get services	0.01 (2)	0.4988(4)
	C2	If students have questions, they can get responses quickly	0.03 (1)	0.5007(2)
	C3	Recruiters are enthusiastic and willing to serve students	0.03 (1)	0.5013(1)
	C4	Recruiters are not too busy to provide services	0.004(3)	0.5002(3)
Assurance (D) 0.20(2)	D1	Recruiters are trustworthy	0.06(2)	0.50035(1)
	D2	Students can feel at ease during consultation and registration	0.11 (1)	0.50028(2)
	D3	Recruitment staff are attentive and courteous	0.03(3)	0.50035(1)
	D4	Recruiters receive appropriate resources to provide better services to students	0.01(4)	0.50001(3)
Empathy (E) 0.49(1)	E1	Recruiters provide diverse services to students	0.06 (3)	0.50049(5)
	E2	Recruiters provide individual care to students	0.03(4)	0.51382(4)
	E3	Recruiters understand the needs of students	0.02(5)	0.54602(3)
	E4	Recruiters will prioritize the rights of students	0.25(1)	0.57330(1)
	E5	Recruiters can provide services based on student availability	0.13(2)	0.55552(2)

Conclusions and Recommendations

Conclusions

Today, Taiwan's demographic structure is facing changes such as aging, low birth rates, and brain drain, which will lead to relatively low labor supply in domestic higher education, industrial structure, and the future labor market (Tang & Wu, 2020). This research takes students from 16 vocational high schools in Yilan County as a case study to explore the military recruitment service factors that may affect their decision to join the

military in 2021. The SERVQUAL scale is adopted as the basis for measurement to evaluate the service quality provided by recruiters. Research results show that "Empathy" has the highest weight of 0.49, showing that vocational high school students focus on personal feelings; "Assurance" and "Reliability" come next, with a weight of 0.20, indicating that the feelings and trust recruiters make students feel are both essential. This research employs the fuzzy analytic hierarchy process to calculate the weight of each factor, among which "empathy" has the highest weight, which is 0.49. More specifically, among the five criteria of empathy, E4 "Recruiters will prioritize the rights of students" has the highest weight, accounting for 0.25. Then a TOPSIS analysis was performed, and the results showed that among the empathy factors, "recruiters will give priority to students' rights" ranked highest, indicating that recruiters must give priority to students' rights.

Recommendations

Enhancing the service quality of military recruiters is a key element of improving the effectiveness of national army recruitment. In the service quality questionnaire for military recruiters, "empathy" has the highest weight, at 0.49; the "tangibility" dimension has the lowest weight of 0.03. The questionnaire shows that recruiting units can maintain the status quo in the "tangibility" dimension, and in terms of "empathy", E4 "Recruiters will prioritize the rights of students" (0.25) has the highest weight. The research found that how to enhance recruitment effectiveness by upgrading the service quality of recruiters is an important factor.

Future Recommendations

The research subjects are limited to students from vocational high schools in Yilan County, Taiwan, and the research scope is not broad enough. It is recommended that differences should be identified for regions with better recruitment status to increase research comprehensiveness in the future.

This research only interviews 2021 vocational high school graduates in Yilan County. It is recommended that the research subjects continue to be observed for 3 to 5 years to truly understand the changes in the service quality of the national army recruiters and obtain more accurate research results.

References

Chang, C.C., Fei, W.C., & Huang, K.J. (2017), Military Welfare Policy and Organization Attachment: The Mediating Role of Perceived Organizational Support and The Moderating Effect of Grade, Journal of National Defense Management, 38(1), pp. 1-10.

Chang, S.X. (2018), Fuzzy Multi-Criteria Decision Making for Evaluation and Statistics, Taipei: Wu-Nan Culture Enterprise, p 426.

Chu, H.C. & Lee, C. H. (2021), A Study on the Military's Image and Service Quality toward the Willingness and Influence to Join the Army-Case of Senior High and Vocational School Students in Hualien, Journal of Quantitative Management, 18(2), pp.1-16.

Fu, W. C. (2016) , Do we like soldier- heroes? The priming effect of U.S. military recruitment advertising, Fu Hsing Kang Academic Journal, 108, pp. 121–142.

Fu, W.C., & Huang, W.J. (2020), We Want You for the Taiwan Army. The Effectiveness of Military Recruiting Advertisements: Perspectives of Regulatory-Focus and Social Distances, Fu Hsing Kang Academic Journal, 116, pp. 1-39.

Ho, C.L. & Chiu, C.T. (2019), The Effect of Experiential Marketing on Customer Satisfaction and Customer Loyalty: The Case of Service Centers in Life Insurance Company, Insurance Monograph, 35(1), pp. 71-105.

Hong, R.L., Lin, K.H., & You, Q. H. (2016), The Analysis of Recruitment & Selection of Hiring Process in The Sport Industry -A Case study of X Sporting Goods Retailer in South Taiwan, NKUST Physical Education, 15, pp. 28-37.

Hsin, Y.S. (2017), Analysis the Activities Planning Benefits of Training Exercise and Military Recruitment of the Joint Operations Training Base Command, Department of Tourism Management, National Kaohsiung University of Applied Sciences. Unpublished Master's Thesis, p75.

Hsu, G.W (2016), Analysis the factors of Applied Elaboration Model for High School Graduates' Intention to Enlisting, The Journal of National Defense University General Education, 6, pp. 17-31.

Huang, Y. M. & Lee P. L. (2021), How to Design Attractive Campus Recruitment? Exploring the Effects of Recruiter Attributes and Structural Characteristics of Campus Recruitment on Job-Seekers' Reactions, Journal of Human Resource Management, 21(2), pp. 33-56.

Lee, C.Y. (2014), Integrating the Strategic Planning of All Volunteer Service for Meeting Military Strategy's Requirements, Fu Hsing Kang Academic Journal, 105, pp. 63-80.

Lin, C.C. (2016), A Study on the Reasons Why Senior High School Students Apply for the Military Academy-Take Department of Applied Arts as an Example, Fu Hsing Kang Academic Journal, 109, pp. 77-98.

Lin, E. T. J., Hung, C. C., Ho, H. W., Xu, Y.R., Lin, M. Y., Hsu, S. Y., & Loh, C.Y. (2015), Measuring Quality of after Service for Automotive Industry by SERVQUAL, Mingdao Journal, 9(3), pp. 29-54.

Liu, M.S., Tsai, L.L., & Liang, J.B. (2016), How the Service Industry Meets Customers' Needs-Take an Fast Food Industry as the Example, Journal of Far East College, 23(1), pp.9-14.

Tang, R.Y., & Wu, H.N. (2020), The Analysis of Human Resources Development Trend and Demands in Talents of Industries in Taiwan, Taiwan Economic Research Monthly, 43(10), pp. 84-92.

Tsai, P. H. (2020), Development of an Attitude Scale about Persons in Volunteer Military Servicemen, Journal of National Defense Management, 41(1), pp. 53-76.

Tsai, P. H. (2020), Research on National Army Recruitment Strategy, Fu Hsing Kang Academic Journal, 116, pp. 113–140.

Wang, J. W., & Tsai, T. C. (2018), A Study of Recruitment Marketing Strategy and Intention of Re-recommend for Air Force Officers School in Taiwan, Journal of National Formosa University, 34(1), pp. 1-19.

Yang, W.F. (2019), Knowing-doing-desirability Gap Exists? Exploring the Impact of Recruitment Information Disclosure on Applicant and Newcomers' Organizational and Job Related Perceptions, Journal of Management and Business Research, 36(4), pp. 391-419.