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An Exploration and an Application of the Recruitment Criteria on Qualified Personnel by the Analytic Hierarchy Process Method at Logistics Enterprises in Vietnam

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Abstract - **This study aims to explore criteria for recruiting qualified personnel in logistics companies in Vietnam and apply these criteria into practical recruitment case by using a multiple decision-making method suggested by the authors. To explore recruitment criteria, the survey sample includes 224 logistics companies operating in one of the largest cities in Vietnam – Ho Chi Minh City. Cronbach's Alpha testing methods and exploratory factor analysis (EFA) to test and build measurement scales are utilized. In addition, multiple linear regression method was used to find out the influence on recruitment selection decision. The research results show that there are four criteria affecting the decision to recruit qualified personnel including skills, knowledge, health, and personality traits. These criteria are then applied into personnel selection by using analytic hierarchy process method to select the best candidate. The paper offers practical help to industrial practitioners on their recruitment activities and contributes significantly to the theory of human resources management, especially the personnel selection criteria and the theory of supply chain management.**

Key words*— *AHP, criteria, logistics, qualified personnel, recruitment

1.   Introduction

According to the report on Logistics Performance Index in 2018 released by the Word Bank, Vietnam ranked 39/160 countries, up 25 places from 64 in 2016, ranking first in the emerging markets. Additionally,

logistics service industry is thriving with a growth rate of 15% - 16% [1] and the demand for human resources by 2030 is up to 2.2 million employees [2]. It can be said that the human resources demand for logistics is very large. However, the personnel issue is of difficulty for the logistics industry, which is currently paid special attention by many businesses, associations, Government and training institutions. According to experts, when recruiting logistics personnel, they are forced to re-train professional knowledge, leading to both time consuming and costly [2]. One of the important reasons is that the training programs at universities, colleges, and vocational colleges are also theoretical, lack of updating international standards and the need for qualified personnel at logistics enterprises. In addition, logistics enterprises hardly publish their set of personnel recruitment criteria, except posting fairly general recruitment information about the education, certificates, working experience, and key skills. Each enterprise makes its own personnel requirements when recruiting for its business. Therefore, it is difficult for the labour force to have an overview of the industry's qualified human resource needs. Besides, in terms of academic aspect, studies on personnel selection criteria for the logistics industry in the era of technology 4.0 are relatively few. Facing this situation, the authors have implemented the topic "*An exploration and an application of the recruitment criteria on qualified personnel by the Analytic Hierarchy Process method at logistics enterprises in Vietnam*" with desires to explore and develop a set of recruitment criteria on qualified personnel for logistics enterprises in Vietnam. The authors then apply that set of recruitment criteria into a practical recruitment case of an enterprise using

the Analytic Hierarchy Process (AHP) to evaluate the effectiveness of those selection criteria. Within the research scope, this can be considered as a completely new topic in the field of logistics.

2. Literature review

2.1 Qualified personnel selection criteria

2.1.1 Qualified personnel

According to Human Resources textbook of University of Labour and Social Affairs "The concept of qualified human resources is summarized in the following aspects: the health of employees, technical expertise, practical competences in knowledge, career skills, social dynamics (including creativity, flexibility, agility at work, …), moral, and attitude towards work, working environment, labour efficiency, income, living standards, and the satisfaction level of individual needs (including physical and spiritual needs of labourers) [3, p.9].

According to Assoc. Prof. Mai Quốc Chánh "The quality of human resources is evaluated through the education, expertise, and skills of workers as well as their health" [4, p.168].

From the above concepts, it can be seen that human resources quality is expressed through internal factors:

- Mental strength: is expressed through education level and professional qualifications of workers. In particular, the education level is provided through the education system, through lifelong learning process. Educational level enables workers to acquire basic knowledge, perform simple tasks to survive. With professional qualifications, it is an important indicator to evaluate the quality of personnel. Highly qualified personnel will be able to acquire, apply new science and technology to their jobs, and be able to think creatively at work, contributing to promoting the business.

Intellectual strength is also shown through soft skills that support jobs such as leadership skills, work organization skills, communication skills … These skills contribute to perfect more the capacity of workers.

- Physical strength: is the state of human health, expressed through the harmonious development of man, both physically and mentally. It is expressed through the criteria of weight, height, life expectancy, disease situation, health care conditions … Physical strength is the basis for all human activities, ensuring

workers can meet specific requirements of work and long-term working.

- Mentality: is the ethical quality and personality of labourers, expressed in production and individual creativity, specifically through the morale and consciousness of employees as the sense of responsibility, thriftiness, a spirit of cooperation, career conscience … These are invisible elements, which play an important role in the sustainable development of the enterprise. This idea is also in line with a review of human capital of Wisedsin et al. which includes skill, learning, knowledge and health of an individual [20].

2.1.2 Characteristics of Logistics

According to Article 233, Law on Commerce of Vietnam 2005 "logistics services are commercial activities whereby traders organize one or more jobs including receipt of goods, transportation, storage, warehousing, customs clearance, other paperwork, and consulting customers, packaging, marking, delivery or other services related to the goods as agreed with customers for remuneration."

Logistics can be divided into three main areas: warehousing, transportation, and forwarding with different activities as follows:

- Warehousing and storage services.
- Service of loading and unloading goods from means of transport such as ships, vehicles, or containers, etc.
- Transport agency services in charge of customs clearance, transportation planning, loading and unloading of goods.
- Transportation – related services include sea, inland, air, rail, road and pipeline transport services.
- Supporting services such as receiving and storing goods, managing information related to the transportation and storage process, handling issues such as defective goods, damaged goods, expired goods, returned goods, inventory …
- Other related logistics services: postal service, technical analysis and testing service, wholesale/ retail trade services, etc.

With the above service characteristics, the working environment of labourers in logistics industry is diversified, which then requires labourers to have a composite knowledge and multiple skills. Some common logistics jobs today include warehouse

operators, sales staff, document staff, port staff, purchasing staff, logistics staff …

2.1.3   Previous studies

According to Kelemenis & Askounis (2010), when selecting personnel, enterprises may focus on 02 groups of criteria: soft skills and technical skills. In particular, soft skills include 05 sub-criteria: strategic decision making, change management/ change adaptability, communication skill, leadership, risk/ crisis management. Technical skills include computer networks, software tools, databases, professional experience, educational background, emerging/new technology [5]. However, the 02 above groups of criteria focus more on technical factors because the two authors proposed criteria for selecting personnel for a multinational information technology company. Therefore, in order to choose the right personnel for the enterprise, we need to lay our emphasis on the enterprise's business field.

In the field of logistics, according to ref [6] and ref [7] personnel selection decision making depended on *experience* and *training* of the candidates. Until 1952, Mosel argued that past experience and training all demonstrated knowledge, skills, and abilities (KSAs) related to the jobs of a logistics candidate or employee [8]. Thus, KSAs are three prerequisites for an employee to be successful at work. This research was later supported by other authors such as [9], [10]; [7]; [11]; [12]. Based on the above studies, in 2004 Myers et al. proposed the Human Capital model for the logistics industry as follows:
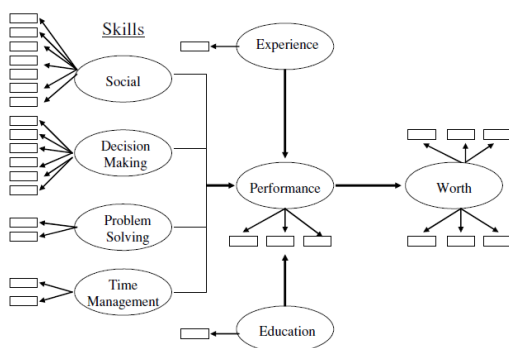
Figure 1. Human Capital Model

Source: [13]

According to Myer et al., experience, education, and skills (including social skills, decision-making skills, problem-solving skills, and time-managing skills)

affect the performance of logistics professionals, which then affects their worth.

In another research, it was concluded that human capital comprising of competency, education and work experience had positive and significant relationship with warehouse operation performance – a part of logistics and supply chain management activities [21]

Besides, depending on the job position (senior manager, middle manager, or employee), labourers will be assessed according to specific criteria. For senior personnel, the psychological characteristics particularly attract enterprises, namely extrovert psychology [14] [15] [16]. Also according to these authors, particularly for middle management personnel, they need to have conscientious. This means *personality traits* of managers in logistics industry will be shaped according to the job position. For selecting highly-skilled employees, enterprises consider *the need for success* and *adaptability* [15]. The need for success is that the candidate has set his job goal and a way to achieve it. In terms of adaptability, candidates will have to show their ability and willingness to work in a constantly changing and dynamic environment.

Through a summary of previous studies, the authors found that in order to select qualified personnel for logistics industry, the following basic criteria would be considered: education, experience, skills, personality traits. Additionally, depending on the specific job position, sub-criteria will be adjusted accordingly.

2.1.4   Research model

Based on the theory of qualified personnel, characteristics of logistics industry, and previous studies, the authors propose the research model as follows:
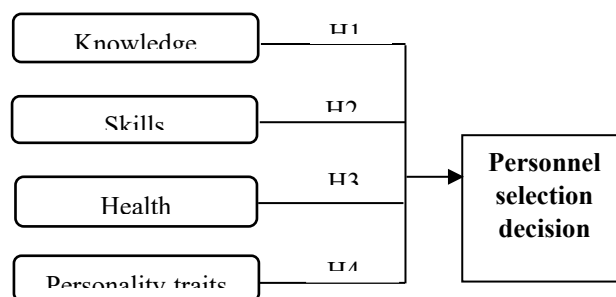
Figure 2. Model of recruitment criteria on qualified personnel

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Knowledge

Knowledge is expressed through the education and technical qualifications of workers. According to Singer & Bruhns (1991), employees' knowledge gained from education is closely related to job performance. In addition, knowledge is also assessed through degrees, which is reflected in the Ohio State University's survey of 2000 logistics experts [16]. As a result of the survey, 93% of respondents had high school degrees, in which 56% had university degrees and 22% had advanced career certificates [17]. Additionally, experience has direct impact on knowledge, so complementing and significantly increasing knowledge. Once knowledge is increased, work efficiency also changes in a positive direction [13].

H1: Knowledge has positive effect on personnel selection decision

Skills

Skills are the term used to refer to soft skills (in addition to hard skills to indicate education levels or professional qualifications) required to succeed in life and work such as social skills, decision-making skills, time-managing skills, problem-solving skills … [13]

H2: Skills have positive effect on personnel selection decision

Health

Worker's health is expressed through mental, physical, and social health [3]. Physical health is expressed through the comfort such as agility, toughness, ability to withstand the harsh conditions of the environment … Mental health embodies emotional, spiritual satisfaction, expressed through love of life, optimism. Social health is expressed in the intimate relationship between families, friends, institutions … The more you integrate with people, the better the social health is. In general, the better the health is, the higher the quality of work is.

*H3: Health has positive effect on personnel selection decision*

Personality traits

Personality traits are expressed through attitudes, behaviours, responsibilities, professional ethics, labour style, professionalism … of labourers. The higher the level of awareness, responsibility, and professional ethics, the more positive the impact on the enterprise's personnel selection decisions is.

H4: Personality traits have positive effect on personnel selection decision

2.2 Analytic Hierarchy process - AHP

AHP was proposed by Saaty in 1997 to model subjective decision-making processes based on multiple attributes in a hierarchical system [18]. Making decision by AHP can be summarized as follows:

Step 1: Set up the hierarchical system by decomposing the problem into a hierarchy of interrelated elements
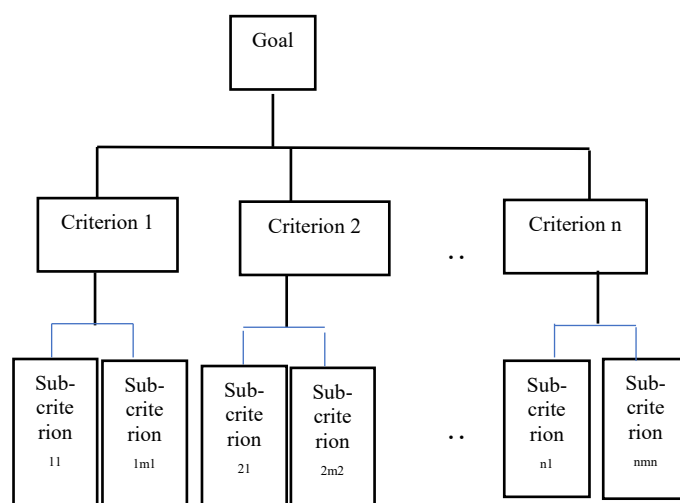
Figure 3. The hierarchical structure of AHP

Step 2: Compare attributes to form the reciprocal matrix.

If we wish to compare a set of n attributes pairwise according to their importance weights, where the attributes are denoted by $a_1, a_2 ..., a_n$ and their weights are denoted by $w_1, w_2 ..., w_n$. Pairwise comparisons are made basing on questionnaires like how many times is criterion a_1 more important /more beneficial than criterion a_2… Saaty used a scale from 1 to 9 for representing equal importance to extreme importance.

Table 1. The fundamental scale of Saaty

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
2	Weak	
3	Moderate importance	Experience and judgment slightly

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		favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favoured very strongly over another, its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity i has one of the above nonzero number assigned to it when compared with activity j, then j has the reciprocal value when compared with i	

Source: [18]

Pairwise comparisons matrix is presented as follows:

$$A = \begin{bmatrix} a_{11} & \cdots & a_{1j} & \cdots & a_{1n} \\ \vdots & & \vdots & & \vdots \\ a_{i1} & \cdots & a_{ij} & \cdots & a_{in} \\ \vdots & & \vdots & & \vdots \\ a_{n1} & \cdots & a_{nj} & \cdots & a_{nn} \end{bmatrix},$$

Where, a_{ij} is the level of evaluation between the ith and the jth criterion

$a_{ij} > 0$, $a_{ij} = 1/a_{ji}$, $a_{ii} = 1$. Note that in realistic situations, w_i/w_j is usually unknown. Thus, the issue of AHP is to find a_{ij} such that $a_{ij} \cong w_i/w_j$

Step 3: Estimate the relative weight
Let a weight matrix be represented as:

$$W = \begin{matrix} & w_1 & \cdots & w_j & \cdots & w \\ w_1 & w_1/w_1 & \cdots & w_1/w_j & \cdots & w_1 \\ \vdots & \vdots & & \vdots & & \\ w_i & w_i/w_1 & \cdots & w_i/w_j & \cdots & w_i \\ \vdots & \vdots & & \vdots & & \\ w_n & w_n/w_1 & \cdots & w_n/w_j & \cdots & w_n \end{matrix}$$

by multiplying W by w yield:

$$W \times w = \begin{matrix} & w_1 & \cdots & w_j & \cdots & w_n \\ w_1 & w_1/w_1 & \cdots & w_1/w_j & \cdots & w_1/w_n \\ \vdots & \vdots & & \vdots & & \vdots \\ w_i & w_i/w_1 & \cdots & w_i/w_j & \cdots & w_i/w_n \\ \vdots & \vdots & & \vdots & & \vdots \\ w_n & w_n/w_1 & \cdots & w_n/w_j & \cdots & w_n/w_n \end{matrix} \begin{bmatrix} w_1 \\ \vdots \\ w_j \\ \vdots \\ w_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ \vdots \\ w_j \\ \vdots \\ w_n \end{bmatrix}$$

or **(W-nI) w = 0**

The above equation solves the eigenvalue problem, we can derive the comparative weights by multiplying the eigenvector w by λmax such that $Aw = λmax.w$, where λmax is the largest eigenvalue of the matrix A, which means find the eigenvector w with respective λmax for $(A- λmax I)w = 0$.

Step 4: Check Consistency ratio – CR of pairwise comparisons

To ensure the consistency ratio of experts during the evaluation process, we need to calculate CR. The equation of CR can be expressed as:

$$CR = \frac{CI}{RI}$$

Where, CI: Consistency index

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

λmax: the largest eigenvalue,
n: the numbers of the attributes
RI: Random index.
RI can be defined in the available table as follows:

Table 2: The R.I. for different size matrices

n	3	4	5	6	7	8	9	10	11	12	13
RI	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49	1.51	1.54	1.56

Source: [18]

If CI ≤ 0.1 (10%), the result is reliable because the experts' evaluations are relatively consistent. If CI > 0.1, the experts' evaluations are relatively inconsistent, somewhat random, and need to be re-evaluated. Using the AHP method in decision making is more effective than other decision methods because of its ease of use. Additionally, we can consider many sub-criteria in evaluation and selection, including qualitative and quantitative factors. It also helps decision makers easily check the consistency in the assessment.

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3.   Methodology

3.1   Explore the recruitment criteria on qualified personnel

- **Sample design:**

+ Target population: the research focuses on exploring the recruitment criteria on qualified personnel for logistics company, so target population will be the expert in charge and knowledgeable about personnel and managerial positions. These people must make decisions on personnel recruitment and have at least 3-year experience in the industry.

+ Sampling: Currently, Vietnam has about 4,000 logistics enterprises, of which 70% are concentrated in Ho Chi Minh City and surrounding areas. Therefore, sampling is concentrated in Ho Chi Minh City and surrounding areas such as Dong Nai, Binh Duong, Vung Tau. Additionally, 90% of enterprises have registered capital of less than VND 10 billion, 1% have capital over VND 100 billion, 1% have capital from VND 50 billion to VND 100 billion, 3 % have capital from VND 20 billion to 50 billion, and 5% have capital from VND 10 billion to VND billion (Thành Chung, 2019). To ensure a comprehensive result, stratified random sampling is applied, in which stratified sampling with the proportion of registered capital – meaning that the stratum of the sample is proportional to the random sample in the population used.

+ Sample size: As stratified sampling is applied, sample size which is defined under design effect (DEFF) is most suitable. The formula for calculating the sample size is as follows:

$$n = [DEFF^*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}{}^*(N-1)+p^*(1-p)]$$

Where, n: sample size

N: population – 2,800 enterprises

p: hypothesized % frequency of outcome factor in the population. Since it is unknown how many percent of enterprises respond, p would be 50% (corresponding to 0.5)

d: confidence limit – 5%

DEFF: design effect – 1.0 for random sample

Z: standardized value. Since confidence level reaches 95%, Z would be 1.96

Thus, the sample size n reaches 338. In particular, the number of specific surveys according to the enterprise capital is presented in table 3.

Table 3. Sample size of the research

Capital amount	< VND 1 billion	VND 10 – 20 billion	VND 20 – 50 billion	VND 50 – 100 billion	> VND 100 billion	Total
Size	304	17	10	3	4	338

- **Data collection and analysis:**

Data were collected through the questionnaire which was distributed to each logistics enterprise based on the 2019 VLA member directory and Vietnam Yellow Pages. In total, the authors contacted and received 224 valid answers.

The collected data were cleaned and processed through SPSS 20 software. Exploratory Factor analysis (EFA) was used to filter the measurement variables, the regression analysis was applied to define the effect level of each criterion.

3.2   Analytic hierarchy process

Analytic hierarchy process was utilized to select personnel at a logistics company (called company A).

- **Sampling design:**

+ Target population: experts who are in charge and knowledgeable about personnel, managers who are able to make decisions on personnel selection.

+ Sample size: According to the process of personnel recruitment of company A, the recruitment decision depends on the HR department manager, the logistics managers, and the Board of Directors. Therefore, the sample size by this method was 3.

- **Data collection and analysis:**

The data for AHP analysis is questionnaires with a scale of 1 to 9 [18] which were sent to respondents including HR managers, logistics managers, Board of Directors. Data were analyzed by Expert Choice software.

4.   Findings of exploring factors affecting qualified personnel.

4.1   Measurement scale test result

The scale is assessed through methods of reliability assessment and EFA. Cronbach's Alpha is utilized to verify the correlation among observed variables. Any observed variable with its item-total correlation less than 0.3 will be excluded [19].

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Cronbach's Alpha analysis results of Knowledge, Skills, Health, Personality Traits, and Selection Decision show that all measurement scales meet the Cronbach's Alpha reliability coefficient conditions, and then are used in model analysis. However, the item-total correlation coefficient of HE5 variable got less than 0.3, so it was deleted. After deleting HE5 variable, Cronbach's Alpha coefficient increased to 0.822, so it is possible to continue using the remaining variable in model analysis.

Table 2. Cronbach's Alpha test results

Scale	Cronbach's Alpha coefficient		Observed variables		Deleted variable
	1st time	2nd time	1st time	2nd time	
Knowledge (KL)	0.660		4		
Skills (SK)	0.710		4		
Health (HE)	0.718	0.822	5	4	HE5
Personality Trait (PT)	0.760		4		
Selection Decision (SD)	0.908		4		

(Source: Analysis of the authors in November 2019)

4.2   EFA and regression results

After deleting HE5 variable, there are 16 variables belonging to 04 factors for running EFA the first time. After running EFA the third time, KMO coefficient reaches 0.815 with its statistical significance of 0.000 and cumulative of 65.048%. This result shows that exploratory analysis of the independent variables is appropriate.

Table 3. Factor rotation matrix

Variable	Factor			
	1	2	3	4
HE4	.873			
HE2	.796			
HE1	.763			
HE3	.718			
PT2		.819		
PT1		.784		
PT4		.699		
PT3		.543		
SK2			.821	
SK1			.788	
SK3			.729	
KL1				.810
KL2				.778
KL3				.644
KMO coefficient				.815
Eigenvalue				1.175
Cumulative				65.048
Bartlett test	Df			91
	Sig			0.000

(Source: Analysis of the authors in November 2019)

Table 4. Regression analysis result

Model	R	R^2	Adjusted R^2	Estimated standard error	Durbin-Watson
1	.697a	.486	.484	.30503	
2	.819b	.671	.668	.24477	
3	.877c	.770	.767	.20517	
4	.893d	.798	.794	.19270	1.787

(Source: Analysis of the authors in November 2019)

In table 4, R^2 (R Square) = 0.794 means that 79.4% of the variation of the selection decision is explained by the linear relationship with the 04 criteria SK, PT, KL and HE. Other criteria have not been mentioned. Also in table 4, it is seen that SK, PT, KL and HE all have statistical significance with its sig. < 0.05 so no criteria are deleted.

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Table 5. Regression coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
4	(Constant)	.619	.104		5.968	.000		
	SK	.301	.024	.428	12.460	.000	.782	1.280
	PT	.217	.022	.347	9.731	.000	.727	1.376
	KL	.207	.024	.295	8.776	.000	.816	1.226
	HE	.098	.018	.182	5.514	.000	.847	1.181

(Source: Analysis of the authors in November 2019)

Table 5 shows that SK factor has the strongest impact on the selection decision, following by PT, KL, and HE factor.

Based on the unstandardized beta (Table 5), the authors select the model and regression equation as follows:

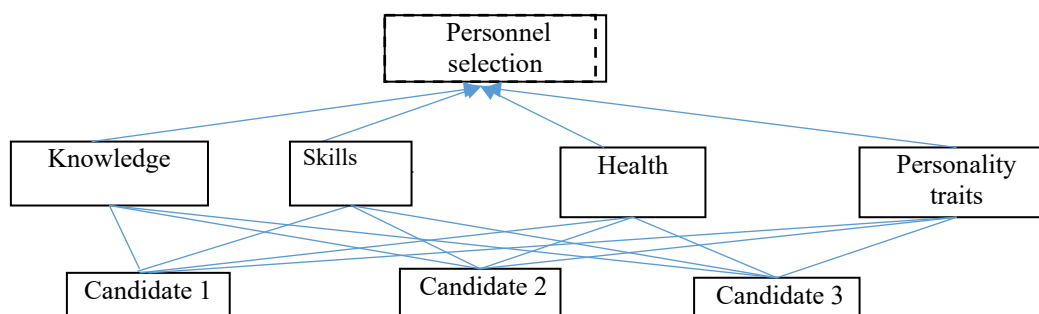$$SD = 0.619 + 0.301SK + 0.217PT + 0.207KL + 0.098HE + \varepsilon_i$$

- When criterion SK increases by 01 unit, the company's selection decision (SD) increases on average by 0.301 units, provided that other factors do not change.
- When criterion PT increases by 01 unit, the company's selection decision (SD) increases on average by 0.217 units, provided that other factors do not change.
- When criterion KL increases by 01 unit, the company's selection decision (SD) increases on average by 0.207 units, provided that other factors do not change.
- When criterion HE increases by 01 unit, the company's selection decision (SD) increases on average by 0.098 units, provided that other factors do not change.

Personnel selection model of company A is as follows:

4.3 Analyze the relationship between the Selection Decision and the characteristics of the business.

Through the ANOVA test results, it is concluded that the type of enterprise, the size of the capital, the size of its personnel does not affect the decision to recruit qualified personnel.

5. An application of AHP into practical recruitment case.

After exploring four recruitment criteria on qualified personnel including Knowledge, Skills, Health, and Personality Traits for logistics companies, the authors apply these criteria into personnel selection at a company called A. A is one of the largest logistics and supply chain companies in Vietnam and one of VNR's TOP 50 Best companies and TOP 500 Biggest companies in Vietnam for the 12th consecutive year. It is a leading regional logistics solutions provider of Aviation, Integrated Logistics, Warehousing, Freight Management, Customs and Distribution services in Indochina. The recruitment process of the company is as follows:

1st round: Examine and classify candidates' profiles that do not meet the requirements on qualifications, health certificates.

2nd round: Firstly, candidates will take a test to grade their professional knowledge. Then, the recruitment council of the company will interview to check and grade the candidates' skills, health, and personality traits. The score of each candidate will be the average of the Council members.

Finally, the company will use AHP method to score and select candidates with the highest overall score.

Figure 4. Personnel selection model of company A

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In the November recruitment, after two rounds, the company selected three candidates, temporarily called Candidate 1, Candidate 2, and Candidate 3. The company then applied AHP into selecting the best candidate. The results show that Candidate 2 appears to be the best candidate with the outstanding knowledge

6. Conclusion and recommendations

The paper aims to support the decision on qualified personnel recruitment for logistics company. Recently this has been the urgent case of not only logistics companies but also the industry. Logistics personnel must have appropriate skills, personality traits, knowledge, and health to deal with the diversified working environment. Selecting the appropriate logistics personnel is a key success factor for an organization. The complexity and significance of the issue call for an analytical method rather than intuitive decisions. The unique features of the industry consist in dealing with precise data and expressing the opinion of the group of experts. AHP is considered an ideal method to deal with the industry's requirement. In addition, this method is simple enough for companies to use.

To select the appropriate logistics personnel basing on the explored recruitment criteria, the authors have some recommendations as follows:

Firstly, there should be a clear orientation for the development of logistics industry from the Government. At the same time, the coordination among relevant ministries, departments, and sectors are able to delineate each party's ability and responsibility in developing logistics service industry, including the development of logistics human resources.

Secondly, the cohesion and cooperation in training between schools and businesses should be strengthened. Therefore, requirements on skills, knowledge, health, and personality traits are met by students. Logistics companies do not need to re-train labourers after recruitment.

Thirdly, it is necessary to have Student support programs. In order to have good human resources to meet the recruitment needs of businesses, the schools should have programs to support students to practice at major logistics companies, thereby increasing the chances of being recruited for students after their graduation. Additionally, field trips and conferences on current national and international logistics activities

and personality traits although health is not good. The following candidate is 1, who has outstanding skills and health, less knowledge than candidate 2. Candidate 3 only dominates in health and personality traits whilst knowledge and skills are really weak compared to the others (See Appendix for detailed caculation)

should be organized for students to have job placement before graduation.

Last but not the least, students and labourers should have a job orientation right from the training process. Students need to be active in the process of finding and accessing logistics companies if they want to work in this service area, then need to actively learn to improve their skills to be able to keep up with the job after graduation. The direct labour groups need to be trained not only in working skills, but also in the physical and mental training, working attitude as well as labour discipline compliance attitude.

In regard to theoretical contributions, the study adds to the theory of human resources management and logistics management the full set of personnel selection criteria including knowledge, skills, health and personality traits. Each criterion comprises certain sub-criteria to make the selection criteria more comprehensive.

As a future step to this paper could be the use of other multiple criteria decision-making methods like SAW, TOPSIS, ANP … to make comparison to the proposed method in this paper. Additionally, the increase of the sample size to the one calculated by the DEFF formula is encouraged.

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Appendix. The results of applying AHP to personnel recruitment

❖ *Step 1: Define weights of criteria*

- **Set up comparison matrix for criteria**

	Knowledge	Skills	Health	Personality traits
Knowledge	1	1/2	3	1/2
Skills	2	1	5	2
Health	1/3	1/5	1	1/5
Personality traits	2	1/2	5	1

- **Normalized matrix for criteria:**

	Knowledge	Skills	Health	Personality traits
Knowledge	3/16	5/22	3/14	5/37
Skills	3/8	5/11	5/14	20/37
Health	1/16	1/11	1/14	2/37
Personality traits	3/8	5/22	5/14	10/37

- **Define weights for criteria:**

Knowledge: $(3/16 + 5/22 + 3/14 + 5/42)/4 = [.187]$
Skills: $(3/8 + 5/11 + 5/14 + 20/37)/4 = [.432]$
Health: $(1/16 + 1/11 + 1/14 + 1/21)/4 = [.070]$
Personality traits: $(3/8 + 5/22 + 5/14 + 5/21)/4 = [.299]$

- **Check consistency ratio**
  - Calculate λmax

$$0.187 \begin{bmatrix} 1 \\ 2 \\ 1/3 \\ 2 \end{bmatrix} + 0.432 \begin{bmatrix} 1/2 \\ 1 \\ 1/5 \\ 1/5 \end{bmatrix} + 0.07 \begin{bmatrix} 3 \\ 5 \\ 1 \\ 5 \end{bmatrix} + 0.299 \begin{bmatrix} 1/2 \\ 2 \\ 1/5 \\ 1 \end{bmatrix} = \begin{bmatrix} 0.763 \\ 1.754 \\ 0.279 \\ 1.239 \end{bmatrix}$$

λmax = [0.736/0.187 + 1.754/0.432 + 0.279/0.07 + 1.239/0.299] / 4 = 4.03
  - $CR = CI/RI = [(4.03 – 4)/3]/0.90 = 0.01$
→ CR is within well acceptable range for consistency

❖ *Step 2: Pairwise comparison matrix for Knowledge*

	Candidate 1	Candidate 2	Candidate 3
Candidate 1	1	1/3	6
Candidate 2	3	1	7
Candidate 3	1/6	1/7	1

By doing the same as step 1, the results of comparing candidates are as follows:
- Priority vector for knowledge:

Candidate 1: 0.298
Candidate 2: 0.632
Candidate 3: 0.069

- Consistency ratio:

CR = 0.088 → CR is within well acceptable range for consistency

❖ *Step 3: Pairwise comparison matrix for Skills*

	Candidate 1	Candidate 2	Candidate 3
Candidate 1	1	7	2
Candidate 2	1/7	1	5
Candidate 3	1/2	1/5	1

- Priority vector for Skills:

Candidate 1: 0.571
Candidate 2: 0.278
Candidate 3: 0.151

- Consistency ratio: CR is within well acceptable range for consistency

❖ *Step 4: Pairwise comparison matrix for Health*

	Candidate 1	Candidate 2	Candidate 3
Candidate 1	1	8	1
Candidate 2	1/8	1	1/8
Candidate 3	1	8	1

By doing the same as step 1, the results of comparing candidates are as follows:
- Priority vector for Health:

Candidate 1: 0.471
Candidate 2: 0.059
Candidate 3: 0.471

- Consistency ratio: is within well acceptable range for consistency

❖ *Step 5: Pairwise comparison matrix for Personality Traits*

	Candidate 1	Candidate 2	Candidate 3
Candidate 1	1	1/3	1/5
Candidate 2	3	1	2
Candidate 3	5	1/2	1

- Priority vector for Personality Traits:

Candidate 1: 0.119
Candidate 2: 0.501
Candidate 3: 0.380

- Consistency ratio: within the acceptable range for consistency

❖ *Step 6: Recruitment result*

- Overall priority vector

Priority vector for criteria [.187] [.432] [.070] [.299]

	Knowledge	Skills	Health	Personality traits
Candidate 1	.298	.571	.471	.119
Candidate 2	.632	.278	.059	.501
Candidate 3	.069	.151	.471	.380

Thus, the overall priority vector is:

Candidate 1: $(.187)(.298) + (.452)(.571) + (.070)(.471) + (.299)(.119) = [.382]$

Candidate 2: $(.187)(.632) + (.452)(.278) + (.070)(.059) + (.299)(.501) = [.398]$

Candidate 3: $(.187)(.069) + (.452)(.151) + (.070)(.471) + (.299)(.380) = [.228]$