Using Fuzzy Approach to Model Skill Shortage in Vietnam's Labor Market in the Context of Industry 4.0

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***Abstract*—**Human resource development is one of the main issues in the socio-economic development strategy and the transform of any regions in the context of the Industry 4.0. However, Vietnamese human resources have been poorly evaluated in the areas of quality, lack of dynamism, and creativity. Therefore, this paper presents fuzzy logic approach to rank seven skills shortage in Vietnam's Labor Market, namely lifelong learning, adaptive capacity, information technology capacity, creativity and innovation capacity, problem-solving capacity, foreign language competency, and organizing and managing competency. The research results have shown that the problem solving skill is the largest gap between an enterprise's requirements and the actual response of employees.

Keywords: fuzzy logic; industry 4.0; human resource; skills shortage; Vietnam

I. INTRODUCTION

Theories of economic growth, especially the endogenous growth model, have recognized the role of human factors in economic growth. Lucas [1] have shown with empirical evidence that human resources are a key factor in determining economic growth and reducing poverty. Thus, human resource development is one of the core issues in the socio-economic development strategy and the transformation of growth models of countries or regions, especially in the context of the Industry 4.0 [2-6]. Many studies have emphasized that higher education decides the quality of a country's human resources [7-12]. In Vietnam, the 11th Central Committee's Meeting, 8th Session issued a resolution for fundamental innovation in comprehensive education and training, aiming to this goal. Goldin and Katz [13] suggested that a high level of education leads to high labor productivity and the higher the total education level of a country, the faster its economy will develop. However, globalization and technological progress have led to structural changes in the organization of businesses and the manner of work and, at the same time, changes in the demand for qualified employees and the professional profile of candidates [14, 15].

Cedefop [16] confirmed the difficulty encountered by the world's employers in finding the candidates with the right skills when recruiting. The labor market in Vietnam is no exception. The World Economic Forum's 2017 [17] global human resources assessment showed that Vietnam's overall human resource index ranked only 64/130. In particular, the "competencies", "development", and "creativity" components in the rankings were 85/130, 67/130, and 120/130, respectively [17]. Similarly, the assessment of the World Economic Forum's readiness to participate in the 4.0 revolution shows that the ranking of highly skilled human resources and labor in Vietnam was quite low, 70/100 and 81/100 [18]. This was also the reason for overall low labor productivity.

In three decades (1991-2022), Vietnam's labor productivity has increased but not significantly [19]. Vietnam's labor productivity is only higher than the group of low-income countries and is at the threshold of 50% of the low-middle income countries. From 2017 to 2022, Vietnam's labor productivity is double the average labor productivity of low-income

countries, equal to more than 50% of low-income countries and 18.3% of middle- countries. In general, Vietnamese human resources have been poorly evaluated in the areas of quality, lack of dynamism, and creativity. The World Bank Report on the labor force in Vietnam also pointed to the weakness of a Vietnamese workforce that lacks the necessary skills [20]. The survey results of the report show that 40% of skilled workers lacked the necessary skills. For technicians, this number was up to 80%. Skill shortages were also drivers of increased training expenditures and average labor costs [21].

Skills can be approached as a multi-dimensional concept, comprised of the quality of education, major areas of study, and previous working experience, otherwise serious bias in human capital evaluation may arise [22]. Besides, various types of skills can be noted, such as technical skills, cognitive skills, and soft skills, etc. also, the required labor market skills have dynamically changed to adapt to the technological innovations of Industry 4.0 [23-26]. For institutions of higher education, the optimal training for the labor market is strategically prioritized [27]. Therefore, it's essential that skills shortage criteria should be identified and ranked for efficient and effective remedies and Vietnamese higher education is not an exception. In recent years, the application of artificial intelligence to understanding the human thought process and having it applied in the real environment has become a prominent theme. Fuzzy logic has paved the way for modeling human behavior and mathematically obscure concepts. This is the method preferred by researchers to solve evaluation issues and make decisions, given its two advantages: i) objectiveness and ii) fuzzy evaluation for dynamic reflection of the research's object. Therefore, this paper is applying a fuzzy approach to the model skills shortage in Vietnam's labor market.

II. RESEARCH BACKGROUND

Skill shortages occur when employers fail to find candidates with the right skills because they are not well-prepared for the jobs or positions that they occupy [28-32]. In designing a new training program or redesigning an existing training program, determining the capabilities and competencies that university graduates must acquire during the educational process is one of the most important aspects of the process. Hernández-March, Del Peso

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[14] suggested that having a clear career orientation is expected to create educational needs at universities that integrate common core competencies so students can be ensured full participation in the labor market upon graduation. To achieve this goal, universities need to know what business requires from university graduates, including their level of preparation, and what business believes can be improved. However, answering the question of what is required for business is not simple.

OECD [33] conducted a Survey of Adult Skills (PIAAC) which included questions about skills and designed an assessment exercise. The skills measure was derived from a combination of self-reported information and skill proficiency. Pellizzari and Fichen [34] explored the PIAAC data and proposed a new measure of skill mismatching, categorizing laborers into three groups: matched, under-skilled and over-skilled. However, the PIAAC only included information on literacy and numeracy skills, which does cover very well the competencies required by the labor market. Previous studies have also focused on evaluating the capacity of the undergraduate laborers. Hernández-March, Del Peso [14] surveyed 872 enterprises in Spain and performed in-depth interviews with 40 business directors or individuals in charge of personnel. The authors pointed out that students needed to improve their interpersonal skills, teamwork, attitudes and motivation toward work, lifelong learning, computer skills, and time management skills. Research showed that differences between the expectations of enterprises and the practical capacity of newly graduated university employees were substantial. New employees often needed up to a year to undertake the assigned jobs.

Bui and Porter [35] interviewed enterprises in New Zealand to discover whether a gap between the expectations of businesses and the proficiency of new accountants existed. The findings showed that employers appreciated some of the characteristics of newly graduated accountants, such as basic knowledge about the field of work, communication ability, teamwork skills, and lifelong learning capacity. However, they lacked other important competencies such as skills to apply knowledge in practice and the ability to grasp and handle jobs [36, 37]. Kemp, Martin [38] further clarified that employers required graduates

to have skills such as research skills, teamwork, communication skills, flexibility, and time management skills. Nevertheless, there were still differences between employers' expectations and the self-evaluated ability of students. Moreover, the perception of such differences also varied. For instance, many new graduates were satisfied with their time management, while employers were dissatisfied with this aspect of the work of the new employees.

In the 21st century, employees have had to meet new challenges in the skills requirements. Suarta, Suwintana [39] insisted that nowadays businesses required workers to be able to work effectively in a volatile economy. The study also suggested that the characteristics of a new graduate were more important than the subjects they studied. Therefore, workers to work on soft skills such as their learning ability, adaptability, communication skills, problem-solving and decision-making skills, teamwork, and creative capacity. Furthermore, 309,000 vacancies in 169 professions of various professional levels in the United Kingdom (UK) was analyzied [40]. The research indicated that employers found it difficult to recruit suitable workers in one third or 106,000 of these positions. The industries that encountered the labor shortages included nursing, computer programming, and human resources. The survey also found that the labor supply shortage at small- and medium-sized businesses was much more serious than at the larger ones. One of the main reasons for this deficiency was the 'low number of applicants with the required skills'. Future employment trends in Cedefop [16] implied the current job supply was structured around the records or functions that, in addition to the scientific and technical knowledge provided by the university, required the development of a wide range of skill demands such as customer interaction, product innovation, planning/organization, learning to learn, problem-solving, customer service, team working, communication, technical or job-specific, advanced ICT, foreign languages, and advanced literacy.

In general, most workforce studies have agreed that the practical capacity of the laborers has not met the requirements of the enterprises. Therefore, many businesses believe that university graduates need to improve their skills in the areas of creativity, problem-solving,

foreign-language competence and information technology. Ablhamid, Santoso [41] used a fuzzy analytic hierarchy process to rank the applicants' profiles to determine the fittest applicant. This approach has proven to be helpful in complicated contexts in a fast-changing world. A similar approach was used by Nguyen, Van Nguyen [42] in developing a competency model of undergraduate employees in the Vietnamese labor market. The findings confirmed the importance of the priority of critical thinking and problem solving, followed by organizing and managing ability, lifelong learning, adaptability, creativity and innovation, expertise and digitalization, and foreign language knowledge. Further exploration of the gaps between the actual and expected skills was made in the paper to guide educators as well as individuals in meeting the labor market demand

III. RESEARCH METHODOLOGY

A two-part questionnaire was prepared to collect data:

Part 1: Information on the survey of people and enterprises. These included: (i) personal information about respondents (gender, title, year of birth); and (ii) Information about the enterprises (headquarters, field of activity).

Part 2: Evaluation criteria of enterprises on the ability to meet the job requirements of university-trained labor. Until recently in Vietnam, no unified set of criteria existed for assessing the quality of such labor. Based on the work of, when determining the criteria for labor capacity in Vietnam, The criteria used to determining labor capacity in Vietnam was drawn from the work of Nguyen, Van Nguyen [42] and was used to create the questionnaires to survey of enterprises on the ability to meet job requirements of university graduates. These criteria include: (i) Lifelong learning; (ii) Creativity and innovation; (iii) IT; (iv) Adaptability; (v) Critical thinking and problem-solving; (vi) Foreign language; and (vii) Organizing and managing ability. These criteria will be assessed on an 11-level scale (level 0 is completely disagree and level 10 is completely agree). The questionnaire also expressed our commitment to using the information only for research purposes, along with the commitment to keep the information confidential to respondents.

In the next step, the questionnaire was sent to enterprises to conduct the survey and determine the assessment of enterprises on the actual capacity of workers. The research team used the following three criteria to select businesses: (i) development orientation of Ho Chi Minh City (HCMC), Vietnam; (ii) the importance of industry groups in socio-economic fields; and (iii) location of the enterprises in Ho Chi Minh City. Based on these criteria, the study focused on businesses in the fields of IT, economics or commerce, transportation, finance or banking and insurance, health services, and tourism (see Table 1).

TABLE I. DESCRIPTION OF RESEARCH SAMPLE

Firm information		
Industry	***Number of firms***	***Percentage***
Information technology	9	15.00%
Economics and commerce	7	11.67%
Transportation	9	15.00%
Finance, banking, insurance	9	15.00%
Health service	6	10.00%
Tourism	9	15.00%
Others	11	18.33%
Total	**60**	**100%**
Location	***Number of firms***	***Percentage***
District 1	18	30.00%
District 2	2	3.33%
District 3	6	10.00%
District 5	2	3.33%
District 7	1	1.67%
District 8	2	3.33%
District10	3	5.00%
Binh Tan District	2	3.33%

Binh Thanh District	3	5.00%
Go Vap District	1	1.67%
Phu Nhuan District	6	10.00%
Tan Binh District	7	11.67%
Tan Phu District	7	11.67%
Total	**60**	**100%**
Respondents Information		
Gender	***Number of people***	***Percentage***
Male	29	48.33%
Female	31	51.67%
Total	**60**	**100%**
Position	***Number of people***	***Percentage***
Chief Executive Officer - CEO	1	1.67%
Director/Deputy Director	15	25.00%
Head/Deputy Head of Department	44	73.33%
Total	**60**	**100%**

There were 60 survey questionnaire responses from businesses. Table 1 provides information on enterprises in the sample. Specifically, most of these enterprises were located in District 1 (30%). District 1 is considered the economic hub of HCMC with the highest number of domestic and foreign enterprise offices. This is also the district with the largest shopping centers in HCMC. These enterprises mainly operated in the field of commerce and services, such as IT, transportation. finance, banking, insurance, and tourism (accounting for 15% for each sector). These were also the areas that HCMC is still developing, and they made the biggest contribution to the economic growth of the city in 2019.

Specifically, the three services sectors with a higher proportion of growth than the average included: wholesale and retail increased, which increased by 8.67%; transportation

and warehousing, which increased by 11.43%; finance and banking, which increased by 9.19%. Meanwhile, the IT sector contributed 4.44% to the city's domestic products in 2019, and Ho Chi Minh City wants to have at least 1,000 more businesses in this field in the future. The tourism sector contributed 6.9% of the gross domestic product in 2018. Ho Chi Minh City, furthermore, is aiming to become a regional and international financial center. Table 1 provides information about the respondents. Notably, the percentage of females was slightly higher than that of males. Also, the respondents were mainly heads or deputy heads of departments of human resources and administration. Finally, to calculate the weights of critical skills shortage in Vietnam's labor market, the fuzzy set theory based on analytic hierarchy process was adopt because its advantage to deal with uncertainty, inaccuracy and ambiguity of data input by experts [43-47]. For defuzzified the fuzzy weights, in this research, we applied the following CoA method [48]:

$$BNP_{w_i} = [(U_{w_i} - L_{w_i}) + (M_{w_i} - L_{w_i})]/3 + L_{w_i} \qquad (1)$$

where BNP_{w_i} is the Best Nonfuzzy Performance (BNP) value of the fuzzy weights of the i^{th} criteria [49].

IV. RESULTS AND DISCUSSION

The research results presented in the Table 2. Seven main criteria were composed of the hierarchical model. Among these skills, the ability to analyze, detect, and solve problems created the largest gap between an enterprise's requirements and the actual response of employees. This reflects the common trend of industry 4.0 in the skills demand of labor forces [50].

Overall, enterprises required workers to meet at 8.1 points on average on the scale of labor capacity. However, enterprises assessed that the actual capacity of employees was only 6.0 points.

TABLE II. DESCRIPTION OF RESEARCH SAMPLE

Skills Shortage	Rank
Lifelong learning	6
Innovation	4
Information technology	7
Adaptability	3
Problem solving	1
Foreign language	5
Organization	2

Ranked second on the difference between the requirements of businesses and the employees' ability in practice were the organizing and managing capacity. Specifically, enterprises sought, on average, for university graduates to reach 7.7 points, employees achieved only an average of 5.9 points. Therefore, the gap between the requirements of enterprises and the practical capacity of workers was about 1.8 points. In addition, the panel discussion also confirms the higher decentralisation in managing capacity. This complies with higher process integration and cross-functional perspectives. Other indicators that also showed that the practical capacities of labor had not kept up with the requirements of

businesses were in adaptive capacity and creativity and innovation capacity. The average requirement level of enterprises for these two indicators were 8.1 and 8.0 points, respectively. However, businesses said that employees only had 6.5 points for adaptive capacity and 6.6 points for creative capacity.

The differences between the requirements of enterprises and the practical capacity of workers for foreign language and lifelong learning were quite small. On average, enterprises required employees to achieve 7.8 points for their ability to use foreign languages, and the actual capacity of workers was 6.6 points. Similarly, the indicators for lifelong learning ability were 7.4 points and 6.3 points, respectively. The capacity with the smallest gap was the IT ability. This finding implies that the importance of continuous learning has been projected by higher education institutions in Vietnam to adapt to future qualification requirements derived from Industry 4.0 [51, 52]. According to the assessment of enterprises, employees were well equipped for this skill (reaching 7.2 points). Therefore, although the requirement for this indicator was quite high (8.2 points), the difference between the requirements of enterprises and the practical capacity of employees was only about 1 point.

V. CONCLUSION

This paper explored enterprise assessment of university graduates in Ho Chi Minh City, Vietnam to meet the job requirements. The results showed that some industries have surplus labor, some lack labor, while others undergo too many managers and not enough people to do the work. Furthermore, the quality of trained workers has not yet satisfied the requirements of employers. Specifically, the authors surveyed seven indicators, namely lifelong learning, adaptive capacity, information technology capacity, creativity and innovation capacity, problem-solving capacity, foreign language competency, and organizing and managing competency. It was shown that the practical capacity of employees is much lower than the requirements of enterprises. The difference was statistically significant. A skills shortage creates unemployment and productivity loss, which, in turn, impedes the industry growth [53, 54]. The findings identified key areas of

education and training needed to bridge the skills gap. Individuals also can strategize how to best invest in adult training to satisfy employers' expectation, shield themselves against career interruptions and the changing skill needs due to rapid digitalization This can benefit economies and firms as well as the unemployed and the employed who is under-qualified employed. Thus, to improve the ability of labor to meet the practical requirements of their work, the coordination between the three major involved parties—authorities, training institutions, and businesses—needs to be the focus of the future investment.

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