Using Fuzzy Logic to Develop Employees' Competency Ranking Model

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Abstract
This paper developed the employees' competency model based on the literature review of both the United Kingdom (UK) and the United States of America (US) approaches. Furthermore, experts' interview is applied to justify the model in the Vietnamese context. A competency model comprising of seven dimensions with ASK (Attitudes, Skills, and Knowledge) components at each dimension was constructed. Then, the fuzzy logic approach was used to prioritize the importance of the dimensions in the employees' competency ranking model. It was found that critical thinking and problems solving was the first criterion expected by the employer in the Vietnamese labor market.
Keywords: Competency model; Human capital; Fuzzy logic; Vietnam.

1. Introduction
Human capital is considered the most crucial factor in national resources, with a decisive role in the growth and development of the economy (Becker, 1994; Huynh *et al.*, 2018; Nguyen *et al.*, 2018; Nguyen Le Hoang Thuy To *et al.*, 2017). Economic growth theories have provided empirical evidence that human capital is the key determinant of economic growth and development (Lucas, 1988; Romer, 1986; Schultz, 1961). In the context of knowledge-based economies with rapid technological changes, human capital role in the individual and national advantages become more competitive.

Competency is part of human capital and is used for its development through education. Vietnam's human capital and highly qualified workforce were ranked relatively low in the world, at 70/100 and 81/100 respectively (Lado and Wilson, 1994; WEF, 2018). This paper aims at proposing the employees' competency ranking model as a tool to orient Vietnam's human resources training in higher education, which is suitable for the needs of the labor market, especially in the Fourth Industrial Revolution (Industry 4.0).

Competency is proved to be a significant tool for human resource management in both public and private sectors (Jamil, 2015). Competency is a multi-disciplinary concept (Kachalov *et al.*, 2015). It is not limited to cognitive factors but also encompasses functional, interpersonal and ethical aspects. Its composition is not constant but evolves with the context. The concept first appeared in 1973 (McClelland, 1973). Its composition is not constant but changes with an increased complexity to match the actual context.

The literature review has resulted in two significant approaches of competency definition, one from the UK and the other from the US. The UK-based approach emphasizes the individual's ability to select and use necessary knowledge, skills and attitudes to achieve the planned outcomes. It leads to the ASK (Attitudes, Skills, and Knowledge) education model with three core components: attitudes (A), skills (S), including soft skills and technical skills, and knowledge (K) (Liem and Sigurjonsson, 2011).

Attitudes refer to the individual's perception and intention, which determine his or her action. In order to act, skills are required with the support of the knowledge. Knowledge is what the individual can consciously learn and find. The competency characteristics keep expanding to cover a rapid change in labor market demand, especially in the era of Industry 4.0. Therefore, the USA competency approach becomes more practical.

In the USA, competency focuses on any driver to the highest performance at each specific position. As a result, more components in defining the competency are included under the umbrella of three major pillars: emotional intelligence (EQ), intelligent quotient (IQ) and personality. While IQ and personality are stable over a lifetime, EQ can be developed and considered as the foundation for human behavior, which is made up of four core skills: (i) self-awareness, (ii) self-management, (iii) social awareness and (iv) social management. Self-awareness and self-management are the personal ability to perceive the subjective emotions accurately and positively direct the

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behavior. The integration of the two skills embeds in personal competence. Social awareness and relationship management refer to the objective emotions successfully understood and managed by each individual.

In this paper, a broad spectrum of competency's criteria based on the USA approach is analyzed to cover the needs of the labor market. Then, each set of competencies shall be evaluated with the ASK components. Critical thinking and problem-solving, which is the ability to analyze, interpret, evaluate, summarize, and synthesize information, are underlined as two of the key competencies required in the current labor market (Trilling and Fadel, 2009). It is clear that with the rapid change in today's technology, creativity and innovation must be fostered to advance productivity, an essential target of each employer (Grzelczak *et al.*, 2017). It is also the motivation for lifelong learning (Stiglitz and Greenwald, 2014). This criterion becomes a prerequisite for more in-depth learning to prepare for the adaptability of each individual. The literature review also goes further with other competencies like expertise and technology application (digitalization); organizing and managing ability. These competencies play a critical role in Industry 4.0 with significant amount of data and smart related issues (Kiesel and Wolpers, 2015; Prifti *et al.*, 2017).

2. Methodology

AHP, a modern structural analysis technique based on psychology and mathematics and developed by Saaty in 1980, is used to identify the criteria weights (Van Nguyen *et al.*, 2016; Van Nguyen *et al.*, 2017). The outcome is the selection of the best option based on the pair comparisons. The method is a combination of both qualitative (hierarchical model construction) and quantitative (pairwise comparison matrices) data in a logical hierarchy (Quyen *et al.*, 2017). This method is flexible, visual, and helpful in criteria conflict-solving and on complex multi-criteria issues. As a result, the subjective and prejudiced attitude to decision making is alleviated. These advantages explain the popularity of AHP in disciplinary researches including economics, social and political sciences as well as technological fields (Nguyen *et al.*, 2018).

In this study, fuzzy logic approach based on the Best Nonfuzzy Performance is employed to rank criteria for employees' competency in the hierarchical model for Vietnam. The following section presents the mathematical process of the weights of employees' competency ranking model (Huynh *et al.*, 2018; Wu *et al.*, 2010):

Step 1. In this study, a semi-qualitative method with experts' interviews using fuzzy pairwise approach were conducted to evaluate and extend the literature review on the competency criteria. Those experts are selected with the consideration of four criteria: (i) expertise and experience in the field, (ii) willingness to participate in the interview, (iii) availability for the interview and (iv) communication capacity.

Step 2. The synthetic pairwise comparison matrix developed by Buckley (1987):

$$\tilde{a}_{ij} = (\tilde{a}_{ij}^1 \otimes \tilde{a}_{ij}^2 \otimes \tilde{a}_{ij}^3 \otimes ... \otimes \tilde{a}_{ij}^n)$$

where is the fuzzy comparison value of criterion i to criterion j.

Step3. To calculate the fuzzy weights of social capital indicators, we need to calculate (Buckley, 1985; Hsieh *et al.*, 2004):

$$\tilde{r}_i = (\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \tilde{a}_{i3} \otimes ... \otimes \tilde{a}_{in})^{1/n}$$

Moreover, for the weight of each criterion:

$$\tilde{w}_i = \tilde{r}_i \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \oplus \tilde{r}_3 ... \oplus \tilde{r}_n)^{-1}$$

Step 4. The fuzzy weights are defuzzified by any defuzzification method (i.e., CoA method)

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

where BNP_{w_i} is the Best Nonfuzzy Performance value.

3. Results and Discussion

In general, the employees' competency model in Vietnam was developed with a combination of both literature review and experts' interviews by using the best nonfuzzy performance (BNP) technique. In Table 1, seven dimensions were composed of the hierarchical model.

Table-1. Weight Coefficients of Competency Ranking Model

Dimensions	BNP	Ranking scale
Lifelong learning	0.155	3
Adaptability	0.119	4
Expertise and digitalization	0.064	6
Creativity and innovation	0.133	5
Critical thinking and problem-solving	0.410	1
Foreign language	0.041	7
Organizing and Managing ability	0.143	2

Among the seven dimensions, critical thinking and problem-solving were the most important elements in the career path of each employee. It was then followed by organizing and managing competence. This is rational due to the demand for more complex work and collaboration in the current labor market. Lifelong learning and creativity &

innovation were ranked 3rd and 4th respectively in the dynamic, global and interdisciplinary working environments of Industry 4.0. In this context, the only way to acquire the latest technologies is through life learning competence and positive attitude toward changes. The demanding working conditions also push the employees' creativity and innovation to reach the targeted productivity.

4. Conclusion

Competence is a key driver to the success of each individual career growth path. Therefore, it is the goal of the national education. This paper proposes the hierarchial competency model by using fuzzy logic approach based on the Best Nonfuzzy Performance (BNP) technique. The findings have confirmed the importance of Attitude, Skill, and Knowledge in making a successful personality. However, more individual effort should be made towards attitude, which is the foundation for skill and knowledge development. In addition, behavioral competencies with interdisciplinary knowledge dominates the domain-related one. These findings prompt education providers, especially universities, to change their lectures and curricula to focus more on students' domain knowledge.

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