Application Chang's Extent Analysis Method for Ranking Barriers in the E-Learning Model Based on Multi-Stakeholder Decision Making

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Abstract   E-learning success model is a crucial topic, especially in the context of the Fourth Industry with artificial intelligence and virtual reality in developing countries. In practice, it is a combination of technology and education; human and system form an integrated digital learning world. E-learning has many outstanding advantages in providing flexible training and equal education to everyone, which has dramatically changed the self-study process due to the ability to customize and effectively meet the learners' demands. However, e-learning is still inferior to traditional learning and teaching in recent years. This paper explores the key barriers to e-learning success based on multi-stakeholder perspectives. The Chang's Extent Analysis Method under fuzzy logic was applied to rank the components of e-learning success model in Vietnam by defining the key barriers to its development. The incorporation of fuzzy set theory in the Analytical Hierarchical Process is superior in representing human judgments. Seven criteria were selected after justifying the experts' opinions in the in-depth interviews. The findings revealed the important order of infrastructure and technology, human resources, setting, evaluation, management and execution, support and pedagogical aspect. The results are significant for the proper action plan to promote e-learning development under the resource constraint.

Keywords   Decision Science, Education Science, E-Learning, Chang's Extent Analysis Method, Success Model

1. Introduction

E-learning is an abbreviation of electronic learning [1]. It includes at least four approaches. It is i) technology-driven, ii) delivery-system-oriented, iii) communication-driven and, iv) an educational paradigm. Research into these approaches have resulted in various findings and have biased implication for policy. In practice, however, it is a combination of technology and education, human and system to form an integrated digital learning world. [2]. E-learning has grown drastically in the previous four decades with so much change in world education. It is forecasted that the increased trend of e-learning market size, exceed the amount of USD 240 billion by 2023. This is justified by the cost-effectiveness, flexibility, possibilities for customization, and the use of updated learning materials in knowledge delivery. The greatest strength of e-learning is for lifelong learning and the promotion of equal educational opportunities regardless of age, gender, race, and geographical location in a knowledge-based society [3, 4]. E-learning can be the key to reaching the United Nations' sustainable development goal on education.

E-learning in Vietnam was introduced by the government resolution No. 49/CP and Directive No. 9772/BGDĐT-CNTT planning the information and communication technology (ICT) development strategy as well the prioritization of ICT in educational reform [5, 6]. Moodle Vietnam was introduced in 2005 following the launch of the e-learning portal the year before the Ministry of Education and Training (MOET) marked a milestone in the growth path of e-learning. However, e-learning still has

been inferior to traditional learning and teaching and, thus, e-learning success has been challenged. This paper presents the key barriers to its success using the approach of fuzzy Chang's Extent Analysis Method.

2. Literature Review

The literature review addresses three issues: i) the definition of success, ii) the identification of e-learning stakeholders, and iii) the key barriers to e-learning success. Based on the rich literature on barriers to e-learning development, a model of the key factors for e-learning success has been constructed with the criteria weighted so that proper action plans can be taken for the successful mission of e-learning.

2.1. The Definition of Success and Stakeholders

Success means positively achieving set goals [7-11]. Davis [12] further confirmed this idea, adding that the goals must be reached under the resource constraints. This definition of success suggests that each individual has a different view based on the setting. E-learning success in this study has been defined by using a multi-stakeholder perspective. At the university level, three major actors have been defined--students, instructors, and e-learning

administrators [13, 14]. However, it seems that only a one-sided view on e-learning success is reflected by this group of stakeholders. Thaufeega [15] noted that teachers and educational institutions form one of the perspectives of the digital learning world. Aparicio, et al. [16] approached the stakeholders adopted a demand and supply view, defining five major groups including i) customers (students, employers), ii) suppliers (educational institutions, accreditation bodies, teachers, content providers, technology providers), iii) boards and shareholders (education ministry), iv) professional associations (teachers' association) and v) special interest groups (students' commissions).

2.2. Key Barriers to E-Learning Success

Previous studies have attempted to identify the determinants of e-learning success [17]. Given the diversified stakeholder's viewpoints, several factors have contributed to the success of the e-learning model [18-20]. Therefore, the barriers to e-learning require an approach that remedies issues to enhance the spread of e-learning under the resources constraint. Seven important components that limit e-learning have been identified (see Figure 1).
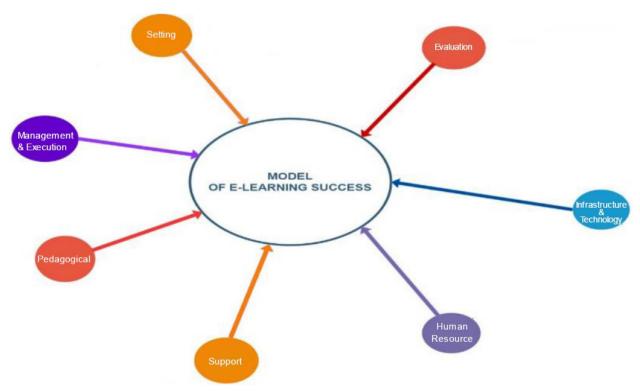

Figure 1. E-learning Success Model

Infrastructure and technology are the first obstacles to e-learning. From the learners' perspective, the ability to work with computers and online privacy are major restraints. [21]. Esterhuyse and Scholtz [22] further mentioned internet speed, actual site design, and insufficiency of hardware and software (platforms) compatible with modern technology. Another critical factor is settings with diversified dimensions of social, political, cultural, geographical and legal issues [23]. Becker, et al. [21] made a survey in Australia and found that the nature of e-learning significantly hindered e-learning success. Peer isolation, learning effectiveness, the validity of online training, and assessment were the main limitations. As a result, certificates issued by certain authorities have been unaccepted. Therefore, positive attitudes and cooperation towards e-learning are critical for its development [24-26]. This also raises the issue of quality recognition, then the evaluation of e-learning programs, content, and students.

Moreover, human resources are the key driver of any success and e-learning is not an exception [27]. According to Soong, et al. [28], both learners' and teachers' competencies are essential to motivate online learning especially the technical skills of instructors, administrators, and technicians. In addition, support also contributes to e-learning development. Prompt feedback, on-demand assistance, and diversified learning resources have been evidenced to be influential in removing e-learning barriers. Khan [23], in particular, emphasized the role of management and execution. In fact, leadership and institutional culture to ether with the strong support commitment from senior management has benefited the development of e-learning. The management of content, delivery, and maintenance is an added value to its success. Pedagogical approaches, methods, and the process of teaching, and curriculum are important for any kind of education, either face-to-face or e-learning [29].

3. Research Methodology

Fuzzy set theory is a special set of mathematical tools that are particularly suited for handling incomplete information or the ambiguity of object classes in the most flexible way [30-38]. The steps of the Chang's extended analysis method under fuzzy environment are as follows [39-41]:

Let $X = \{x_1, x_2, . . ., x_n\}$ be an object set, and $U = \{u_1, u_2, . . ., u_m\}$ be a goal (objective) set.

Then, the m extent analysis values for each ith object for m goals are obtained and shown as follows [42, 43]:

$\tilde{M}_{g_i}^{j}$ where $i = 1, 2,..., n; j = 1, 2,…, m$

Step 1: Obtain priority weights

The value of fuzzy Chang's extended analysis synthetic on the ith is expressed as:

$$S_i = \left(\sum_{i=1}^{m} l_i, \sum_{i=1}^{m} m_i, \sum_{i=1}^{m} u_i \right) \otimes \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i} \right) \quad (1)$$

Step 2: Comparing degrees of possibility

The degree of possibility of $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ is expressed as follows [44]:

$$V(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = \mu_{M_2}(d)$$

$$= \begin{cases} 1 & \text{if } m_2 \geq m_1 \\ 0 & \text{if } l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & \text{otherwise} \end{cases} \quad (2)$$

Step 3: Obtaining the weight vector

The degree possibility for a convex fuzzy number to be greater than k convex fuzzy numbers M_i ($i = 1, 2,…, k$) can be defined by:

$V(M \geq M_1, M_2,…, M_k) = V[(M \geq M_1)$ and $(M \geq M_2)$ and $… (M \geq M_k)] = \min V(M \geq M_i), i = 1, 2,…, k.$ (3)

Assume that

$$d'(A_i) = \min V(S_i \geq S_k)$$

for $k = 1, 2,…, n; k \neq i$.

Then, the weight vector is given by:

$$W' = (d'(A_1), d'(A_2),..., d'(A_n))^T \quad (4)$$

where A_i ($i = 1, 2,…, n$) are n elements.

Step 4: Calculate the normalized weight vector

$$W = (d(A_1), d(A_2),..., d(A_n))^T \quad (5)$$

Step 5. Ranking of the components

After having components weights, the ranking of all components is determined.

4. Results and Discussion

E-learning success model is a crucial topic, especially in the context of the Fourth Industry with artificial intelligence (AI), virtual reality (VR) and big data [2, 45-49]. We have solved the problem of the vagueness in human judgement in the comparison matrice when evaluating the barriers to e-learning success, which has been ignored in the literature. Our research provides insights into the key factors determining its development by integrating the literature review and expert knowledge

in the field. A multi-stakeholder perspective is an innovative approach for a comprehensive model. Moreover, the fuzzy logic technique is useful in ranking the model's components, as shown in Table 1.

Resources are the drivers for growth in economic models. In the case of e-learning, the same can be found with infrastructure and technology. The greater the effects of the application of technology, the better the attitude of students using these technologies [50-52]. Attitude helps ease off the usability, enhances student's academic performance as well as their chance of career success. Universities must apply technologies in their e-learning model to achieve the highest learning outcomes. In particular, accessibility is reflected by the ease of accessing and browsing the Internet on campus. A high access speed, the ease of using web-based courses, and the reliability of communication among students and between students and teachers further inspire students to use e-learning [2, 53-58]. Moreover, technology is one of the three pillars of e-learning evolution history. Technological advancements have promoted all of the three phases of e-learning development, including premise establishment, formation and development, and the contemporary context.

Table 1. Ranking the e-learning success components

Components	Weight	Rank
Infrastructure and technology	0.1700	1
Human resource	0.1668	2
Settings	0.1665	3
Evaluation	0.1597	4
Management and execution	0.1345	5
Support	0.1103	6
Pedagogical aspect	0.0921	7

However, human resources are also significant and, in some cases, their role is superior to physical assets. In an e-learning success model, human resources were second followed by infrastructure and technology. In fact, human competence of online learning is required for all stakeholders, including students, teachers (lecturers or facilitators), instructors, technical supporters as well as administrators to motivate participation in the digital world [14, 59]. Specifically, e-learning favorable attitude and useful perception from teachers are considered as moderating factors for their e-learning competence development. Thus, in order to enhance e-learning, educational institutions should focus on raising teachers' attitudes and awareness about the usefulness of this training method. Professional training courses and a variety of reference materials, as well as appropriate incentive scheme, can motivate teachers to voluntarily participate in online training [60, 61].

Moreover, our research findings suggest that the setting has a strong impact. This is justified for the failure of e-learning given a rich infrastructure and technology as well as human resources. Indeed, social and cultural aspects are most severe, especially in the case of Vietnam, where Confucian philosophy guided the country and favored face-to-face classes and the role of the teacher [62-65].

The consequence is unacceptable of online certification made by certain authorities. Therefore, correct evaluations can mitigate this negative attitude. Quality assurance is considered as a solution [66-68]. In Asia, the issue of ensuring the quality of online training is very diverse. Some countries use the same process and standards for assessing the quality of both face-to-face and online education (such as Hong Kong and Singapore). Several other countries have established separate criteria for evaluating the quality of online training, such as Malaysia and Sri Lanka. The lesson for Vietnam educational institutions with e-learning training is a roadmap to promote e-learning quality.

Another factor is the management and execution, which requires strong leadership as well as tight management of content, delivery, and maintenance [69, 70]. Without a strong commitment from leadership, the institutional mission may go awry and lead to the failure of e-learning. This also benefits the support, which makes available learning resources and communication in place [71, 72]. The pedagogical aspect is the seventh contributor to the e-learning success model. The behind rationale is the role of the curriculum and teaching process.

5. Conclusions

Vietnam's economy has witnessed remarkable growth in recent years in the Southeast Asia [73-82]. This achievement is attributed to the nation's high-quality human resource development strategy [83-89]. Each nation and institution is chasing for the goal of human development and e-learning is an excellent educational delivery system for promoting lifelong learning during the Fourth Industrial Revolution [47, 90]. Further, the multi-stakeholder with the budget constraints. Therefore, the findings from this research can efficiently and effectively prioritize the model components for governments and institutions to balance e-learning development with available resources. To facilitate e-learning with proper strategy, institutional factors should be prioritized because this is one goal for multi-purposes, resulting in effective leadership, rational allocation of resources. Positive attitudes towards e-learning from the stakeholder must be cultivated. In this research, only literature reviews and experts' judgments are conducted. Therefore, prudence must be taken in generalizing the research findings in various contexts.

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