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ASSESS THE LEVEL OF BARRIERS OF MAIN FACTORS TO CHOOSING E-LEARNING IN HO CHI MINH CITY

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Abstract

This article identifies and evaluates the main barrier factors influencing the choice of e-learning from the perspectives of multiple stakeholders. Stakeholder perspectives focus on exploring conflicting viewpoints. The Symbiotic Organisms Search (SOS) algorithm is applied to evaluate and rank the factors of a successful e-learning model in Ho Chi Minh City by identifying the main barriers to choosing this model. The article presents four final criteria selected after analyzing and evaluating the opinions of experts in in-depth interviews. The findings show that the order of importance is infrastructure and technology, human resource quality, management and implementation, support and pedagogy. The results contribute several important insights to developing solutions to improve the quality of online teaching and learning within the framework of limited resources.

Keywords: E-learning, the Symbiotic Organisms Search (SOS), infrastructure and technology, human resource quality, management and implementation.

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Introduction

E-learning, also known as electronic learning, is a dynamic and multifaceted form of education that has been defined through various lenses, including communication-oriented, technology-oriented, delivery system-oriented, and educational model-oriented approaches (Sangrà et al., 2012). Each of these perspectives offers distinct insights into how E-learning functions and evolves, leading to different implementation strategies and pedagogical solutions. Despite these variations, a common thread across all definitions is the integration of digital technology with educational practices, centered around the learner. This synergy creates a vibrant and comprehensive digital learning environment that holds immense potential for transforming traditional education. Although E-learning is a relatively recent development in the history of education, its growth has been accelerated by rapid advancements in science and technology. The proliferation of internet access, mobile devices, cloud computing, and interactive platforms has enabled E-learning to expand beyond conventional boundaries. It offers numerous advantages, such as democratizing access to education regardless of age, gender, ethnicity, or geographic location. Learners can engage in continuous education at their own pace, anytime and anywhere, fostering a culture of lifelong learning. This aligns closely with the United Nations' Millennium Development Goals, which emphasize inclusive and equitable quality education as a foundation for sustainable development.

In the context of Vietnam, the E-learning market is emerging as a promising sector, with an estimated potential value of approximately 2 billion USD and an impressive annual growth rate of up to 40% (Sang & Tài, 2017). However, the current landscape remains heavily concentrated in specific areas such as exam preparation, foreign language instruction, and soft skills training. While these domains reflect immediate market demand, they also highlight the limited scope of E-learning's application in broader educational reform. Despite receiving considerable attention from the Vietnamese government through various resolutions, directives, and policy initiatives aimed at promoting digital transformation in

education, E-learning has yet to achieve widespread adoption. Traditional face-to-face learning continues to dominate, particularly in formal education settings. This preference for conventional methods presents a significant barrier to the success and scalability of E-learning. Cultural attitudes, limited digital infrastructure in certain regions, and a lack of pedagogical training for educators in online environments further compound the challenges.

This article aims to explore and analyze the key barriers that hinder the adoption of E-learning in Ho Chi Minh City—a metropolitan area often considered the most favorable environment for digital education due to its technological infrastructure, urban population, and policy support. By examining the social, technical, and institutional factors affecting E-learning uptake, the study seeks to provide actionable insights for stakeholders to enhance the effectiveness and reach of digital learning initiatives in Vietnam.

Methods

Research design and data collection

This study employed a multi-dimensional quantitative approach to evaluate the relative importance and perceived impact of four foundational factors influencing E-learning implementation (Figure 1): (1) infrastructure and technology Esterhuyse & Scholtz, 2015) (Khan, 2005) (Valverde-Berrocoso et al., 2020) (Hu & Raman, 2024), (2) human resource quality (Soong et al., 2001) (Khan, 2005) (Abdelaziz et al., 2009), (3) learner support and responsiveness (Khan, 2005) (Olawale et al., 2025) (Barikzai et al., 2024), and (4) management and implementation (Karen, 2013) (Barikzai et al., 2024). These factors were selected based on a comprehensive literature review and prior theoretical frameworks in the field of digital education.

To empirically assess these variables, a structured survey instrument was developed and distributed to a diverse sample of participants, including educators, students, administrators, and technical staff. The survey was designed to capture two key dimensions for each factor: (i) the level of interest or perceived importance, and (ii) the perceived contribution of the factor to the success of E-learning adoption. This dual-layered evaluation enabled a more nuanced understanding of stakeholder priorities and interpretations across different institutional and experiential contexts.

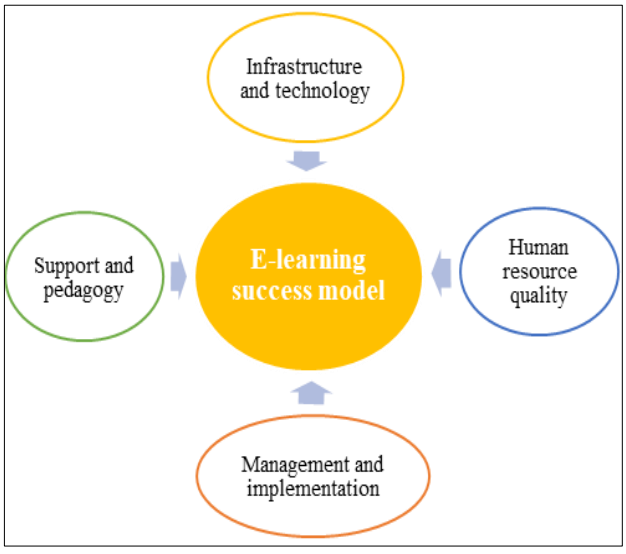


Figure 1. Factors affecting E-learning

Based on Khan (2005), the factors of Infrastructure and technology encompass three major components, namely Hardware, Software, and Speed of Internet, which are essential for ensuring effective access to and participation in E-learning activities (Figure 2). For the Human Resource Quality factor, which comprises three dimensions: Teacher Ability, Learner Competence, and Technical Skill (Figure 3). These dimensions were synthesized from previous studies on E-learning success factors, particularly those of Soong et al. (2001), Khan (2005), and Abdelaziz et al. (2009). With the Management and

Implementation factor, which consists of three dimensions: Culture and Habit, Operation and Maintenance, and Support from Leader (Figure 4). These dimensions were adapted from previous studies on E-learning implementation and organizational readiness, particularly Karen (2013) and Barikzai et al. (2024). Figure 5 presents the Support and pedagogy factor, which consists of four dimensions: Course Design, Technical Support, Resource Database, and Teaching Method. These dimensions were adapted from the E-learning frameworks and learner support literature proposed by Khan (2005) and Olawale et al. (2025).

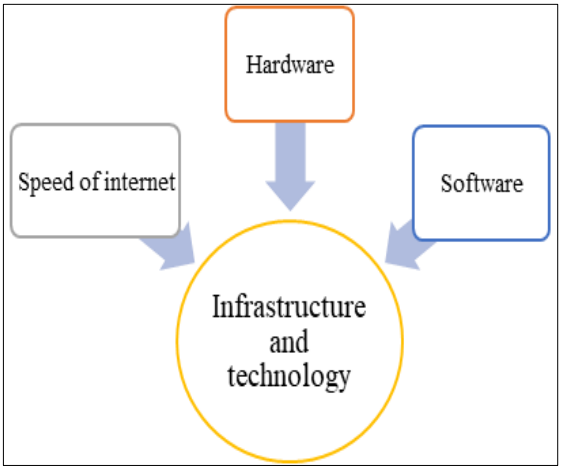


Figure 2. Factors of Infrastructure and technology

Respondents were asked to rate each factor using a percentage scale, which was later normalized and encoded as variable ri (where i = 1, 2, 3, 4) representing the importance level of each factor. Corresponding contribution indices CIi were derived to reflect the perceived influence of each factor on E-learning outcomes. These values served as input for subsequent modeling and optimization procedures. The survey data were collected electronically and processed using statistical and computational tools to ensure consistency and reliability. Descriptive statistics were used to summarize the distribution of responses, while interpolation and optimization algorithms were applied to model the selection tendency functions and identify critical thresholds. This methodological framework allowed for both comparative analysis and predictive modeling, supporting the identification of key barriers and informing strategic recommendations for E-learning development.

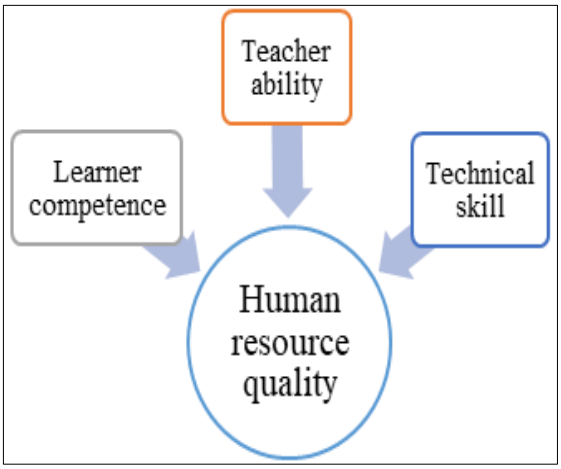


Figure 3. Factors of Human resource quality

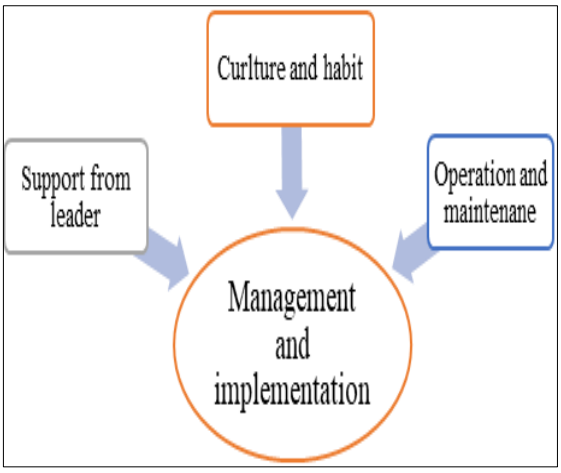


Figure 4. Factors of Management and implementation

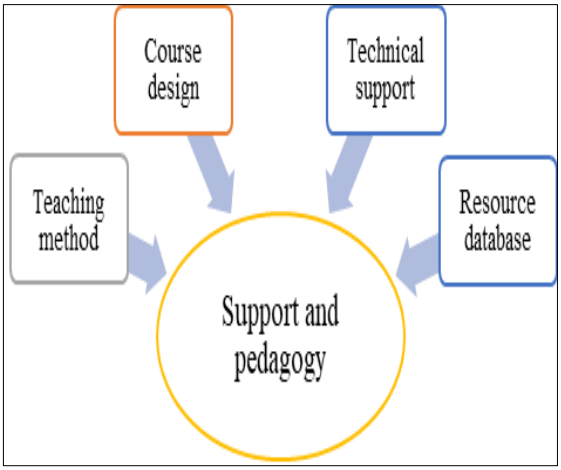


Figure 5. Factors of Support and pedagogy

Following data collection, all responses were carefully processed to ensure both accuracy and authenticity. This step involved data cleaning, normalization, and validation procedures to eliminate inconsistencies and outliers, thereby establishing a reliable dataset for subsequent analysis.

Given the quantitative nature of this study and the need to evaluate complex relationships among multiple variables, we adopted a combination of statistical and optimization techniques to assess and rank the identified barrier factors. This methodological approach was selected to ensure both analytical rigor and the ability to model nonlinear dynamics inherent in stakeholder perceptions.

To model the nonlinear relationships between the importance levels (r_i) and their corresponding contribution indices (CI_i), we applied the Lagrange interpolation algorithm (Kai et al, 2016). This technique allowed us to construct polynomial functions that accurately represent the trend of each factor based on discrete data points derived from survey responses.

In addition, to capture smooth transitions and minimize abrupt changes in the data trends, we utilized the Spline function (Habermann & Kindermann, 2007). This method provided a more refined curve-fitting approach, ensuring continuity and differentiability across the entire range of values. The use of spline interpolation was particularly effective in visualizing the gradual shifts in perceived importance and contribution across the four barrier dimensions. To determine the optimal ranking of the barrier factors based on multi-objective criteria, we employed the Symbiotic Organisms Search (SOS) algorithm (Van Hong & The, 2022). This nature-inspired metaheuristic optimization technique was chosen for its ability to efficiently explore complex solution spaces and converge on global optima. The SOS algorithm facilitated the identification of the maximum value of the total contribution function TB,

enabling us to extract the optimal set of ri values that reflect the most significant barriers to E-learning implementation. Together, these analytical tools provided a robust framework for evaluating the interrelationships among the four core factors and for generating actionable insights into their relative influence. The integration of interpolation and optimization techniques ensured that the analysis was both data-driven and theoretically grounded.

All computations were performed using MATLAB 2016b on a system configured with an Intel(R) Core(TM) i7-4600U processor running at 2.69 GHz, 8 GB RAM, and a 64-bit Windows 10 operating system. This setup ensured sufficient processing power and compatibility with the chosen algorithms, allowing for efficient data handling and accurate output generation. The integration of mathematical modeling and stakeholder perception analysis provides a robust framework for understanding the barriers to E-learning implementation. By combining qualitative insights with quantitative rigor, this study contributes to the development of more resilient and context-sensitive online education strategies.

Data processing

Each factor that hinders participation in E-learning contributes differently to the overall effectiveness of implementation. To identify which barriers exert the greatest influence, it is necessary to determine the relative weight or priority of each factor. This process—commonly referred to as weight determination—provides insight into how individual elements affect the success of E-learning systems. In this study, the authors employ two mathematical modeling techniques to analyze the selection tendency of each barrier: the Lagrange interpolation algorithm (Kai et al, 2016) and the Spline function (Habermann & Kindermann, 2007). These methods are used to construct a selection tendency function for each factor, denoted as CI_i, where i ranges from 1 to 4, corresponding to the four identified barriers.

The function CI_i is defined as a single-variable function of r_i, which represents the importance level of the i-th factor. In this context, r_i reflects the factor's perceived priority, while CI_i quantifies its contribution to the overall success of E-learning implementation. Both CI_i and r_i are expressed as percentages, derived from survey-based evaluations that capture stakeholder preferences and perceptions.

By applying interpolation and smoothing techniques, the study models how changes in perceived importance (r_i) influence the contribution level (CI_i) of each barrier. This approach allows for a nuanced understanding of factor prioritization and supports data-driven decision-making in the design and optimization of E-learning systems.

$$CI_i = f(r_i) \qquad (1)$$

Equation (1) expresses the CI_i as a function of the individual factors (r_i) identified in this study, where CI denotes the overall CI_i and r_i represents the individual factors affecting the choice of E-learning. The purpose of Equation (1) is to examine the relationship between the Contribution level and each factor through survey data analysis. By evaluating the correlation between CI_i and r_i, the study identifies the relative importance and influence of each factor on learners' decisions to adopt E-learning.

To facilitate the evaluation of factor importance, we assign the variables ri to represent the four key factors as outlined in Table 1.

Table 1. Table of influencing factors associated with reference values

i	r_i	Element
1	r_1	Support and pedagogy
2	r_2	Management and implementation
3	r_3	Infrastructure and technology
4	r_4	Human resource quality

Given the complexity of the trend function derived from the survey data and the need to balance accuracy with computational efficiency, we selected a quadratic form compatible with a sine function to represent the CI function. Accordingly, Equation (1) is reformulated as follows:

$$CI_i = a_i + b_i r_i + c_i r_i^2 + |e_i \sin(f_i r_i)| + r_{i,\min} \quad (2)$$

Simultaneously, the variable ri is constrained by the following equation:

$$\sum_{i=1}^{4} r_i = 100\% \quad (3)$$

Based on Equation (2), and following the evaluation and processing of the input values, we derive the parameter value table for the function f(ri), as presented in Table 2.

Table 2. Table of coefficients of the CI function and boundary conditions of the variable r_i

Unit	1	2	3	4
r_i^{min}(%)	0	0	0	0
r_i^{max}(%)	100	100	100	100
a_i	1856.799	451.325	1149.998	856.799
b_i	38.5397	46.1592	40.3966	38.5397
c_i	0.1625	0.1059	0.0904	0.0925
e_i	100	100	100	100
f_i	0.064	0.084	0.084	0.064

Since CI_i (for i = 1 to 4) represents the contribution level of factor i to the success of E-learning implementation, the maximum value of Equation (4) corresponds to the optimal value of r_i that must be identified in order to determine the most significant barriers to E-learning development:

$$TB = \sum_{i=1}^{4} CI_i \quad (4)$$

Result and Discussion

The Symbiotic Organisms Search (SOS) algorithm was employed to identify the maximum value of TB as defined in Equation (4). Based on the optimal TB, the corresponding values of ri are presented in Table 3.

Table 3. Calculated r_i value

Unit	1	2	3	4
r_i	15.1197	17.8799	38.1906	28.8098

The convergence of the TB function is described by Figure 6.

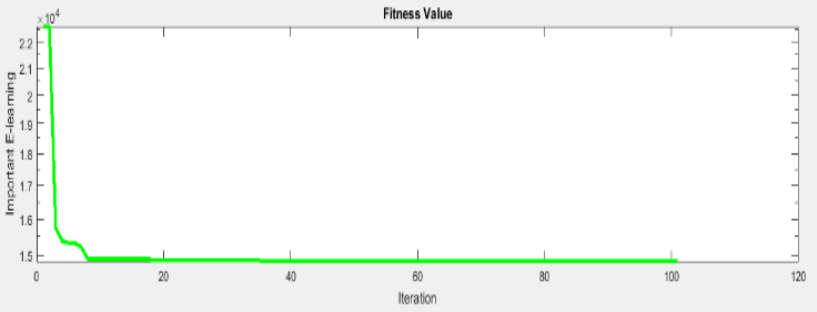


Figure 6. Convergence and value of the CI function.

After using the SOS algorithm to find ri values so that the objective function TB reaches the highest value. Arranging the ri values from largest to smallest, with the larger the value, the more important the level, we get the results of evaluating the main barrier factors to the process of choosing E-learning.

Table 4. Ranking the e-learning success components.

Components	Rank	r_i
Infrastructure and technology	1	38.1906
Human resource quality	2	28.8098
Management and implementation	3	17.8799
Pedagogical aspect	4	15.1794

Based on the results of data processing and survey analysis, it is evident that the success of an electronic-based learning model depends significantly on the infrastructure and technology system. This factor serves as the technical foundation that enables seamless interaction between learners and instructors, ensuring continuity and stability in the online learning process. A robust technological infrastructure provides the necessary conditions for E-learning to function effectively and scale across different contexts. However, the findings also reveal that infrastructure and technology alone are not sufficient to guarantee the development and expansion of E-learning. An equally critical component is the quality of human resources. In the ranking of barrier factors, human resource quality emerges as the second most influential element, underscoring the central role of individuals in operating, maintaining, and enhancing online learning systems.

In any E-learning model—whether synchronous or asynchronous—the competence of each participant is essential. Instructors must possess strong professional expertise, pedagogical skills suited to digital environments, and the ability to leverage technology for effective knowledge delivery. Learners, on the other hand, need self-directed learning capabilities, critical thinking, and the ability to apply acquired knowledge in real-world scenarios. Additionally, system operators and maintenance personnel must have sufficient technical proficiency to detect errors, resolve issues promptly, and ensure uninterrupted system performance. If any individual within this ecosystem fails to meet the required standards, the entire system is at risk. A chain reaction may occur, where one weak link disrupts the functionality of others, potentially leading to the collapse of the entire E-learning model. This highlights the interdependence of roles and the necessity for coordinated efforts among all stakeholders involved.

Beyond these two primary factors, the analysis also indicates that management and implementation and pedagogical aspects hold nearly equal levels of importance. However, upon deeper examination, management and implementation slightly outweigh pedagogical considerations in terms of impact. This distinction can be attributed to the nature of each factor: management practices are more tangible, observable, and measurable, whereas pedagogical elements are often abstract, experiential, and difficult to quantify. A compelling example of this dynamic can be observed in Ho Chi Minh City, a locality known for its advanced technical infrastructure and high-quality human resources. Despite these favorable conditions, the application of E-learning has encountered notable challenges. This suggests

that even with strong technological and human capital, the absence of effective management and strategic implementation can hinder the success of online education initiatives.

Cultural and societal attitudes also play a role. In contexts where traditional face-to-face education is deeply valued, and the presence of a hands-on instructor is considered essential, the transition to a digital learning model may face resistance. The idea of teaching and learning through lines of code or sequences of binary digits (0s and 1s) can be difficult to accept, especially in societies that prioritize direct human interaction in education. Turning to the pedagogical aspect, this factor encompasses curriculum design, instructional methods, and the organization of learning content. It is inherently subjective and relies heavily on the perceptions and experiences of both learners and educators. During the research process, the authors encountered challenges in explaining and clarifying this concept to survey participants. It required careful revision and contextualization to ensure accurate understanding and meaningful responses.

Unlike management and implementation—which can be assessed through performance metrics, workflow efficiency, and coordination—pedagogical quality is more elusive. It involves emotional engagement, cognitive resonance, and the ability to inspire learners. These elements are difficult to model mathematically or represent through quantitative indicators. As such, while pedagogical considerations are undeniably important, their impact is harder to isolate and measure compared to more operational factors. In contrast, management and implementation are more straightforward to evaluate. These activities include planning, resource allocation, coordination among departments, and monitoring of outcomes. Effective management ensures that all components of the E-learning system function harmoniously, reduces operational risks, and enhances the overall learning experience. This clarity and familiarity make management practices easier to recognize, assess, and improve.

In summary, the analysis demonstrates that the success of E-learning is not determined by a single factor but rather by the interplay of multiple elements. Infrastructure and technology provide the foundation, human resources drive the system, management ensures cohesion, and pedagogy shapes the learning experience. Each factor contributes differently, and their relative importance varies depending on context, culture, and institutional readiness. Identifying and ranking these barrier factors is crucial for educational leaders and policymakers. By understanding which elements exert the greatest influence, targeted interventions can be designed to strengthen weak areas, optimize resource allocation, and foster sustainable growth in E-learning. The findings of this study offer a comprehensive framework for evaluating the conditions necessary for successful online education and highlight the importance of holistic planning in digital transformation efforts.

Conclusion

Human development and lifelong learning remain fundamental priorities for societies worldwide, and E-learning has emerged as an important means of supporting these objectives through flexible, accessible, and scalable educational opportunities. Based on survey data and a multi-stakeholder analytical framework, this study identified four key factors influencing the adoption of E-learning in Ho Chi Minh City, namely infrastructure and technology, human resource quality, learner support and responsiveness, and management and implementation. The findings reveal that limitations related to technological infrastructure, digital competencies, institutional support, learning resources, and organizational commitment continue to pose significant barriers to effective E-learning implementation. By incorporating the perspectives of educators, learners, administrators, and technical staff, this study provides a comprehensive understanding of the challenges associated with E-learning adoption and offers practical implications for educational institutions and policymakers seeking to develop more effective and sustainable digital learning strategies. Future research should expand the scope of investigation to different regions and educational contexts, both within Vietnam and internationally, to further examine the evolving role of emerging technologies, policy frameworks, and pedagogical innovations in enhancing the effectiveness, accessibility, and sustainability of E-learning systems.

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Author Contribution

TP Van Hong - Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing - Original Draft, Writing - Review & Editing, Visualization.

Conflict of Interest

Authors declare no conflict of interest.

Declaration on the Use of Generative AI

The authors used Microsoft Copilot as a tool to assist with English language editing during manuscript preparation.

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