DOI: https://doi.org/10.62985/j.huit_ojs.vol26.no3E.561

FACTORS AFFECTING STUDENTS' PERCEPTIONS OF DIGITAL TRANSFORMATION AND LIFELONG LEARNING ABILITY: A CASE STUDY AT HO CHI MINH CITY UNIVERSITY OF INDUSTRY AND TRADE

Nguyen Le Ngoc Tram, Le Thi Kieu Oanh, Pham Thi My Duyen, Le Van Vu, Nguyen Thi Minh Phuong*

Ho Chi Minh City University of Industry and Trade

*Email: *phuongntm@huit.edu.vn*

Received: 13 April 2026; Revised: 29 April 2026; Accepted: 14 May 2026

ABSTRACT

In the context of digital transformation and the growing importance of lifelong learning in higher education, this study examines the factors influencing students' awareness of digital transformation and their lifelong learning capacity at Ho Chi Minh City University of Industry and Trade. The study aims to identify key influencing factors and to clarify the relationship between awareness of digital transformation and lifelong learning capacity. A quantitative research approach was employed, with data collected from 561 full-time undergraduate students through an online survey and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results indicate that school policies and support, digital skills, and learning motivation have significant positive effects on students' awareness of digital transformation, whereas the digital learning environment has no significant impact. Awareness of digital transformation, in turn, positively influences students' lifelong learning capacity. Furthermore, learning motivation and school support policies directly affect lifelong learning capacity, while digital skills exert an indirect effect through awareness of digital transformation. These findings highlight the mediating role of digital transformation awareness in enhancing students' lifelong learning capacity. The findings reveal that institutional policies and support, learning motivation, and digital skills significantly enhance students' awareness of digital transformation, which in turn exerts the strongest effect on lifelong self-learning competency. The digital learning environment does not show a significant direct effect, indicating that technological infrastructure alone is insufficient without cognitive awareness and institutional facilitation. The study recommends that higher education institutions strengthen supportive policies and initiatives to improve students' awareness of digital transformation to foster lifelong learning capacity.

Keywords: Support policies, learning motivation, digital skills, lifelong learning capacity, awareness of digital transformation.

1. INTRODUCTION

In recent years, digital transformation has emerged as a global megatrend, profoundly reshaping socio-economic structures and organizational practices, particularly in the field of higher education. The rapid advancement of digital technologies such as artificial intelligence, big data, cloud computing, and the Internet has fundamentally transformed the ways in which knowledge is created, disseminated, and consumed. [1] emphasizes that digital technologies are not merely supporting tools but key drivers of educational transformation, requiring

learners to develop digital competence alongside the ability to continuously learn throughout their lives. The increasing integration of digital technologies into higher education has accelerated the expansion of online and blended learning formats. According to [1], participation in massive open online courses (MOOCs) has exceeded 220 million learners globally, reflecting a structural shift in learners' engagement with education. Similarly, [2] argue that digital transformation in education enhances accessibility, flexibility, and personalization of learning experiences, thereby redefining traditional teaching–learning paradigms. However, the effectiveness of this transformation largely depends on learners' awareness, readiness, and capacity to actively engage in digital learning environments [3].

Within this context, lifelong learning has been widely recognized as a core competence for individuals to remain adaptive and competitive in an increasingly dynamic and digitalized labor market. [4] conceptualizes lifelong learning as a continuous, voluntary, and self-motivated process of acquiring knowledge and skills across the lifespan for both personal and professional development. Empirical evidence further underscores that lifelong learning capacity is essential for sustaining employability, innovation, and socio-economic resilience in the digital economy [5]. In higher education, lifelong learning is closely associated with self-regulated learning, motivation, and the ability to effectively utilize digital technologies for continuous knowledge development [6], [7].

A growing body of literature highlights the significant role of individual and institutional factors in shaping students' learning behavior and outcomes in digital contexts. Learning motivation, grounded in self-determination theory, has been shown to be a key driver of students' engagement, persistence, and self-directed learning [8], [9]. Digital skills and digital literacy also play a critical role by enabling learners to navigate, evaluate, and apply digital resources effectively in learning processes [10], [11]. At the institutional level, supportive school policies, infrastructure, and learning environments are essential in fostering positive attitudes toward technology use and promoting students' readiness for digital transformation [12], [13].

In Vietnam, digital transformation has been identified as a national strategic priority, as reflected in the National Digital Transformation Program approved by Decision No. 749/QĐ-TTg issued by Prime Minister of Vietnam on 3 June, 2020. The Vietnamese government has emphasized the role of digital transformation in education as a foundation for developing a knowledge-based economy and a digitally competent workforce. Recent reports indicate rapid growth in digital infrastructure and online connectivity, creating favorable conditions for the expansion of digital learning in higher education [14]. Nevertheless, empirical studies suggest that many Vietnamese university students still encounter challenges in adapting to digital learning environments, particularly in self-regulation, independent learning, and awareness of the broader implications of digital transformation [15], [16].

Despite the expanding literature on digital transformation and lifelong learning, several research gaps remain. Existing studies tend to examine technology adoption, digital competence, or learning outcomes in isolation, with limited attention paid to students' awareness of digital transformation as a mediating mechanism linking institutional and individual factors to lifelong learning capacity [17]. Moreover, empirical evidence from the Vietnamese higher education context remains scarce, particularly studies employing robust quantitative methods to explore the interrelationships among digital skills, learning motivation, institutional support, digital transformation awareness, and lifelong learning capacity. Accordingly, this study is guided by the following research objectives: (1) to examine the effects of digital skills, learning motivation, the digital learning environment, and institutional policies and support on students' awareness of digital transformation; (2) to analyze the direct effects of these factors on students' lifelong self-learning competency; and

(3) to investigate the mediating role of digital transformation awareness in the relationship between these antecedents and lifelong self-learning competency.

Based on the above objectives, this study seeks to address the following research questions:

RQ1: What factors influence students' awareness of digital transformation in higher education?

RQ2: How do digital skills, learning motivation, institutional policies and support, and the digital learning environment affect students' lifelong self-learning competency?

RQ3: Does awareness of digital transformation mediate the relationships between these factors and lifelong self-learning competency?

To address these gaps, the present study aims to identify and analyze the factors influencing students' awareness of digital transformation and their lifelong learning capacity at Ho Chi Minh City University of Industry and Trade. Specifically, the study examines the direct and indirect effects of school support policies, digital skills, learning motivation, and the digital learning environment on lifelong learning capacity, with awareness of digital transformation considered as a mediating construct. By employing Partial Least Squares Structural Equation Modeling (PLSSEM), this study seeks to contribute empirical evidence to the literature on digital transformation and lifelong learning in higher education, while offering practical implications for policymakers and educational institutions in enhancing students' readiness for the digital era.

2. THEORETICAL BACKGROUND

2.1. Theoretical background

Unified Theory of Acceptance and Use of Technology (UTAUT): The Unified Theory of Acceptance and Use of Technology (UTAUT), developed by [18] is one of the most widely applied theoretical frameworks for explaining individuals' acceptance and use of information technology. The model posits that behavioral intention and technology use are primarily determined by four key constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions. These constructs collectively capture both individual perceptions and contextual factors that shape technology adoption behavior. Within educational contexts, UTAUT has been extensively employed to examine students' acceptance of digital learning technologies and online platforms [19]. Performance expectancy reflects learners' beliefs regarding the usefulness of digital technologies for improving learning outcomes, while effort expectancy relates to perceived ease of technology use. Facilitating conditions, including institutional infrastructure and technical support, play a critical role in enabling effective technology use [18]. In the present study, UTAUT provides a theoretical foundation for understanding how students perceive and respond to digital transformation in higher education. Specifically, digital skills can be associated with effort expectancy, as students with higher digital competence are more capable of using digital tools effectively. Similarly, the digital learning environment and institutional policies and support reflect facilitating conditions that enable or constrain students' engagement with digital technologies. Prior research indicates that supportive institutional environments and adequate digital infrastructure positively influence students' perceptions of technology usefulness and acceptance [1], [19]. Accordingly, it is expected that digital skills, digital learning environments, and institutional support contribute to shaping students' awareness of digital transformation by enhancing their perceived usefulness, ease of use, and readiness to engage with digital learning technologies.

Self-Determination Theory (SDT): Self-Determination Theory (SDT), proposed by [8] is a prominent motivational framework that explains human behavior based on the satisfaction of three fundamental psychological needs: autonomy, competence, and relatedness. According to SDT, individuals are more likely to engage in activities willingly and persistently when these needs are fulfilled, leading to higher levels of intrinsic motivation. In educational settings, SDT has been widely applied to explain students' engagement, persistence, and self-directed learning behaviors. Learning motivation, particularly intrinsic motivation, has been shown to positively influence students' goal setting, cognitive engagement, and willingness to invest effort in learning activities [9], [20]. Highly motivated students tend to actively seek learning opportunities and continuously update their knowledge and skills, which are essential characteristics of lifelong learners.

In the context of higher education, SDT provides a strong theoretical basis for explaining lifelong learning capacity. Students who possess higher levels of learning motivation are more likely to engage in continuous and self-regulated learning, adapt to changing learning environments, and sustain learning efforts beyond formal education [6]. Moreover, motivation also encourages students to embrace innovation and adapt to digital transformation in education, as motivated learners are more open to exploring new technologies and learning methods. Based on SDT, learning motivation is expected to directly enhance students' lifelong self-learning competency and indirectly support their engagement with digital transformation processes.

Drawing on the Unified Theory of Acceptance and Use of Technology (UTAUT) and Self-Determination Theory (SDT), this study integrates technological acceptance and motivational perspectives to explain students' awareness of digital transformation and lifelong self-learning competency. UTAUT emphasizes the role of digital skills, institutional conditions, and learning environments in shaping individuals' perceptions and acceptance of digital technologies [18], [19], while SDT highlights learning motivation as a core driver of continuous, autonomous, and self-directed learning behavior [8], [9]. Accordingly, this study proposes that digital skills, digital learning environments, learning motivation, and institutional policies and support significantly influence students' awareness of digital transformation. Furthermore, awareness of digital transformation is expected to play a pivotal role in enhancing students' lifelong self-learning competency, as learners who recognize the strategic importance of digital technologies are more likely to engage in continuous learning and skill development [4], [6]. These theoretical relationships provide the foundation for the development of the research hypotheses presented in the subsequent section.

Previous empirical studies have examined the impacts of digital transformation and technology adoption on learning outcomes from various perspectives. [18] empirically demonstrated that perceived usefulness and facilitating conditions are critical determinants of technology acceptance. In educational contexts, [19] further confirmed that institutional support significantly influences students' attitudes toward technology use and their intention to adopt digital learning tools. Regarding lifelong learning, [6] emphasized the importance of self-regulated learning in developing learners' autonomy and sustained learning. Empirical studies by [9], [20] also affirmed that learning motivation plays a crucial role in enhancing students' engagement, persistence, and long-term learning outcomes. Recent research in digital education has increasingly focused on the interaction between digital competence and learning environments. Studies indicate that high-quality digital learning environments positively affect students' satisfaction, engagement, and learning performance [13], [21]. In addition, [1] highlights digital skills and digital learning environments as key determinants of learners' readiness for lifelong learning in the digital era.

Despite these advancements, most prior studies have examined technological, motivational, and institutional factors in isolation. There remains a lack of empirical research investigating

their combined effects on students' awareness of digital transformation and lifelong self-learning competency, particularly within the context of Vietnamese higher education. Addressing this gap, the present study seeks to provide integrated empirical evidence by examining these relationships at Ho Chi Minh City University of Industry and Trade.

2.1.1 Digital Transformation and Lifelong Learning in Higher Education

This section provides a conceptual overview of digital transformation and lifelong learning in higher education. Digital transformation has become a central phenomenon shaping contemporary higher education systems worldwide. It refers not only to the adoption of digital technologies but also to fundamental changes in pedagogical practices, organizational structures, and learning cultures enabled by digital innovation [1], [2]. According to the [5], digital transformation supports more interactive, flexible, and learner-centered educational environments, thereby enhancing students' capacity to acquire competencies required in the digital economy. In higher education, digital transformation extends beyond the implementation of learning management systems and online platforms to include curriculum redesign, data-driven decision-making, and the promotion of digital skills and self-directed learning [12], [13] emphasizes that digital learning environments facilitate personalization and accessibility, which are critical conditions for fostering lifelong learning among students. However, the effectiveness of digital transformation largely depends on students' awareness and understanding of its relevance to their academic and professional development. Digital transformation awareness reflects students' perceptions, understanding, and evaluation of the role of digital technologies in learning processes. Students with higher levels of awareness are more likely to engage actively with digital tools, adapt to innovative learning methods, and develop competencies aligned with lifelong learning [17]. In contrast, limited awareness may lead to passive technology use and reduced learning effectiveness, despite the availability of advanced digital infrastructure. Lifelong learning has been widely recognized as a key competence in knowledge-based and technology-driven societies. [4] defines lifelong learning as a continuous and self-motivated process of learning throughout life for personal, civic, and professional purposes. In higher education, lifelong learning capacity is closely related to self-regulated learning, adaptability, and continuous skills development [6], [7]. Digital transformation and lifelong learning are therefore intrinsically linked, as digital environments require learners to take greater responsibility for their own learning trajectories.

2.1.2. Digital Skills and Digital Transformation Awareness

Digital skills, commonly associated with digital literacy and competence, refer to individuals' ability to use digital technologies effectively to access, evaluate, create, and communicate information [10], [11]. In educational contexts, digital skills enable students to participate actively in digital learning environments and to exploit the potential of digital tools for academic purposes. Empirical studies suggest that students with higher digital skills are more capable of recognizing the benefits and relevance of digital technologies in learning, which enhances their awareness of digital transformation [22], [23]. As digital competence increases, students are more confident in using digital platforms and are more likely to perceive digital transformation as an opportunity rather than a challenge. Based on this theoretical and empirical evidence, the following hypothesis is proposed:

H1: Digital skills positively influence students' awareness of digital transformation.

2.1.3. Digital Learning Environment and Digital Transformation Awareness

The digital learning environment encompasses the technological infrastructure, digital platforms, instructional design, and support services that facilitate online and blended learning experiences [13]. A well-designed digital learning environment enhances interaction, engagement, and satisfaction among learners [21]. Previous research indicates that the quality

of the digital learning environment significantly influences students' perceptions of technology and their willingness to engage in digital learning [3]. When students experience usability, interactivity, and institutional support within digital environments, they are more likely to develop positive perceptions and greater awareness of digital transformation in education [1]. Accordingly, this study proposes:

H2: The digital learning environment positively influences students' awareness of digital transformation.

2.1.4. Learning Motivation and Digital Transformation Awareness

Learning motivation plays a central role in shaping students' learning behaviors and engagement. According to Self-Determination Theory (SDT), intrinsic motivation enhances individuals' willingness to engage in activities that support personal growth and development [8]. In educational contexts, motivated students are more proactive in exploring new learning methods and technologies Studies have shown that learning motivation positively affects students' attitudes toward digital learning and technology use [20], [24]. Motivated students are more likely to perceive digital transformation as meaningful and relevant to their learning goals, thereby increasing their awareness of digital transformation. Therefore, the following hypothesis is formulated:

H3: Learning motivation positively influences students' awareness of digital transformation.

2.1.5. Institutional Policies and Support and Digital Transformation Awareness

Institutional policies and support refer to universities' strategies, resources, training programs, and facilitation mechanisms that enable effective technology integration in education [12], [19]. Facilitating conditions are a key determinant of technology acceptance, as emphasized in both UTAUT and technology acceptance research [18]. Empirical evidence suggests that strong institutional support enhances students' confidence in using digital technologies and promotes positive perceptions of digital transformation [1], [19]. When universities provide clear policies, technical support, and capacity-building initiatives, students are more likely to recognize the strategic importance of digital transformation. Thus, this study hypothesizes:

H4: Institutional policies and support positively influence students' awareness of digital transformation.

2.1.6. Determinants of Lifelong Self-Learning Competency

Lifelong self-learning competency reflects students' ability to regulate their own learning, maintain learning motivation, and continuously develop knowledge and skills over time [6]. Digital skills are a foundational component of lifelong learning, as they enable learners to access digital resources and engage in self-directed learning activities [11]. Research suggests that students with higher digital skills demonstrate stronger lifelong learning capacity, as they are better equipped to independently pursue learning opportunities in digital environments [5]. Therefore, this study proposes:

H5: Digital skills positively influence students' lifelong self-learning competency.
Similarly, the digital learning environment plays a crucial role in supporting self-regulated and continuous learning. Studies indicate that well-structured digital environments enhance students' self-efficacy, engagement, and autonomous learning behaviors [7], [13]. Hence, the following hypothesis is advanced:

H6: The digital learning environment positively influences students' lifelong self-learning competency.

Learning motivation is consistently identified as a key predictor of lifelong learning. Motivated students are more likely to persist in learning, set long-term goals, and engage in continuous skill development [6], [25]. Accordingly:

H7: Learning motivation positively influences students' lifelong self-learning competency.

Institutional policies and support also contribute to lifelong learning by creating enabling conditions and fostering a supportive learning culture [4], [12]. Universities that promote flexible learning pathways and digital competence development encourage students to adopt lifelong learning behaviors. Therefore:

H8: Institutional policies and support positively influence students' lifelong self-learning competency.

2.1.7. Digital Transformation Awareness and Lifelong Self-Learning Competency

This section specifically focuses on the hypothesized directional relationship between digital transformation awareness and lifelong self-learning competency within the proposed research model. Awareness of digital transformation is expected to play a critical role in enhancing lifelong learning capacity. Students who clearly understand the significance of digital transformation are more likely to engage in continuous learning and skill upgrading to remain relevant in a digital society [5], [17]. Digital transformation awareness fosters proactive learning attitudes and encourages students to leverage digital technologies for long-term personal and professional development. Thus, this study hypothesizes:

H9: Students' awareness of digital transformation positively influences their lifelong self-learning competency.

2.1.8. The mediating role of digital transformation awareness

Beyond the direct relationships proposed above, this study further examines the mediating role of digital transformation awareness (AW) in linking key antecedents to lifelong self-learning competency (LLL). In digital education contexts, awareness is not only an outcome of technological and motivational factors but also a cognitive mechanism through which these factors influence learning behaviors, digital transformation literature [26], [27], individuals who possess higher levels of digital skills are more likely to understand, recognize, and appreciate the value and implications of digital transformation. This enhanced awareness subsequently facilitates better engagement in lifelong learning processes. Therefore, digital transformation awareness is expected to mediate the relationship between digital skills and lifelong self-learning competency. Similarly, Self-Determination Theory [8], [25] suggests that learning motivation drives individuals to actively engage with new knowledge and technological changes. Motivated learners tend to develop a stronger awareness of digital transformation, which in turn encourages continuous learning behavior. Furthermore, institutional policies and support play a critical role in shaping students' perceptions and awareness. Based on the Unified Theory of Acceptance and Use of Technology (UTAUT) [18], organizational support enhances individuals' understanding and readiness to adopt digital transformation, which subsequently translates into improved learning outcomes. Although the digital learning environment provides technological infrastructure and opportunities for interaction [21], [28], its influence on lifelong learning may depend on whether it can effectively enhance students' awareness of digital transformation. Based on these arguments, digital transformation awareness is proposed as a mediating variable in the following relationships:

H10: Digital transformation awareness mediates the relationship between digital skills and lifelong self-learning competency.

H11: Digital transformation awareness mediates the relationship between digital learning environment and lifelong self-learning competency.

H12: Digital transformation awareness mediates the relationship between learning motivation and lifelong self-learning competency.

H13: Digital transformation awareness mediates the relationship between institutional policies and support and lifelong self-learning competency.

3. METHODOLOGY

3.1. Research design

This study employed a quantitative research approach with a cross-sectional design to empirically test the theoretical model examining factors influencing students' awareness of digital transformation and their lifelong self-learning competency at Ho Chi Minh City University of Industry and Trade. Cross-sectional design is widely used in educational and behavioral research to collect data at a single point in time and to analyze relationships among constructs within a proposed research model [29]. Data were collected through an online questionnaire survey conducted between December 2025 and February 2026. Online surveys were selected due to their effectiveness in reaching many respondents, as well as their convenience, cost efficiency, and suitability for studies involving student populations [30]. The research process consisted of four key steps: (1) development of the theoretical framework and hypotheses based on UTAUT and Self-Determination Theory; (2) design of the survey instrument and pilot testing; (3) data collection through an online questionnaire; and (4) data analysis using PLS-SEM. The use of an online survey was considered appropriate due to its efficiency in reaching a large student population, its compatibility with digital learning contexts, and students' familiarity with online communication platforms.

3.2. Data collection

The target population for this study consisted of full-time undergraduate students currently enrolled at Ho Chi Minh City University of Industry and Trade (HUIT). To ensure sample diversity and reflect the digital transformation context across various disciplines, participants were recruited from multiple faculties, including Business Administration, Information Technology, Food Technology, and Engineering, among others. Data were collected through an online questionnaire via Google Forms, distributed through Zalo communication groups. A convenience sampling method was employed due to its efficiency in reaching respondents when probability sampling is not feasible [31]. Participants had to meet specific criteria: (1) being full-time students at HUIT; (2) having experience with digital learning platforms; and (3) voluntarily agreeing to participate. Ethical considerations were strictly followed, with respondents informed of the study's purpose, their right to withdraw, and guarantees of anonymity and confidentiality.

After screening for incomplete or invalid responses, a total of 561 valid questionnaires (N = 561) were retained for analysis. This sample size significantly exceeds the requirements for Partial Least Squares Structural Equation Modeling (PLS-SEM). Following the "10-times rule" [32] and the recommendations of [29], [33], the minimum required sample for this model's complexity was 250. Thus, the final sample of 561 provides robust statistical power (above 0.80) and ensures the reliability of the empirical findings.

3.3. Measurement scale

The survey questionnaire was developed based on established theoretical frameworks and the adaptation of previously validated measurement scales from prior reputable studies. The constructs and items were grounded in established literature on digital skills, technology

acceptance, self-determined motivation, self-regulated learning, and lifelong learning in digital education contexts [5], [6], [7], [11]. The measurement model consists of key dimensions related to learners' individual competencies, perceptions and attitudes toward digital transformation, and characteristics of the digital learning environment in higher education. Learner-related constructs: Lifelong self-learning competency (LLL) was measured using five observed items adapted from [6]. These items reflect learners' ability to plan, self-regulate, monitor, and sustain long-term learning activities, which are fundamental characteristics of lifelong and self-directed learning. Digital skills (DS) were measured using four items adapted from [11] and [22]. These items focus on students' ability to effectively use digital technologies, manage and process information, communicate digitally, and solve problems in digital environments. Learning motivation (LM) was operationalized with four items derived from Self-Determination Theory and self-regulated learning literature. These items assess students' intrinsic interest in learning, autonomy, effort investment, and commitment to continuous learning.

Perceptual, and environmental constructs: Awareness of digital transformation (AW) was measured using four items adapted from prior studies on technology acceptance and digital transformation [11], [26], [27]. These indicators evaluate students' understanding and recognition of the role, importance, and educational impact of digital transformation. The digital learning environment (DLE) was assessed using four items derived from [21] and [28], emphasizing interaction, accessibility, convenience, and overall effectiveness of online and blended learning environments. Institutional policies and support (SUP) were measured using four items adapted from [5], [18] and [19]. These items reflect students' perceptions of institutional commitment, technical support, infrastructure, and policy orientation toward digital transformation in education.

All observed variables were measured using a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Prior to the main survey, the questionnaire was linguistically refined to ensure suitability for the Vietnamese higher education context. A pilot test was conducted to evaluate item clarity, comprehensibility, and preliminary reliability, thereby enhancing the validity and robustness of the measurement instrument.

3.4. Data analysis

Data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 3.0 software. PLS-SEM was selected due to its suitability for prediction-oriented research, complex models involving multiple latent constructs and indicators, and its robustness to violations of normal data distribution assumptions [29], [32]. PLS-SEM is particularly appropriate for studies with medium sample sizes and an exploratory focus on theory development and extension [35]. In this study, both the measurement model and the structural model were evaluated following established PLS-SEM guidelines, including assessments of reliability, convergent validity, discriminant validity, and path coefficients [29], [36]. Given that all constructs were modeled reflectively, the Consistent PLS-SEM approach was applied to improve the consistency and accuracy of parameter estimates in the structural model [35]. Bootstrapping procedures were employed to assess the statistical significance of path coefficients; the structural model was assessed to examine the relationships between variables. Path coefficients (β), Statistics obtained through bootstrapping, P-values, and the coefficient of determination (R^2) were used to evaluate the significance and explanatory power of the model.

4. RESULTS AND DISCUSSION

4.1. Respondent profile

Gender, the descriptive statistics indicate that among the 561 respondents, female students accounted for most of the sample, representing 73.8% (n = 414). Male students constituted 25.8% of the respondents (n = 145), while respondents identifying as other genders accounted for a very small proportion of 0.4% (n = 2). This distribution suggests a clear predominance of female participants in the study sample. Academic Year, the distribution of respondents across academic years reveals an uneven composition of the sample. Second-year students represented the largest proportion, accounting for 67.9% of the respondents (n = 381), followed by third-year students at 20.7% (n = 116). First-year students accounted for 6.4% (n = 36), while fourth-year students represented 4.5% (n = 25). A small group of respondents (0.5%, n = 3) reported other academic classifications. The dominance of second-year students suggests that participation was highest among students who had already become familiar with the university learning environment while still maintaining flexible study schedules compared to final-year students. This group is also more likely to have experienced digital learning platforms and technology-supported courses, making them particularly relevant to the research context. Regarding Faculty

Regarding academic disciplines, most respondents were enrolled in the Faculty of Business Administration, accounting for 79.0% of the sample (n = 443). Other faculties were represented to a lesser extent, including Food Technology (5.0%, n = 28), Finance and Accounting (3.9%, n = 22), Foreign Languages (2.3%, n = 13), Commerce (2.1%, n = 12), and Tourism and Culinary Arts (2.0%, n = 11). Each of the remaining faculties accounted for less than 2% of the total sample. This distribution indicates a concentration of respondents from business-related programs, reflecting the higher enrollment size of this faculty and its greater exposure to digital tools and technology-enabled teaching practices. It should be noted that the sample is characterized by a predominance of students from business-related disciplines, as well as a relatively high proportion of female and second-year students. This distribution reflects the actual enrollment structure and higher exposure to technology-enhanced learning within these programs at HUIT. However, such characteristics may limit the generalizability of the findings to students in more technically oriented disciplines, such as engineering or information technology. Future research should therefore examine multi-disciplinary samples to validate the robustness of the proposed model across different academic contexts.

4.2. Measurement Model Assessment

In the first step of the PLS-SEM analysis, the measurement model was evaluated to assess the reliability and validity of the reflective constructs prior to testing the structural relationships. Following established guidelines for reflective measurement models, the assessment focused on indicator reliability (factor loadings), internal consistency reliability (Cronbach's alpha, rho_A, and composite reliability), convergent validity (average variance extracted – AVE), and discriminant validity [29], [32].

For exploration and predictive research, composite reliability (CR) values ranging from 0.60 to 0.70 are considered acceptable, while values above 0.70 indicate satisfactory internal consistency [32], [37], [38]. Indicator loadings above 0.70 are preferred, whereas loadings above 0.50 may be retained if overall construct reliability and validity are satisfactory [32], [39]. Based on these criteria, the measurement model was rigorously assessed as presented in the following subsections.

Factor Loadings, the standardized outer loadings of all observed indicators. As shown, all indicators exhibit high factor loadings, ranging from 0.815 to 0.907, exceeding the recommended threshold of 0.70 and thus demonstrating strong indicator reliability. Specifically, indicators

measuring Institutional Policies and Support (SUP) display loadings between 0.856 and 0.907, with SUP2 showing the highest loading (0.907), indicating that the indicators effectively capture the underlying construct. For Digital Skills (DS), factor loadings range from 0.825 to 0.861, all of which surpass the acceptable threshold. Indicators related to the Digital Learning Environment (DLE) show loadings between 0.815 and 0.869; although DLE1 has the lowest loading (0.815), it remains well above the cut-off value and was therefore retained in the model. Similarly, Awareness of Digital Transformation (AW) exhibits very high loadings ranging from 0.861 to 0.904, indicating excellent convergent properties. The construct Lifelong Self-Learning Competency (LLL) shows strong loadings from 0.855 to 0.884, reflecting a robust representation of the latent variable. Finally, indicators of Learning Motivation (LM) range from 0.831 to 0.843, all exceeding the recommended threshold and confirming adequate indicator reliability. Overall, none of the indicators required removal, and the results confirm that the measurement model satisfies the criteria for indicator reliability and convergent validity, allowing further assessment of construct reliability and validity. Construct Reliability and Convergent Validity: the results for internal consistency reliability and convergent validity of the constructs, including Cronbach's alpha, rho_A, composite reliability (CR), and average variance extracted (AVE). The results demonstrate that all constructs exhibit strong internal consistency and reliability. Cronbach's alpha values range from 0.857 to 0.918, exceeding the recommended threshold of 0.70, indicating satisfactory internal consistency among the indicators. Similarly, rho_A values range from 0.860 to 0.918, further confirming the stability and reliability of the constructs. Composite reliability values range from 0.903 to 0.938, exceeding the minimum requirement of 0.70 while remaining below the upper threshold of 0.95, suggesting high reliability without redundancy among indicators [2]. Regarding convergent validity, AVE values range from 0.700 to 0.772, all surpassing the recommended minimum level of 0.50. This indicates that each construct explains more than 50% of the variance in its corresponding indicators. Among the constructs, Lifelong Self-Learning Competency (LLL) exhibits the highest composite reliability (CR = 0.938) and Cronbach's alpha (0.918), reflecting a particularly strong and stable measurement scale. Although Learning Motivation (LM) displays the lowest reliability values among the constructs, all indices remain well above the acceptable thresholds, confirming its adequacy. Overall, the results provide strong evidence that the measurement model demonstrates satisfactory internal consistency, reliability and convergent validity.

Table 1. Measurement model results

Constructs	Items	Factor Loadings	Cronbach's Alpha	CR	AVE
University Policy & Support (SUP)	SUP1	0.873	0.901	0.931	0.771
	SUP2	0.907			
	SUP3	0.876			
	SUP4	0.856			
Digital Skills (DS)	DS1	0.825	0.861	0.905	0.705
	DS2	0.845			
	DS3	0.861			
	DS4	0.827			
Digital Learning Environment (DLE)	DLE1	0.815	0.862	0.906	0.707
	DLE2	0.869			
	DLE3	0.827			
	DLE4	0.852			

Digital Transformation Awareness (AW)	AW1	0.866	0.902	0.931	0.772
	AW2	0.904			
	AW3	0.861			
	AW4	0.884			
Lifelong Learning Capability (LLL)	LLL1	0.858	0.918	0.938	0.752
	LLL2	0.866			
	LLL3	0.884			
	LLL4	0.874			
	LLL5	0.855			
Learning Motivation (LM)	LM1	0.841	0.857	0.903	0.700
	LM2	0.843			
	LM3	0.832			
	LM4	0.831			

Note: *Average variance extracted = AVE; Composite reliability = CR*

Discriminant Validity: Discriminant validity was assessed using the Fornell-Larcker criterion [36]. To satisfy this criterion, the square root of the Average Variance Extracted (AVE) for each construct must be greater than its highest correlation with any other latent construct. As shown in Table 2, the diagonal values (bolded) represent the square root of the AVE, while the off-diagonal values represent the inter-construct correlations. All diagonal values are higher than the corresponding correlations in their respective rows and columns. For instance, while the correlation between Digital Transformation Awareness (AW) and Lifelong Learning Capability (LLL) is relatively high (0.824), it remains lower than their respective square roots of AVE (0.879 and 0.867). These results confirm that each construct is empirically distinct and that discriminant validity is well-established, allowing for subsequent structural model analysis.

Table 2. Discriminant Validity (Fornell-Larcker Criterion)

Constructs	SUP	DS	DLE	AW	LLL	LM
University Policy and Support (SUP)	0.878					
Digital Skills (DS)	0.513	0.840				
Digital Learning Environment (DLE)	0.753	0.563	0.841			
Digital Transformation Awareness (AW)	0.693	0.591	0.624	0.879		
Lifelong Learning Capability (LLL)	0.694	0.572	0.638	0.824	0.867	
Learning Motivation (LM)	0.659	0.584	0.640	0.668	0.678	0.837

4.3. Structural Model Evaluation

After confirming that the measurement model met the required reliability and validity criteria, the second step involved evaluating the structural model to test the proposed research hypotheses. The structural model was assessed using SmartPLS version 3.0 [40] to examine both direct and indirect relationships among the latent constructs in the research model. To assess the significance of the structural path coefficients, the bootstrapping procedure with 2,000 resamples was applied, as recommended for PLS-SEM analysis [1], [3]. Bootstrapping enables robust estimation of standard errors, t-values, and confidence intervals, thereby supporting reliable hypothesis testing in predictive and exploratory research models [32], [37]. The explanatory and predictive accuracy of the structural model was evaluated using the

coefficient of determination (R^2) and the Stone–Geisser's cross-validated redundancy measure (Q^2). While R^2 indicates the proportion of variance in endogenous constructs explained by exogenous predictors, Q^2 assesses the predictive relevance of the model through a blindfolding procedure [32], [41]. Coefficient of Determination (R^2): the R^2 and adjusted R^2 values for the endogenous constructs in the model.

The coefficient of determination (R^2) was used to assess the model's explanatory power. According to [32], R^2 values of approximately 0.25, 0.50, and 0.75 can be described as weak, moderate, and substantial, respectively. The results indicate that Awareness of Digital Transformation has an R^2 value of 0.593 and an adjusted R^2 value of 0.590, suggesting that approximately 59.3% of the variance in digital transformation awareness is explained by its predictor variables. This level of explanatory power can be considered moderate to high. For Lifelong Self-Learning Competency, the R^2 value is 0.726 with an adjusted R^2 of 0.723, indicating that the model explains 72.6% of the variance in lifelong self-learning competency. According to established benchmarks, this represents a strong explanatory power. The very small differences between R^2 and adjusted R^2 for both endogenous constructs suggest that the model is not overfitted and that the explanatory capacity is robust. Overall, these results demonstrate that the structural model exhibits a strong ability to explain variance in the key endogenous constructs, particularly lifelong self-learning competency.

Predictive Relevance (Q^2): To further assess the predictive relevance of the model, the blindfolding procedure was employed to calculate Stone–Geisser's Q^2 values for the endogenous constructs. The Q^2 statistic evaluates how well the observed values are reconstructed by the model and the parameter estimates [32]. A Q^2 value greater than zero indicates that the model has predictive relevance for a particular endogenous construct, while values of 0.02, 0.15, and 0.35 reflect small, medium, and large predictive relevance, respectively.

The results of predictive relevance, Q^2 value for Awareness of Digital Transformation is 0.451, and for Lifelong Self-Learning Competency it is 0.540. Both values are substantially greater than zero and exceed the threshold of 0.35, indicating strong predictive relevance for these two endogenous constructs. For the exogenous variables (Institutional Policies and Support, Digital Skills, Digital Learning Environment, and Learning Motivation), Q^2 values are not reported (SSO = SSE), which is appropriate because these constructs are not predicted by other variables in the structural model. Taken together, the Q^2 results confirm that the model demonstrates strong predictive capability, particularly for lifelong self-learning competency. Combined with the R^2 values discussed earlier, these findings indicate that the structural model possesses high explanatory and predictive quality, thereby providing a solid foundation for interpreting the hypothesized relationships among the constructs

Hypothesis Testing Results: Table 3 presents the results of hypothesis testing based on the structural path coefficients obtained from the PLS-SEM analysis. Overall, the findings indicate that most of the proposed relationships in the research model are statistically significant at the 5% level, providing strong empirical support for the theoretical foundations derived from the Unified Theory of Acceptance and Use of Technology (UTAUT) and Self-Determination Theory (SDT).

With respect to the determinants of awareness of digital transformation, digital skills ($\beta = 0.217$, $p < 0.001$), learning motivation ($\beta = 0.264$, $p < 0.001$), and institutional policies and support ($\beta = 0.362$, $p < 0.001$) all exert significant positive effects. Among these predictors, institutional policies and support demonstrate the strongest impact on students' awareness of digital transformation, highlighting the critical role of organizational and facilitating conditions emphasized by UTAUT. In contrast, the effect of the digital learning environment on awareness of digital transformation is not statistically significant ($\beta = 0.060$, $p = 0.119$),

indicating that the availability of digital platforms alone is insufficient to enhance students' awareness without appropriate motivational and institutional support mechanisms.

Regarding lifelong self-learning competency, the results reveal that learning motivation ($\beta = 0.139$, $p < 0.001$) and institutional policies and support ($\beta = 0.134$, $p = 0.003$) have significant positive direct effects, consistent with the assumptions of SDT and technology acceptance literature. However, neither digital skills ($\beta = 0.049$, $p = 0.058$) nor the digital learning environment ($\beta = 0.066$, $p = 0.079$) show a significant direct relationship with lifelong self-learning competency. These findings suggest that technological capabilities and environments do not automatically translate into sustained lifelong learning unless supported by motivational and cognitive mechanisms.

Importantly, awareness of digital transformation exhibits a strong and highly significant positive effect on lifelong self-learning competency ($\beta = 0.568$, $p < 0.001$), representing the strongest relationship in the structural model. This result underscores the pivotal role of digital transformation awareness as a key explanatory and mediating construct linking technological, motivational, and institutional factors to students' lifelong learning outcomes.

In summary, six hypotheses (H1, H3, H4, H7, H8, and H9) are supported, while three hypotheses (H2, H5, and H6) are not supported. The overall pattern of results confirms that awareness of digital transformation functions as a central mechanism through which digital skills, learning motivation, and institutional support contribute to the development of lifelong self-learning competency among university students. This finding extends UTAUT by highlighting the mediating role of awareness and aligns with SDT in emphasizing the importance of motivation in sustaining long-term learning behaviors in the context of digital transformation.

Table 3. Direct effects and indirect effects

Hypothesis	Relationship	Path Coefficient	T Values	P Values
H1	Digital Skills → Digital Transformation Awareness	0.217	5.110	0.000
H2	Digital Learning Environment → Digital Transformation Awareness	0.060	1.178	0.119
H3	Learning Motivation → Digital Transformation Awareness	0.264	5.427	0.000
H4	Institutional Policies and Support → Digital Transformation Awareness	0.362	7.066	0.000
H5	Digital Skills → Lifelong Self-Learning Competency	0.049	1.569	0.058
H6	Digital Learning Environment → Lifelong Self-Learning Competency	0.066	1.411	0.079
H7	Learning Motivation → Lifelong Self-Learning Competency	0.139	3.754	0.000
H8	Institutional Policies and Support → Lifelong Self-Learning Competency	0.134	2.747	0.003
H9	Digital Transformation Awareness → Lifelong Self-Learning Competency	0.568	13.056	0.000
H10	Digital skills → Digital transformation awareness → lifelong self-learning competency.	0.123	4.668	0.000

H11	Digital learning environment → Digital transformation awareness → lifelong self-learning competency	0.034	1.172	0.121
H12	Learning motivation → Digital transformation awareness → lifelong self-learning competency	0.150	5.091	0.000
H13	Institutional policies and support → Digital transformation awareness → lifelong self-learning competency	0.206	6.219	0.000

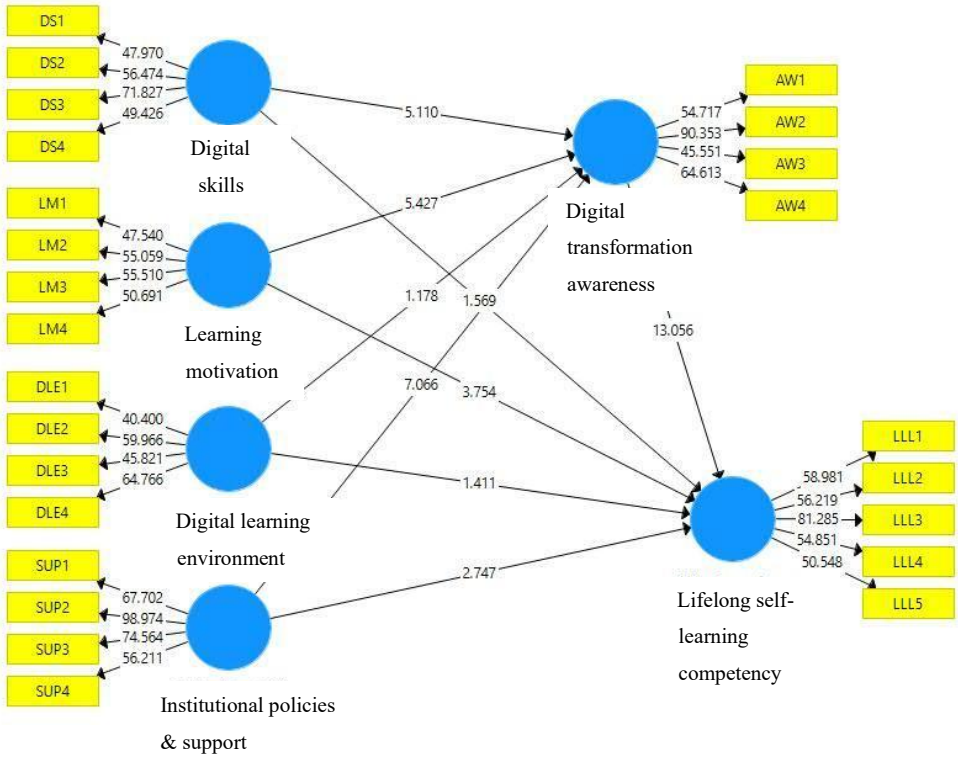

Figure 1. The results of path analysis (Source: Authors)

Mediation Analysis: To further examine the underlying mechanism of the proposed model, a mediation analysis was conducted, the results of the mediation analysis, examining the indirect effects of digital skills, digital learning environment, learning motivation, and institutional policies and support on lifelong self-learning competency through awareness of digital transformation.

The results indicate that awareness of digital transformation plays a significant mediating role in several relationships within the research model. Specifically, the indirect effects of digital skills on lifelong self-learning competency through digital transformation awareness are positive and statistically significant ($\beta = 0.123$, $p < 0.001$), supporting H10. This finding suggests that digital skills enhance lifelong learning primarily by increasing students' awareness of digital transformation rather than through a direct pathway. Similarly, learning motivation demonstrates a significant positive indirect effect on lifelong self-learning competency via digital transformation awareness ($\beta = 0.150$, $p < 0.001$), confirming H12. This result aligns with Self-Determination Theory, indicating that motivated students are more likely to develop a positive awareness of digital transformation, which subsequently translates into sustained lifelong learning behaviors.

The strongest indirect effect is observed for institutional policies and support, which significantly influence lifelong self-learning competency through awareness of digital transformation ($\beta = 0.206$, $p < 0.001$), supporting H13. This finding underscores the critical role of organizational support in fostering students' digital awareness, thereby facilitating long-term self-learning capacity, as emphasized by the UTAUT framework. In contrast, the indirect effect of the digital learning environment on lifelong self-learning competency through digital transformation awareness is not statistically significant ($\beta = 0.034$, $p = 0.121$), leading to the rejection of H11. This suggests that the mere presence of a digital learning environment is insufficient to enhance lifelong learning outcomes unless it effectively contributes to students' awareness of digital transformation. Overall, the mediation analysis confirms that awareness of digital transformation functions as a key transmission mechanism, through which digital skills, learning motivation, and institutional support are converted into lifelong self-learning competency. These findings highlight the central role of cognitive awareness in connecting technological and motivational antecedents with sustainable learning outcomes in higher education.

4.4. Discussion

This study examined the direct and indirect effects of digital skills, digital learning environment, learning motivation, institutional policies and support on students' lifelong self-learning competency, with awareness of digital transformation acting as a mediating variable. The findings provide important empirical insights into how technological, motivational, and institutional factors interact to foster lifelong learning in the context of digital transformation in higher education.

Determinants of Digital Transformation Awareness: The results reveal that institutional policies and support, learning motivation, and digital skills significantly and positively influence students' awareness of digital transformation. Among these factors, institutional policies and support exert the strongest effect, underscoring the importance of facilitating conditions emphasized in the Unified Theory of Acceptance and Use of Technology (UTAUT) [18]. This finding is consistent with prior studies suggesting that institutional infrastructure, clear policies, and technical support play a crucial role in shaping students' perceptions and acceptance of digital technologies in educational settings [1], [13], [19].

The significant role of learning motivation in enhancing digital transformation awareness aligns well with Self-Determination Theory (SDT), which posits that intrinsically motivated learners are more proactive in exploring new learning tools and adapting to innovation [8], [9]. Motivated students are more likely to actively engage with digital platforms, thereby developing a deeper understanding of the value and implications of digital transformation in education. This finding supports previous research highlighting the interplay between motivation and technology engagement in digital learning environments [6], [20]. Digital skills also exhibit a significant positive effect on digital transformation awareness, confirming that students who possess stronger digital competencies tend to better recognize the usefulness and relevance of digital technologies for learning. This result is consistent with prior studies on digital literacy and technology acceptance, which emphasize that technological competence enhances users' perceptions of usefulness and ease of use [11], [22].

In contrast, the digital learning environment does not have a significant direct effect on awareness of digital transformation. This finding diverges somewhat from assumptions in UTAUT and prior research suggesting that learning environments shape technology perceptions [21]. However, it may reflect the reality that the mere presence of digital platforms is insufficient to raise students' awareness unless such environments are accompanied by institutional guidance, pedagogical integration, and motivational support. Similar conclusions have been noted in recent studies arguing that digital transformation is not solely a

technological issue but also a pedagogical and organizational process [1], [17], the non-significant direct effects of digital skills and the digital learning environment suggest the existence of a cognitive bottleneck, whereby technological resources and competencies do not automatically translate into lifelong learning capacity unless they are cognitively internalized through students' awareness of digital transformation. In this sense, awareness functions as a critical interpretive lens that gives meaning and long-term learning value to digital capabilities and institutional support.

Direct Effects on Lifelong Self-Learning Competency: With respect to lifelong self-learning competency, the findings show that learning motivation and institutional policies and support have significant direct effects, whereas digital skills and the digital learning environment do not. The strong influence of learning motivation is consistent with SDT and extensive literature on lifelong and self-regulated learning, which emphasizes that sustained learning behavior is driven primarily by intrinsic motivation, autonomy, and personal commitment [6], [7], [8]. Similarly, the positive impact of institutional policies and support highlights the role of the educational environment in fostering lifelong learning capacity. Supportive institutional conditions, such as access to digital resources, training opportunities, and flexible learning pathways, encourage students to engage in continuous learning beyond formal curricula [5], [12]. This finding reinforces arguments that lifelong learning is not only an individual responsibility but also a systemic outcome shaped by organizational structures and policies. The non-significant direct effects of digital skills and the digital learning environment on lifelong self-learning competency suggest that technical proficiency and digital infrastructure alone do not automatically lead to sustained lifelong learning. This nuanced result is consistent with earlier studies indicating that digital competence must be accompanied by appropriate cognitive and motivational mechanisms to translate into long-term learning behaviors [5], [11].

Mediating Role of Digital Transformation Awareness: One of the most important contributions of this study lies in demonstrating the central mediating role of digital transformation awareness. The mediation analysis reveals that awareness significantly transmits the effects of digital skills, learning motivation, and institutional policies and support to lifelong self-learning competency. Among these indirect relationships, institutional policies and support through awareness show the strongest effect, followed by learning motivation and digital skills. These findings extend UTAUT by highlighting awareness as a critical cognitive mechanism linking facilitating conditions and individual capabilities to learning outcomes. While UTAUT traditionally focuses on behavioral intention and usage, this study demonstrates that awareness of digital transformation plays a pivotal role in shaping deeper, long-term educational outcomes such as lifelong learning competency. At the same time, the mediating role of awareness aligns with SDT by illustrating how motivation fosters cognitive engagement, which subsequently translates into sustained learning behavior. Conversely, the absence of a significant mediating effect for the digital learning environment reinforces the notion that environmental factors must be meaningfully experienced and cognitively internalized to influence long-term learning outcomes. This result echoes recent critiques of technology-centric approaches to digital education, which argue that without learner awareness and pedagogical integration, digital environments alone yield limited impact [1].

4.5. Theoretical and Contextual Implications

Theoretical Contributions: This study advances the literature on digital transformation and lifelong learning in higher education through three primary theoretical lenses, Elevating the Cognitive Dimension of Digital Transformation:

Traditionally, research has focused on technological infrastructure or isolated digital skills. This study provides robust empirical evidence that Digital Transformation Awareness

(DTA) is the most potent predictor of Lifelong Self-Learning Competency (LSC). By establishing DTA as a central cognitive construct, this research shifts the theoretical focus from "access to technology" to the "internalization of digital change." Clarifying Mediating Mechanisms: The findings enrich the mechanism-based perspective by revealing that technological capabilities do not automatically translate into learning outcomes. Notably, digital skills influence LSC primarily through the indirect pathway of awareness. This suggests a "cognitive bottleneck" where technical proficiency must be paired with strategic awareness to foster sustained self-directed learning behaviors. Integrative Framework Synthesis: By bridging the Unified Theory of Acceptance and Use of Technology (UTAUT) with Self-Determination Theory (SDT), this study offers a holistic model that integrates organizational (institutional support), individual (skills and motivation), and environmental (digital learning environment) factors. This cross-disciplinary integration addresses the fragmented nature of existing literature and provides a comprehensive explanatory bridge in the context of emerging economies like Vietnam.

Practical and Contextual Implications: The results offer critical insights for university administrators and educational policymakers, particularly in developing academic landscapes. Prioritizing "Soft" Over "Hard" Infrastructure: The nonsignificant direct effect of the Digital Learning Environment (DLE) suggests that mere investment in hardware or software upgrades is insufficient. Institutions should pivot toward "soft" investments, pedagogical design and learner experience. Digital platforms must be embedded in interactive models (e.g., project-based or collaborative inquiry) rather than used for passive content delivery. Strategic

Awareness Campaigns: Since awareness is the critical mediator, universities should implement targeted orientation programs and internal communication strategies. These should move beyond basic literacy to explicitly address the value and professional implications of digital transformation, utilizing real-world industry cases to foster student readiness. Pedagogical Alignment of Digital Skills: Technical training should be decoupled from rote learning and integrated into applied pedagogies. By linking digital tool proficiency with problem-based learning, institutions can ensure that technical skills are cognitively perceived as relevant, thereby transforming "skills" into "genuine learning capacity." Refining Assessment through Digital Traces: To convert DLE into a stronger driver of LSC, universities should align digital platforms with formative assessment practices. Utilizing digital learning traces for continuous evaluation, rather than relying solely on summative exams, it can increase students' perceived importance of digital engagement and strengthen self-learning behaviors. Sustainable Digital Foundations: While DLE had a limited direct impact in this study, it remains a necessary baseline. Continuous improvement focused on interactivity and personalization is required. Strategic initiatives in developing countries must ensure that infrastructure investments are matched by organizational initiatives to achieve a sustainable and meaningful educational impact.

5. CONCLUSION

This study investigated the factors influencing students' awareness of digital transformation and lifelong self-learning competency in the context of higher education, using empirical evidence from Ho Chi Minh City University of Industry and Trade. Drawing on the Unified Theory of Acceptance and Use of Technology (UTAUT) and Self-Determination Theory (SDT), the research provides a comprehensive explanation of how technological, motivational, and institutional factors interact to shape lifelong learning in a digitally transforming educational environment.

The findings demonstrate that awareness of digital transformation plays a pivotal role in fostering lifelong self-learning competency. While learning motivation and institutional

policies and support exert direct positive effects on lifelong learning, digital skills influence lifelong self-learning capacity primarily through an indirect pathway via digital transformation awareness. In contrast, the digital learning environment does not show significant direct or indirect effects, suggesting that the mere availability of digital platforms is insufficient to enhance lifelong learning outcomes without meaningful cognitive engagement and institutional facilitation. Overall, the study advances existing literature by empirically validating digital transformation awareness as a central explanatory mechanism linking individual capabilities, motivational drivers, and organizational support to sustainable learning outcomes. The results emphasize that effective digital transformation in higher education requires not only technological infrastructure but also strategic efforts to enhance students' understanding, motivation, and readiness to engage in continuous learning.

Despite its contributions, this study has several limitations that should be acknowledged. First, the research adopts a cross-sectional survey design, capturing students' perceptions at a single point in time. As a result, it does not fully reflect how digital transformation awareness and lifelong self-learning competency may evolve over time, nor does it allow for strong causal interpretations. Second, although the sample size is relatively large (N = 561), the sample is heavily concentrated in business-related disciplines, particularly Business Administration, which accounts for approximately 79% of respondents. Differences in learning environments and technology exposure across academic fields, such as engineering, natural sciences, or foreign languages, may restrict the generalizability of the findings to the broader university population.

Future research can extend this study in several important directions. Longitudinal research designs could be employed to examine changes in digital transformation awareness and lifelong learning competency over time. Expanding the sample across multiple universities, regions, or learner groups would enhance external validity and generalizability. Additionally, future studies may consider incorporating other mediating or moderating variables, such as digital self-efficacy, technology readiness, or instructor support, to further clarify underlying mechanisms. Finally, qualitative approaches, including in-depth interviews or case studies, could provide richer insights into students' lived experiences and help explain why digital learning environments do not exert stronger effects in the current model.

In conclusion, this study contributes both theoretical and practical insights into the development of lifelong self-learning competency in the digital transformation era, offering a foundation for future research and for more effective digital transformation strategies in higher education.

Acknowledgement: The authors would like to express their sincere gratitude to their supervisor and Ho Chi Minh City University of Industry and Trade for their support and guidance.

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