# Advancing E-Learning Adoption in Saudi Arabia: Extending TAM with Multi-Level External Variables and Accessibility

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## ABSTRACT

**This study explores the key factors influencing the adoption of E-learning systems among undergraduate students in Saudi Arabia by extending the Technology Acceptance Model (TAM) with multi-level external variables. These include individual-level factors (self-efficacy, enjoyment, computer anxiety), cultural-level (subjective norms, experience), and system-level (content quality). Furthermore, the study examines the moderating effect of accessibility on the relationships between perceived usefulness, perceived ease of use, and intention to use Blackboard as a representative E-learning platform. Data collected from 400 undergraduate students at Shaqra University and analyzed using PLS-SEM. The findings indicated that self-efficacy significantly predicts perceived ease of use but not perceived usefulness. Subjective norms positively influenced only perceived usefulness. Enjoyment and experience positively affected both perceived ease of use and usefulness, while computer anxiety negatively impacts ease of use alone. Content quality demonstrates a strong positive effect on both core TAM constructs. Accessibility moderates the relationship between ease of use and intention to use Blackboard. Aligned with Saudi Vision 2030's educational goals, these findings highlight the importance of digital infrastructure, skill development, and inclusive access in shaping students' adoption of E-learning technologies.**

**Keywords:** E-learning adoption, Technology Acceptance Model, perceived usefulness, perceived ease of use, accessibility, Blackboard, Saudi Vision 2030.

## INTRODUCTION

In recent years, the integration of digital technologies into education has transformed learning experiences globally, and Saudi Arabia is no exception. Aligned with its ambitious Vision 2030, the Kingdom seeks to modernize its educational sector, foster a digitally driven economy, and position itself as a global leader in higher education [1]. A key component of this transformation is the widespread adoption of E-learning, viewed as a means to enhance accessibility, efficiency,

and educational quality. Within this context, the implementation of E-learning technologies-particularly Learning Management Systems (LMS)-has become a strategic priority for Saudi universities [2]. This digital shift is supported by significant investments in technological infrastructure, alongside initiatives to improve digital literacy and reduce technological disparities across regions.

Despite this momentum, the adoption of E-learning in Saudi higher education remains inconsistent due to challenges at both institutional and individual levels. Barriers include limited digital skills, inadequate technical support, varying levels of prior experience with educational technology, and infrastructural gaps between urban and rural areas [3, 4]. Additionally, individual-level psychological factors such as computer anxiety (CA) hinder students' engagement with digital platforms. Conversely, self-efficacy (SE)-students' confidence in using digital tools-plays a pivotal role in shaping perceptions of perceived ease of use (PEOU) and perceived usefulness (PU) [5, 6].

At the cultural level, subjective norms (SN)-social expectations and peer influence-continue to shape students' attitudes toward E-learning, particularly in collectivist contexts such as Saudi Arabia, where family and institutional endorsement significantly influence behavioral choices [7, 8]. Enjoyment (ENJ)-the intrinsic pleasure derived from using digital platforms-is another motivational factor that promotes student engagement and system acceptance [9]. Likewise, experience (EXP) with E-learning systems fosters familiarity and reduces cognitive load, enhancing system usability [10]. Another critical determinant is content quality (CQ), defined as the perceived relevance, clarity, and interactivity of online materials. High-quality content has been shown to significantly influence both PU and PEOU, acting as a cornerstone for user satisfaction and sustained engagement [11, 12].

Alongside these variables, accessibility (ACC)-referring to stable internet connectivity, adequate devices, and available technical support-acts both as a direct enabler of system adoption and a moderating variable that strengthens or weakens the relationship between system perceptions and students' behavioral intention (BI) [13, 14].

This study investigates the multifaceted factors influencing E-learning adoption in Saudi Arabia by extending the Technology Acceptance Model (TAM) through the integration of individual (SE, ENJ, CA), cultural (SN, EXP), and system-level (CQ) variables. It further examines ACC as a moderating factor that may amplify or attenuate the effects of PU, PEOU, and BI. While prior research has explored E-learning adoption across various global contexts, there remains a notable gap in understanding how these variables interact within the unique socio-technological landscape of Saudi higher education [8]. Recently, Shaqra University adopted the Blackboard platform as its official E-learning system. Accordingly, this study assesses the extent to which students accept and intend to use this platform as part of their academic experience.

In addition, the study identifies specific obstacles faced by students in rural areas and offers targeted recommendations to bridge the digital divide. By contextualizing TAM within the Saudi framework, this research provides practical insights for policymakers, university administrators, and EdTech stakeholders seeking to enhance digital learning strategies in line with Vision 2030. Ultimately, this study contributes to advancing the Kingdom's educational

transformation by offering evidence-based strategies to support the sustainable integration of digital technologies in higher education.

## LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

Understanding the factors that influence E-learning adoption is critical in enhancing technology-driven educational practices, particularly in regions undergoing digital transformation. In the Saudi Arabian context, national policy reforms under Vision 2030 have prioritized the modernization of higher education through the integration of E-learning platforms [1]. Despite significant investment in digital infrastructure, the adoption and sustained use of E-learning systems among students remain inconsistent.

Although several studies have explored E-learning from various perspectives [15, 16] students' perspectives have not been thoroughly investigated. Thus, this area of study is still in its infancy [17]. This review synthesizes both theoretical and empirical literature on E-learning adoption. The Technology Acceptance Model (TAM) serves as the dominant theoretical framework for examining users' acceptance of technology. According to TAM, perceived usefulness (PU) and perceived ease of use (PEOU) directly predict behavioral intention [18]. Subsequent extensions of TAM have incorporated external variables such as self-efficacy, subjective norms, and system characteristics to improve predictive validity [19]. Although TAM model has been widely applied in E-learning contexts [20], their application with different cultures becomes important to ensure its applicability and reliability [21].

Self-efficacy, defined as an individual's belief in their ability to perform tasks using technology [22], has been identified as a key determinant of E-learning acceptance. It influences both PU and PEOU by shaping students' confidence in navigating digital platforms. While numerous studies affirm the positive relationship between self-efficacy and technology adoption [6, 23] findings remain contextually inconsistent. For instance, while studies in Poland and the UAE have confirmed its effect on PU and PEOU [24, 25] others in Bangladesh and Azerbaijan report negligible or non-significant effects [26, 27]. These mixed results suggest that the impact of self-efficacy may vary by socio-cultural and infrastructural context.

- **H1:** Self-efficacy positively affects students' perceived ease of use of Blackboard.
- **H2:** Self-efficacy positively affects students' perceived usefulness of Blackboard.

Subjective norms, which reflect the perceived social pressure to perform or abstain from a behavior [28], play a critical role in technology adoption within collectivist societies such as Saudi Arabia. Social endorsement from family, peers, and academic institutions has been shown to influence E-learning usage [8, 29]. However, the literature presents conflicting findings. While studies in China and Sri Lanka demonstrate a significant effect of subjective norms on PU and PEOU [30, 31], other investigations, including those in Canada and Bangladesh, report limited or no influence [26] The divergence in these outcomes highlights the importance of cultural context in moderating the influence of social expectations.

- **H3:** Subjective norms positively affect students' perceived usefulness of Blackboard.
- **H4:** Subjective norms positively affect students' perceived ease of use of Blackboard.

Enjoyment defined as the intrinsic pleasure or satisfaction derived from using E-learning tools has emerged as an influential factor in adoption models, especially among younger learners. It

positively affects both PU and PEOU by enhancing user engagement and motivation [5, 32]. In the Saudi context, where traditional classroom dynamics still persist, enjoyment may play a crucial role in reshaping attitudes toward online platforms.

- **H5**: Enjoyment positively affects students' perceived ease of use of Blackboard.
- **H6**: Enjoyment positively affects students' perceived usefulness of Blackboard.

Experience with technology is another significant antecedent of E-learning acceptance. Prior experience with digital tools enhances students' confidence and reduces uncertainty in navigating learning management systems [3, 8]. Experienced users are more likely to perceive E-learning systems as intuitive and beneficial, which can lead to stronger behavioral intentions.

- **H7**: Experience positively affects students' perceived ease of use of Blackboard.
- **H8**: Experience positively affects students' perceived usefulness of Blackboard.

Content quality, which includes the relevance, clarity, and interactivity of digital learning materials, has also been shown to influence PU and PEOU. High-quality content enhances perceived effectiveness and learner satisfaction, thereby increasing overall adoption [2, 4]. In the context of Saudi Arabia, where learners rely heavily on formal resources, content quality becomes a critical predictor of system usage.

- **H9**: Content quality positively affects students' perceived ease of use of Blackboard.
- **H10**: Content quality positively affects students' perceived usefulness of Blackboard.

Computer anxiety, or the apprehension associated with using digital tools, has been identified as a barrier to technology adoption. Studies indicate that students with higher levels of anxiety perceive systems as less easy to use, which indirectly diminishes their intention to adopt E-learning [5, 12].  Addressing this barrier through training and support mechanisms can improve acceptance outcomes, especially among less technologically confident learners.

- **H11**: Computer anxiety negatively affects students' perceived ease of use of Blackboard.
- **H12**: Computer anxiety negatively affects students' perceived usefulness of Blackboard.

Accessibility, defined as access to reliable internet, devices, and supporting infrastructure, has been shown to facilitate higher levels of technology use, particularly in developing countries[32]. In Saudi Arabia, regional disparities in digital connectivity remain a key barrier to equitable adoption [2, 4]. Studies suggest that accessibility affects the relationship between system perceptions (PU, PEOU) and adoption behavior [23]. However, in high-access environments, its effect may diminish, as noted by Park [33] [37] in the South Korean context.

- **H13**: Accessibility moderates the relationship between perceived usefulness and intention to use Blackboard.
- **H14**: Accessibility moderates the relationship between perceived ease of use and intention to use Blackboard.

While TAM has been widely validated, its explanatory power in non-Western settings may depend on cultural, infrastructural, and institutional variables. In the case of Saudi Arabia, existing research has primarily focused on system readiness or instructor adoption [7, 13], with limited attention given to student-level factors such as digital confidence, social environment, and access equity. To address these gaps, the current study proposes a contextualized TAM model to advance understanding of E-learning adoption in Saudi higher education. The model

integrates key predictors of behavioral intention, including self-efficacy, enjoyment, experience, subjective norms, content quality, computer anxiety, and accessibility, offering a comprehensive and empirically grounded framework tailored to the local context.

## RESEARCH FRAMEWORK

The proposed model builds on the Technology Acceptance Model (TAM) and extends it by incorporating individual, cultural, and system-level external variables. As shown in Figure 1, Self-Efficacy, Enjoyment, and Computer Anxiety represent individual-level factors; Subjective Norms and Experience reflect cultural-level influences; and Content Quality is considered a system-level factor. The model also introduces Accessibility as a moderator, expected to strengthen the relationships between perceived usefulness, perceived ease of use, and intention to use Blackboard. This addition reflects infrastructural challenges and digital divides in Saudi higher education. By contextualizing TAM with culturally and technologically relevant constructs, the framework aims to provide a comprehensive understanding of E-learning adoption among university students in Saudi Arabia.
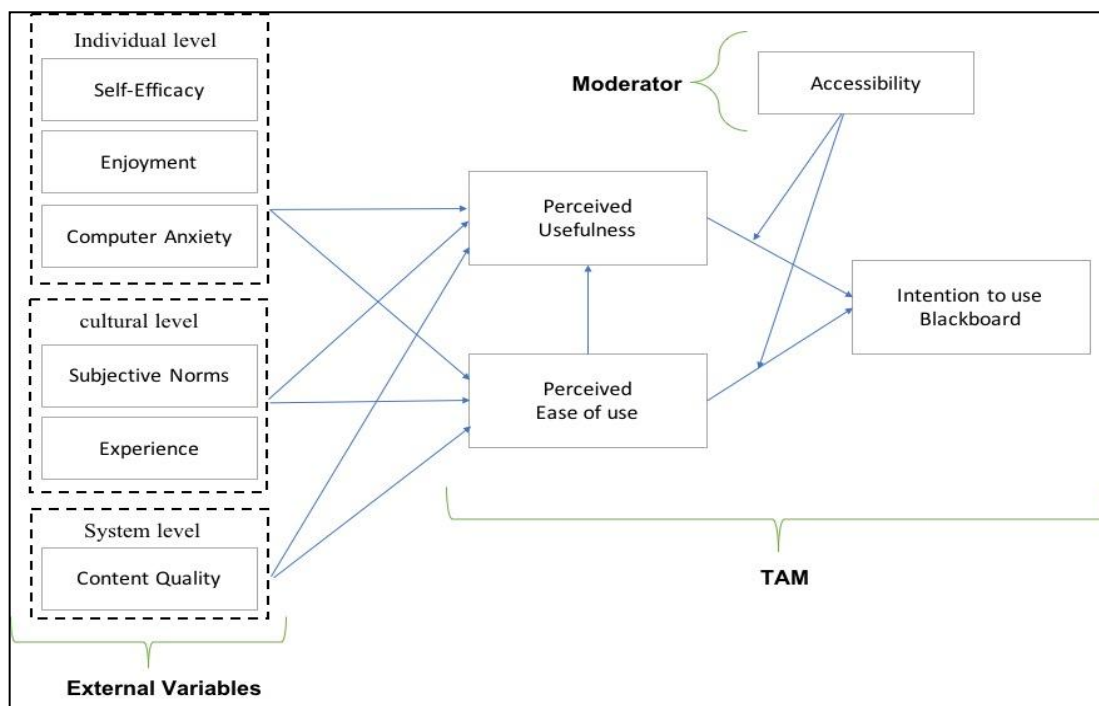


**Figure 1: Conceptual Framework**

## RESEARCH METHODOLOGY

This research aims to test the proposed model and hypotheses using survey data and statistical analysis to explore the relationships among these variables. Data were collected from 400 undergraduate students at Shaqra University and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) to test the hypothesized relationships between the variables. The survey instrument was developed based on validated scales from prior E-learning studies.It consists of sections covering demographics, individual, cultural, and system factors, as well as TAM components (perceived usefulness, ease of use) and accessibility. A 5-point Likert scale was used to measure responses.

To ensure validity and reliability, measurement items for each construct were adapted from well-established studies. Self-efficacy was measured using three items adapted from [33-35], which assess students' confidence in independently using the Blackboard system under varying conditions. Enjoyment was measured by three items adapted from [32], reflecting users' emotional engagement and interest in using Blackboard. Computer Anxiety factor was measured using 4 items adapted from [26], which evaluate users' discomfort, stress, and fear associated with computer usage.

Subjective norms were measured using three items adapted from [28, 32, 36], assessing the influence of peers, family, and institutional expectations on students' use of Blackboard. Experience was measured using four items derived from [26, 27, 35, 36]. These items evaluate students familiarity with digital learning environments. Content quality was measured using four items adapted from [37] focusing on students' perceptions of the clarity, relevance, interactivity, and structural organization of the digital learning content provided through Blackboard.

Perceived usefulness was measured using five items adapted from [18] assessing students' beliefs about Blackboard's effectiveness in enhancing their learning. Perceived ease of use was assessed using three items also adapted from [18], reflecting the degree to which students find the system free of effort and easy to navigate. Intention to use Blackboard was measured using three items adapted from [18] focusing on students' willingness and plans to use the platform in the future. Accessibility was measured using three items adapted from [32, 33], evaluating students' access to internet, devices, and technical support necessary for engaging with the Blackboard system.

The validity of the instrument was assessed through expert reviews and Content Validity Index (CVI) calculations [38]. The survey was translated into Arabic using the back-translation method [38] to ensure cultural relevance. A pilot study involving 150 participants was conducted to examine construct validity, and Exploratory Factor Analysis (EFA) was employed to refine and confirm the item structure. Data were analyzed using SPSS for descriptive statistics and PLS-SEM for hypothesis testing for hypothesis testing [39].

## DATA ANALYSIS AND FINDINGS
### Respondents Demographic Profiles
Table 1 presents the frequency distribution of respondents' demographic characteristics.

**Table 1: Frequency distribution of demographic characteristics**

| Variable | Level | Frequency | Percent |
|---|---|---|---|
| **Gender** | Female | 243 | 60.7 |
| | Male | 157 | 39.3 |
| **Age (year)** | 18-24 | 340 | 85 |
| | 25-30 | 45 | 11.3 |
| | >35 | 15 | 3.7 |
| **Year of study** | Year 1 | 66 | 16.5 |
| | Year 2 | 130 | 32.5 |
| | Year 3 | 94 | 23.5 |
| | Year 4 | 110 | 27.5 |

The majority were female (60.7%), while males represented 39.3%. Most participants (85%) were aged 18–24, aligning with the typical age group of university students., while 11.3% were aged 25–30, and 3.7% were 35 or older. Regarding academic level, Year 2 students formed the largest group (32.5%), followed by Year 4 (27.5%), Year 3 (23.5%), and Year 1 (16.5%). Overall, the sample reflects a predominantly young, female student population with representation across all academic years which is important when interpreting the findings related to E-learning adoption.

## Descriptive Statistics

The descriptive statistics for all research variables, as presented in Table 2, provide a comprehensive overview of the responses for each construct measured in the study. Self-efficacy (SE) recorded a moderate mean of 3.64 (SD = 1.02), indicating that participants generally feel somewhat confident in their ability to use E-learning platforms. Subjective norms (SN) and enjoyment (ENJ) had moderate means of 3.57 and 3.44 (SD = 0.91 and 0.99), suggesting neutral to slightly positive perceptions of social influence and enjoyment. Experience (EXP) showed a relatively high mean of 3.74 (SD = 0.94), reflecting familiarity and comfort with digital tools. Content quality (CQ), perceived usefulness (PU), and perceived ease of use (PEOU) also fell within the moderate range, with means of 3.59 (SD = 0.93), 3.67 (SD = 0.99), and 3.56 (SD = 1.03), respectively. In contrast, computer anxiety (CA) had a low mean of 2.55 (SD = 0.78), indicating low levels of discomfort with technology. Finally, both intention to use Blackboard (INT) and accessibility (ACC) recorded moderate means of 3.59 (SD = 1.02) and 3.78 (SD = 0.92), suggesting generally positive attitudes toward using the platform.

**Table 2: Descriptive Statistics for all Research Variables**

| Variable | Minimum | Maximum | Mean | Std. Deviation | Level |
|---|---|---|---|---|---|
| SE | 1 | 5 | 3.64 | 1.02 | Moderate |
| SN | 1 | 5 | 3.57 | 0.91 | Moderate |
| ENJ | 1 | 5 | 3.44 | 0.99 | Moderate |
| EXP | 1 | 5 | 3.74 | 0.94 | High |
| CQ | 1 | 5 | 3.59 | 0.93 | Moderate |
| CA | 1 | 5 | 2.55 | 0.78 | Low |
| PU | 1 | 5 | 3.67 | 0.99 | High |
| PEOU | 1 | 5 | 3.56 | 1.03 | Moderate |
| INT | 1 | 5 | 3.59 | 1.02 | Moderate |
| ACC | 1 | 5 | 3.78 | 0.92 | High |

SE: Self-efficacy, SN: Subjective norms, ENJ: Enjoyment, EXP: Experience, CQ: Content quality, CA: Computer anxiety, PU: Perceived usefulness, PEOU: Perceived ease of use, INT: Intention to use Blackboard, ACC: Accessibility.

## Measurement Model

Figure 2 illustrates the modified model based on the PLS algorithm for examining the relationships among the various constructs in the study on E-learning adoption. The model demonstrates several significant paths between the latent variables, showcasing how self-efficacy, enjoyment, computer anxiety, experience, subjective norms, and content quality influence the perceived usefulness and perceived ease of use of the Blackboard system, which in turn affects intention to use. Notably, perceived usefulness has a strong positive impact on intention to use ($\beta$ = 0.786), with a relatively moderate impact from perceived ease of use ($\beta$ = 0.623). Accessibility also plays an important role, with a notable path from accessibility to

intention to use (β = 0.407), indicating that ease of access contributes positively to users' willingness to engage with E-learning systems. The model reflects how subjective norms and experience also influence both perceived usefulness and perceived ease of use, although their effects are weaker compared to self-efficacy and enjoyment. The results suggest a strong overall fit for the model, with all constructs showing acceptable loadings and significant relationships, which helps validate the conceptual framework for E-learning adoption in the context of Saudi Arabia.
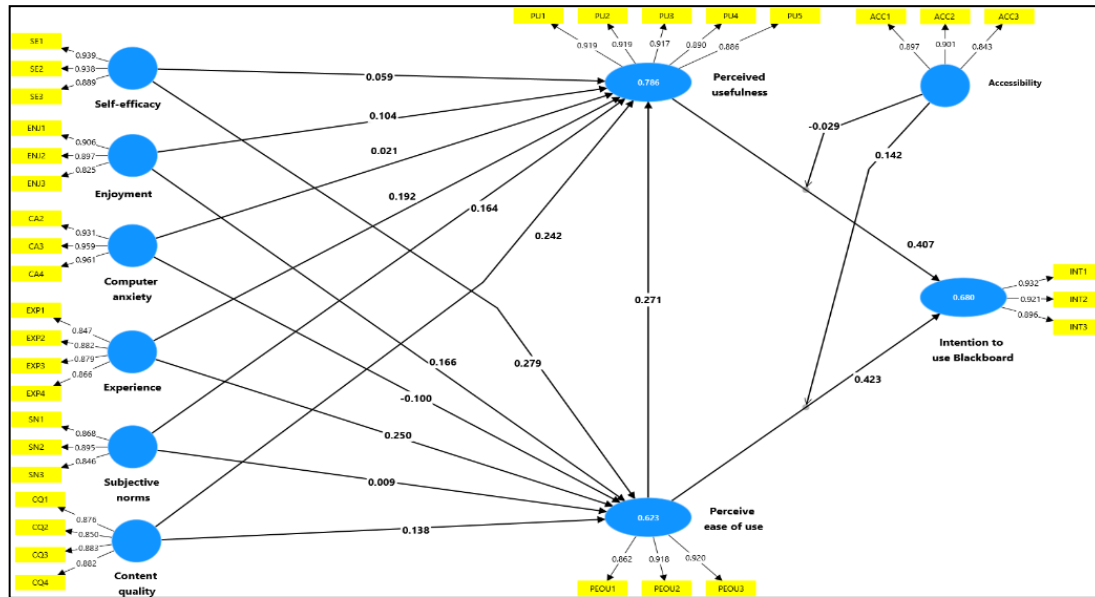


**Figure 2: Modified Model (PLS Algorithm)**

**Convergent Validity:**

Table 3 presents the results of convergent validity and composite reliability for all constructs included in the study. The findings indicate that the majority of constructs meet the recommended thresholds for these measurement criteria. Most items achieved outer loadings above the recommended minimum of 0.70, supporting good convergent validity.

For example, the Accessibility construct (ACC1, ACC2, ACC3) shows strong outer loadings, with ACC1 and ACC2 both above 0.9, suggesting a high level of reliability and agreement within this construct. However, Computer Anxiety (CA1) was deleted due to a low loading of 0.373, which would have reduced the construct's reliability. The Cronbach's alpha values for all constructs are above the threshold of 0.7, demonstrating good internal consistency [40-43]. For instance, the Intention to use Blackboard construct (INT1, INT2, INT3) achieves a Cronbach's alpha of 0.907, signifying high internal consistency. Similarly, Composite reliability values for each construct, such as Self-efficacy (0.913) and Perceived ease of use (0.887), also exceed the acceptable value of 0.7, supporting the robustness of the measurement model. Lastly, the Average Variance Extracted (AVE) values, ranging from 0.754 to 0.821, confirm that each construct explains a significant portion of variance in its items, further supporting the convergent validity of the measurement model.

## Table 3: Result of Convergent Validity and Composite Reliability for all Constructs

| Construct | Item | Outer load | | Cronbach's alpha | Composite reliability | AVE |
|---|---|---|---|---|---|---|
| | | Initial | Modified | | | |
| **Accessibility** | ACC1 | 0.897 | 0.897 | 0.856 | 0.863 | 0.776 |
| | ACC2 | 0.901 | 0.901 | | | |
| | ACC3 | 0.843 | 0.843 | | | |
| **Computer anxiety** | CA1 | 0.373 | deleted | 0.947 | 0.953 | 0.904 |
| | CA2 | 0.893 | 0.931 | | | |
| | CA3 | 0.919 | 0.959 | | | |
| | CA4 | 0.926 | 0.961 | | | |
| **Content quality** | CQ1 | 0.876 | 0.876 | 0.896 | 0.898 | 0.762 |
| | CQ2 | 0.85 | 0.85 | | | |
| | CQ3 | 0.883 | 0.883 | | | |
| | CQ4 | 0.882 | 0.882 | | | |
| **Enjoyment** | ENJ1 | 0.906 | 0.906 | 0.849 | 0.855 | 0.768 |
| | ENJ2 | 0.897 | 0.897 | | | |
| | ENJ3 | 0.825 | 0.825 | | | |
| **Experience** | EXP1 | 0.847 | 0.847 | 0.891 | 0.891 | 0.754 |
| | EXP2 | 0.882 | 0.882 | | | |
| | EXP3 | 0.879 | 0.879 | | | |
| | EXP4 | 0.866 | 0.866 | | | |
| **Intention to use Blackboard** | INT1 | 0.932 | 0.932 | 0.904 | 0.907 | 0.840 |
| | INT2 | 0.921 | 0.921 | | | |
| | INT3 | 0.896 | 0.896 | | | |
| **Perceive ease of use** | PEOU1 | 0.862 | 0.862 | 0.883 | 0.887 | 0.811 |
| | PEOU2 | 0.918 | 0.918 | | | |
| | PEOU3 | 0.92 | 0.92 | | | |
| **Perceived usefulness** | PU1 | 0.919 | 0.919 | 0.946 | 0.946 | 0.821 |
| | PU2 | 0.919 | 0.919 | | | |
| | PU3 | 0.917 | 0.917 | | | |
| | PU4 | 0.89 | 0.89 | | | |
| | PU5 | 0.886 | 0.886 | | | |
| **Self-efficacy** | SE1 | 0.939 | 0.939 | 0.912 | 0.913 | 0.851 |
| | SE2 | 0.938 | 0.938 | | | |
| | SE3 | 0.889 | 0.889 | | | |
| **Subjective norms** | SN1 | 0.868 | 0.868 | 0.841 | 0.85 | 0.757 |
| | SN2 | 0.895 | 0.895 | | | |
| | SN3 | 0.846 | 0.846 | | | |

SE: Self-efficacy, SN: Subjective norms, ENJ: Enjoyment, EXP: Experience, CQ: Content quality, CA: Computer anxiety, PU: Perceived usefulness, PEOU: Perceived ease of use, INT: Intention to use Blackboard, ACC: Accessibility.

Table 4 presents the results of the discriminant validity assessment using the Fornell-Larcker criterion, which evaluates the extent to which the constructs in the model are distinct from one another. This method compares the square root of the Average Variance Extracted (AVE) for each construct with the correlations between that construct and others in the model [44-47]. In this case, all diagonal values are greater than the correlations between the constructs, which is a critical requirement for demonstrating discriminant validity. Overall, the discriminant validity results suggest that the constructs in the model are appropriately distinct and measure separate concepts, ensuring the reliability of the hypothesized relationships.

## Table 4: Discriminant Validity (Fornell-Larcker Approach)

|      | ACC | CA | CQ | ENG | EXP | INT | PEOU | PU | SE | CN |
|------|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| ACC  | 0.881 | | | | | | | | | |
| CA   | -0.167 | 0.951 | | | | | | | | |
| CQ   | 0.325 | -0.209 | 0.873 | | | | | | | |
| ENG  | 0.287 | -0.263 | 0.708 | 0.877 | | | | | | |
| EXP  | 0.273 | -0.36 | 0.723 | 0.729 | 0.868 | | | | | |
| INT  | 0.409 | -0.298 | 0.654 | 0.65 | 0.656 | 0.916 | | | | |
| PEOU | 0.375 | -0.343 | 0.658 | 0.684 | 0.717 | 0.76 | 0.901 | | | |
| PU   | 0.325 | -0.281 | 0.778 | 0.754 | 0.784 | 0.759 | 0.775 | 0.906 | | |
| SE   | 0.358 | -0.278 | 0.696 | 0.733 | 0.729 | 0.626 | 0.714 | 0.750 | 0.923 | |
| CN   | 0.312 | -0.278 | 0.666 | 0.710 | 0.683 | 0.593 | 0.620 | 0.735 | 0.724 | 0.87 |

SE: Self-efficacy, SN: Subjective norms, ENJ: Enjoyment, EXP: Experience, CQ: Content quality, CA: Computer anxiety, PU: Perceived usefulness, PEOU: Perceived ease of use, INT: Intention to use Blackboard, ACC: Accessibility. Bolded numbers are square root of AVE.

Table 5 presents the discriminant validity analysis using the Heterotrait-Monotrait (HTMT) ratio, which is an essential measure for assessing the distinctiveness of the constructs used in the model. The HTMT values in this table reveal the degree to which the constructs are related to each other. A value below 0.90 indicates that the constructs are sufficiently distinct, showing that they do not overlap significantly [48-51]. In this table, the HTMT values for most construct pairs are well below 0.90, suggesting that the variables exhibit adequate discriminant validity.

## Table 5: Discriminant Validity (HTMT Method)

|      | ACC | CA | CQ | ENG | EXP | INT | PEOU | PU | SE | CN |
|------|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| ACC  | | | | | | | | | | |
| CA   | 0.190 | | | | | | | | | |
| CQ   | 0.371 | 0.226 | | | | | | | | |
| ENG  | 0.333 | 0.288 | 0.809 | | | | | | | |
| EXP  | 0.315 | 0.392 | 0.807 | 0.834 | | | | | | |
| INT  | 0.457 | 0.320 | 0.727 | 0.740 | 0.730 | | | | | |
| PEOU | 0.426 | 0.373 | 0.737 | 0.788 | 0.807 | 0.848 | | | | |
| PU   | 0.359 | 0.296 | 0.843 | 0.842 | 0.854 | 0.820 | 0.848 | | | |
| SE   | 0.403 | 0.299 | 0.77 | 0.833 | 0.809 | 0.688 | 0.795 | 0.807 | | |
| CN   | 0.364 | 0.302 | 0.757 | 0.830 | 0.775 | 0.666 | 0.708 | 0.812 | 0.820 | |

SE: Self-efficacy, SN: Subjective norms, ENJ: Enjoyment, EXP: Experience, CQ: Content quality, CA: Computer anxiety, PU: Perceived usefulness, PEOU: Perceived ease of use, INT: Intention to use Blackboard, ACC: Accessibility

Figure 3 illustrates the results of the path model, analyzed using bootstrapping to assess relationships among the study's core constructs. The model reveals that perceived usefulness (β = 0.786) and perceived ease of use (β = 0.623) are the strongest predictors of students' intention to use Blackboard. Accessibility also shows significant effects on both perceived ease of use (β = 0.407) and intention (β = 0.680), highlighting its critical role in adoption of technology. Self-efficacy, enjoyment, experience, and content quality positively influence TAM constructs, while computer anxiety negatively affects perceived ease of use. Subjective norms show a weaker influence, indicating limited social pressure in this context. Overall, the findings underscore the combined influence of individual, social, and infrastructural factors in shaping E-learning adoption.
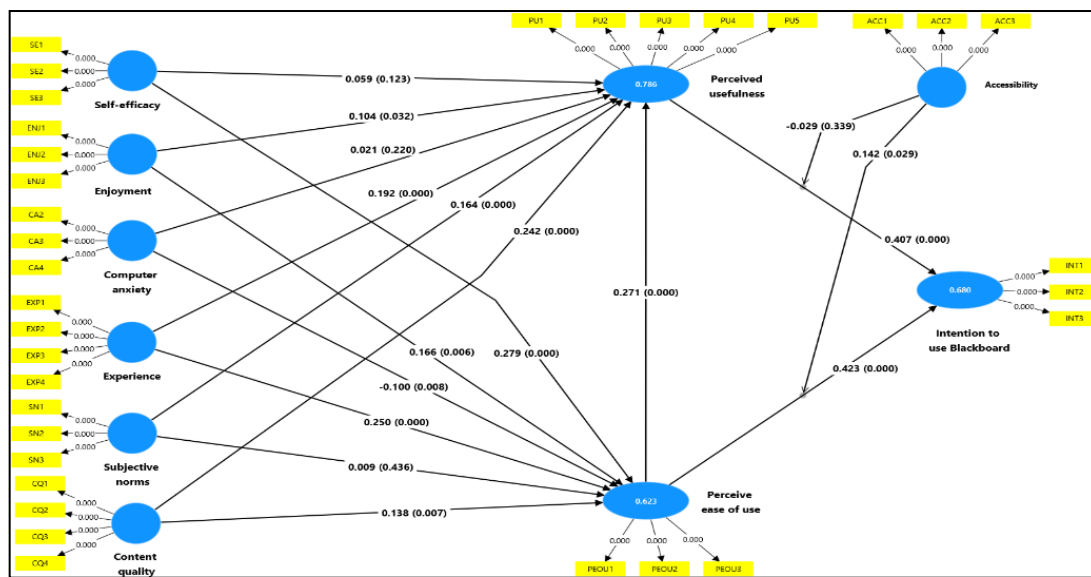
**Figure 3: Path Model (Bootstrapping)**

**Test of Hypotheses**

Table 7 presents the path model assessment results, revealing several significant relationships among the study variables. Self-efficacy had a significant positive effect on perceived ease of use ($\beta = 0.279$, T = 4.271, $p < 0.001$), suggesting that students who feel confident in their technological abilities are more likely to find E-learning systems easy to navigate. However, its effect on perceived usefulness was not significant ($\beta = 0.059$, T = 1.142, $p = 0.127$), indicating that confidence alone may not lead students to view the system as beneficial for their academic success. Subjective norms significantly influenced perceived usefulness ($\beta = 0.164$, T = 3.544, $p < 0.001$) but did not affect perceived ease of use ($\beta = 0.009$, T = 0.164, $p = 0.435$). This reflects the role of social and institutional expectations in shaping students' perception of E-learning's value, while having little impact on their experience with using the system.

Enjoyment had significant positive effects on both perceived ease of use ($\beta = 0.166$, T = 2.461, $p = 0.007$) and perceived usefulness ($\beta = 0.104$, T = 1.830, $p = 0.034$), highlighting the motivational role of user engagement. Similarly, experience positively affected both PEOU ($\beta = 0.250$, T = 3.932, $p < 0.001$) and PU ($\beta = 0.192$, T = 3.729, $p < 0.001$), indicating that prior familiarity enhances E-learning perceptions. Content quality also influenced both PEOU ($\beta = 0.138$, T = 2.436, $p = 0.007$) and PU ($\beta = 0.242$, T = 4.620, $p < 0.001$), reinforcing the role of high-quality content in shaping user attitudes. Computer anxiety had a significant negative effect on PEOU ($\beta = -0.100$, T = 2.430, $p = 0.008$), indicating that students who feel anxious or stressed when using technology are less likely to find the system easy to use. Its effect on perceived usefulness, however, was not significant ($\beta = 0.021$, T = 0.784, $p = 0.217$), suggesting that emotional discomfort may not diminish perceived value, but it does hinder usability. Importantly, perceived ease of use significantly influenced perceived usefulness ($\beta = 0.271$, T = 4.434, $p < 0.001$), confirming a key TAM relationship. Both PEOU ($\beta = 0.423$, T = 6.162, $p < 0.001$) and PU ($\beta = 0.407$, T = 5.763, $p < 0.001$) strongly predicted students' intention to use Blackboard, suggesting that ease of use and perceived usefulness are key drivers of users' intention to engage with E-learning platforms. These findings collectively provide valuable insights into the factors that shape E-learning adoption in Saudi Arabia.

### Table 6: Results Path Model Assessment

| Path | β | SE | T value | P Values | 95% CI | | Results |
|---|---|---|---|---|---|---|---|
| | | | | | LL | UL | |
| **SE -> PEOU** | 0.279 | 0.065 | 4.271 | <0.001 | 0.169 | 0.383 | Supported |
| **SE -> PU** | 0.059 | 0.052 | 1.142 | 0.127 | -0.026 | 0.145 | Not Supported |
| **SN -> PU** | 0.164 | 0.046 | 3.544 | <0.001 | 0.088 | 0.241 | Supported |
| **SN -> PEOU** | 0.009 | 0.056 | 0.164 | 0.435 | -0.08 | 0.102 | Not Supported |
| **ENJ -> PEOU** | 0.166 | 0.067 | 2.461 | 0.007 | 0.057 | 0.276 | Supported |
| **ENJ -> PU** | 0.104 | 0.057 | 1.83 | 0.034 | 0.013 | 0.198 | Supported |
| **EXP -> PEOU** | 0.250 | 0.064 | 3.932 | <0.001 | 0.146 | 0.355 | Supported |
| **EXP -> PU** | 0.192 | 0.051 | 3.729 | <0.001 | 0.107 | 0.276 | Supported |
| **CQ -> PEOU** | 0.138 | 0.057 | 2.436 | 0.007 | 0.05 | 0.234 | Supported |
| **CQ -> PU** | 0.242 | 0.052 | 4.62 | <0.001 | 0.152 | 0.324 | Supported |
| **CA -> PEOU** | -0.100 | 0.041 | 2.43 | 0.008 | -0.17 | -0.035 | Supported |
| **CA -> PU** | 0.021 | 0.026 | 0.784 | 0.217 | -0.024 | 0.062 | Not Supported |
| **PEOU -> PU** | 0.271 | 0.061 | 4.434 | <0.001 | 0.174 | 0.376 | Supported |
| **PEOU -> INT** | 0.423 | 0.069 | 6.162 | <0.001 | 0.307 | 0.535 | Supported |
| **PU -> INT** | 0.407 | 0.071 | 5.763 | <0.001 | 0.294 | 0.526 | Supported |

SE: Self-efficacy, SN: Subjective norms, ENJ: Enjoyment, EXP: Experience, CQ: Content quality, CA: Computer anxiety, PU: Perceived usefulness, PEOU: Perceived ease of use, INT: Intention to use Blackboard, ACC: Accessibility

## Coefficient of Determination (R2)

Table 8 summarizes the coefficient of determination ($R^2$) values, which indicate the proportion of variance in the dependent variables explained by the model [52-55]. The $R^2$ for Perceived Usefulness (PU) is the highest at 0.786 (Adj. $R^2$ = 0.782), reflecting strong explanatory power. Intention to Use Blackboard (INT) shows an $R^2$ of 0.680 (Adj. $R^2$ = 0.676), suggesting that the model explains 68% of the variance in adoption intention. Perceived Ease of Use (PEOU) also demonstrates substantial variance explained, with an $R^2$ of 0.623 (Adj. $R^2$ = 0.617), indicating a solid model fit.

### Table 7: Results of Coefficient of Determination ($R^2$)

| Endogenous Latent Variable | $R^2$ | Adj $R^2$ |
|---|---|---|
| Intention to use Blackboard | 0.680 | 0.676 |
| Perceive ease of use | 0.623 | 0.617 |
| Perceived usefulness | 0.786 | 0.782 |

## Predictive Relevance $Q^2$ of Structural Model

As shown in Table 9, the predictive relevance ($Q^2$) values confirm that the model has substantial predictive accuracy [56-59]. Perceived Usefulness achieved the highest $Q^2$ value of 0.747, indicating strong predictive relevance. Perceived Ease of Use also shows a robust $Q^2$ of 0.606, while Intention to Use Blackboard records a $Q^2$ of 0.559.

### Table 8: Results of Predictive Relevance ($Q^2$)

| Endogenous Latent Variable | $Q^2$ |
|---|---|
| Intention to use Blackboard | 0.559 |
| Perceive ease of use | 0.606 |
| Perceived usefulness | 0.747 |

These results highlight the model's effectiveness in predicting key behavioral outcomes related to E-learning adoption.

## Moderation Analysis

Table 10 presents the results of the moderation analysis assessing the effect of accessibility on the relationships between perceived usefulness (PU) and perceived ease of use (PEOU) with intention to use Blackboard (INT). The interaction term ACC × PU → INT was found to be non-significant ($\beta$ = –0.029, T = 0.42, p = 0.337), indicating that accessibility does not moderate the effect of perceived usefulness on intention to use. In contrast, the interaction between accessibility and perceived ease of use (ACC × PEOU → INT) showed a statistically significant positive effect ($\beta$ = 0.142, T = 1.912, p = 0.028), with a 95% confidence interval of [0.018, 0.262]. This suggests that higher accessibility strengthens the influence of perceived ease of use on students' intention to adopt Blackboard, reinforcing the importance of equitable access in facilitating E-learning adoption.

**Table 9: Moderating Effects of Accessibility on Relationship Between Perceived Ease of Use and Perceived Usefulness with Intention to Use Blackboard.**

| Moderating Effect | β | SE | T value | P Values | 95% CI | | |
|---|---|---|---|---|---|---|---|
| | | | | | LL | UL | Results |
| ACC x PU -> INT | -0.029 | 0.07 | 0.42 | 0.337 | -0.144 | 0.087 | Not Supported |
| ACC x PEOU -> INT | 0.142 | 0.074 | 1.912 | 0.028 | 0.018 | 0.262 | Supported |

PU: Perceived usefulness, PEOU: Perceived ease of use, INT: Intention to use Blackboard, ACC: Accessibility.

## DISCUSSION

The findings of this study offer meaningful insights into the factors influencing E-learning adoption among university students in Saudi Arabia. One of the most notable outcomes is the significant role of self-efficacy, as students with greater confidence in their digital skills were more likely to perceive E-learning platforms as accessible and user-friendly. This aligns with prior research suggesting that higher self-efficacy promotes technology adoption [3, 6]. Given the disparities in digital literacy across Saudi regions, especially between urban and rural areas, enhancing self-efficacy through targeted training programs is essential [9]. Although subjective norms had a relatively weaker effect on perceived ease of use, perceived usefulness was more pronounced. This suggests that students are more likely to adopt E-learning systems when they perceive these tools to be socially endorsed or culturally acceptable. The role of social influence in technology adoption has been well-documented in the Saudi context [11]. Social expectations from peers, families, perceptions of digital learning shape students' perceptions of digital learning. For instance, students are more inclined to see value in these systems when their academic and social environments actively support their use [8]. Enjoyment also emerged as a critical predictor. Students who found E-learning platforms engaging and enjoyable were more likely to perceive them as useful and easy to use. Enjoyment, as an intrinsic motivator, fosters continued use by making digital learning emotionally satisfying [5]. Therefore, interactive features, gamification, and intuitive design can enhance user engagement and support sustained adoption. Similarly, experience with digital platforms was another strong enabler. Students familiar with learning management systems (LMS), such as Blackboard, reported higher levels of both perceived ease of use and usefulness. This confirms prior findings suggesting that prior exposure to digital platforms enhances users' comfort and readiness [2, 3].

The study also confirms the importance of content quality (CQ). Structured, interactive, and relevant course materials significantly enhanced both perceived usefulness and ease of use. Conversely, poor content whether outdated or disengaging can undermine the adoption of even the most sophisticated platforms [60, 61]. Therefore, investing in high-quality digital content and instructional design is crucial. While computer anxiety had a modest impact, students who experienced higher levels of discomfort or fear when using technology were more likely to struggle with ease of use perceptions. This supports existing literature on psychological barriers to digital adoption [5, 13]. Providing user-friendly interfaces, support hotlines, and peer mentoring can help reduce anxiety and build digital confidence. Accessibility emerged as a pivotal determinant of both perceived ease of use and intention to use. Without reliable internet access, appropriate devices, and institutional support, students are unlikely to adopt digital tools regardless of system quality [2, 62]. Addressing regional disparities in infrastructure is essential for advancing digital inclusion, particularly under the objectives of Saudi Vision 2030.

These findings offer valuable implications for both policymakers and educational institutions. From a policy perspective, efforts should focus on strengthening digital infrastructure, improving internet accessibility, and supporting mobile-friendly LMS platforms particularly in underserved areas [4]. At the institutional level, enhancing digital literacy through structured tutorials, peer mentoring, and accessible technical support can boost students' self-efficacy and reduce computer anxiety. Moreover, involving students in content co-design and promoting E-learning adoption through faculty engagement can reinforce subjective norms, enhance content quality, foster enjoyment, and ultimately sustain long-term platform use.

## LIMITATIONS AND FUTURE RESEARCH

While this study offers meaningful contributions to understanding E-learning adoption within the Saudi context, several limitations should be acknowledged. The cross-sectional design restricts the ability to establish causal relationships; longitudinal studies are recommended to track changes in user perceptions over time and with increased technological exposure. Furthermore, this study focused on Blackboard; additional research comparing other platforms like Moodle or Microsoft Teams could reveal system-specific adoption patterns and interaction effects among the identified variables. Moreover, the growing integration of emerging technologies such as artificial intelligence, virtual reality, and learning analytics presents promising avenues for future investigation. For instance, AI-enhanced personalization may boost perceived usefulness, while immersive VR platforms could increase enjoyment and reduce computer anxiety by offering more intuitive and engaging experiences. Exploring how these technologies intersect with TAM constructs in Saudi higher education could inform the next wave of digital transformation in education.

## CONCLUSION

This study examined the impact of multi-level external variables and accessibility on the adoption of E-learning platforms in Saudi Arabia, providing a comprehensive understanding of the key factors shaping behavioral intention toward digital learning platforms. The findings revealed the critical role of self-efficacy in shaping perceived ease of use, as well as the influence of subjective norms on perceived usefulness, reflecting the importance of both individual confidence and social support. Furthermore, enjoyment and prior experience were found to have a dual effect on both perceived usefulness and ease of use, emphasizing the importance of

user engagement and technological familiarity in facilitating adoption. Notably, content quality demonstrated a strong influence on core TAM constructs, reinforcing the role of system-level attributes in shaping positive perceptions. Conversely, computer anxiety negatively affected perceived ease of use, highlighting the need to address emotional barriers to technology adoption. Accessibility emerged as a crucial enabling factor, enhancing both perceived ease of use and behavioral intention. Overall, these findings emphasize the interplay of cognitive, affective, social, and infrastructural dimensions in driving E-learning acceptance within the context of Saudi higher education.

The practical implications of this study are multifaceted. Policymakers should focus on enhancing digital infrastructure, particularly in underserved regions, to bridge the accessibility gap and ensure equitable access to E-learning platforms. Simultaneously, enhancing digital competence and reducing computer anxiety through targeted training and support programs can foster self-efficacy and sustained engagement. Educational institutions should prioritize the development of high-quality content and intuitive platforms that enhance both enjoyment and usability. Cultivating a supportive learning culture, where subjective norms reinforce positive attitudes toward technology, can further facilitate adoption. Future research could expand the model to include emerging variables such as personalization and gamification. Additionally, comparative studies involving different platforms or technologies may yield insights into how varying system characteristics influence acceptance behaviors.

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