

Factors influencing E-learning use for driver's license renewal in Thailand: A digital inclusion perspective

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Abstract: Digital public services can reduce time and place barriers, but their public value depends on citizens' ability to complete digital procedures successfully. This study examined factors associated with reported use of Thailand's Department of Land Transport online training for driver's license renewal and their implications for inclusive public-service delivery. A cross-sectional survey of 320 previous users was analyzed using descriptive statistics, Pearson correlations, and multiple regression. All four predictors were positively associated with system use ($r = .497-.578$). The regression model was significant, $F(4, 315) = 79.419$, $p < .001$, explaining 50.2% of the variance (adjusted $R^2 = .496$; RMSE = .869). Technology self-efficacy had the largest standardized coefficient ($\beta = .284$), followed by digital literacy ($\beta = .251$), access to technology ($\beta = .206$), and facilitating conditions ($\beta = .164$). Collinearity diagnostics were acceptable (VIF = 1.41–1.68), and all predictors retained unique explanatory value. The findings indicate that online availability alone does not ensure digital inclusion; citizens also require practical access, digital capability, effective support, and confidence in completing online tasks. Because the study was cross-sectional and included only prior users, findings should be interpreted as associations with reported use rather than causal effects or determinants of initial adoption.

Keywords: Digital government, Digital inclusion, E-learning, Driver's-license renewal, Public service delivery, Technology self-efficacy.

1. Introduction

Public agencies are moving an increasing share of citizen services to digital channels in order to simplify procedures and make access less dependent on time and place. The COVID-19 period accelerated this transition because governments relied more heavily on remote channels to sustain service delivery while limiting face-to-face contact [1-3]. As a result, digital government now extends beyond internal computerization and increasingly concerns how services are designed around accessibility, resilience, inclusion, and efficient public-resource use [4-6]. These concerns are especially relevant where distance, administrative burden, or uneven access can make conventional services difficult to reach.

In Thailand, this shift is embedded in public-sector reform. The Digital Government Development Agency [7] calls for public services that are convenient, transparent, modern, and responsive to citizens [7]. Meeting that objective requires more than placing an existing procedure online. Digital processes must also be understandable and usable by people whose devices, skills, and prior experience differ substantially.

The Department of Land Transport provides a useful case of this transition because licensing services combine regulation, citizen interaction, and road-safety education. Its online training platform allows renewal applicants to complete the required learning component before they proceed to the remaining licensing steps [8]. This arrangement can reduce travel and office congestion while preserving access to safety-related instruction [9, 10]. However, online availability does not ensure

equal use. A citizen with weak connectivity, limited digital skills, little prior experience, or low confidence may still face substantial barriers. Such differences reflect a digital divide that concerns not only possession of technology, but also the ability to use it and derive practical benefit from it [11-14].

Prior e-learning research points to several conditions that shape participation and continued use, including access to technology, system quality, user readiness, institutional support, and individual capability [3, 15-18]. These issues take on a different meaning in a government setting because users are ordinary citizens rather than a relatively homogeneous group of students or employees. Technology-acceptance theory offers one explanation for variation in use: the Technology Acceptance Model emphasizes perceived usefulness and ease of use [19], whereas the Unified Theory of Acceptance and Use of Technology identifies facilitating conditions as an important source of practical support [20]. Technology self-efficacy adds another dimension by capturing a person's confidence in carrying out technology-based tasks [21]. Studies in higher education and healthcare likewise connect e-learning engagement with facilitating conditions, digital literacy, and self-efficacy [22-24].

Three gaps motivate the present study. First, most e-learning adoption evidence is derived from voluntary educational or organizational settings, whereas government e-learning may be embedded in a required or semi-required administrative procedure. Second, citizen populations are more heterogeneous in age, education, device quality, connectivity, and prior digital experience than typical student or employee samples, making digital inclusion a central service-design problem rather than a peripheral access issue. Third, prior studies often examine access, acceptance, skills, or support separately; fewer studies estimate their unique contributions within a single citizen-facing public-service model, especially in developing-country contexts [5, 25, 26]. Recent Thai evidence further shows that facilitating conditions can be a major driver of adoption in infrastructure-intensive smart-service settings, raising a context-sensitive question: does external support remain dominant when the task is an individual online government procedure, or do personal capability and confidence become more important? The present study addresses these gaps by integrating material access, digital capability, service support, and user confidence within one model; testing that model in a mandatory or semi-mandatory public-service context; and translating the empirical pattern into implications for inclusive service design. Because sustainability outcomes are not measured directly, sustainable public-service delivery is treated as an implication of accessible, resilient, and resource-efficient digital provision rather than as an observed dependent variable.

Accordingly, the study addresses two research questions: RQ1: To what extent are technology access, digital literacy, facilitating conditions, and technology self-efficacy associated with reported use of the online driver's license renewal training service? RQ2: Which of these factors retains the strongest unique association with use when the predictors are considered simultaneously? These questions complement the four directional hypotheses developed below.

2. Literature Review and Hypothesis Development

2.1. Digital Public Services and E-Learning System Use

Moving a government service online can lower travel requirements, waiting times, and administrative workload, but these advantages are realized only when citizens can enter, navigate, and complete the digital process [2, 26, 27]. In e-learning research, continued participation has been associated with device and internet access, digital competence, support conditions, self-efficacy, and institutional readiness [16, 22, 24, 28]. For a public service, these factors are also questions of inclusion because users with different levels of digital readiness should still be able to obtain comparable service benefits [5]. Accordingly, the framework evaluates four candidate predictors of renewal-training use: access to technology, digital literacy, facilitating conditions, and technology self-efficacy.

The conceptual model integrates complementary perspectives rather than treating technology acceptance as a single attitudinal process. Digital divide and inclusion research emphasizes whether citizens possess meaningful access and the capability to derive practical benefit from technology [11-14, 26]. UTAUT highlights the enabling role of facilitating conditions [20], while technology self-efficacy

captures the confidence needed to persist with unfamiliar digital tasks [21]. In the present framework, access represents material opportunity, digital literacy represents practical capability, facilitating conditions represent the enabling service environment, and self-efficacy represents personal agency and confidence. Estimating these factors together helps distinguish whether variation in use is associated primarily with infrastructure, skills, support, or confidence.

2.2. Access to Technology and E-Learning System Use

For this study, access to technology refers to having a suitable device, dependable connectivity, and the basic resources required to complete the online training process. Limited access can prevent entry to the platform, interrupt completion, or make the digital option less workable than an in-person alternative. Research on e-learning indicates that adequate devices and stable internet connections facilitate participation and can improve perceptions of convenience and usefulness [29]. Because government users vary in their socioeconomic and educational circumstances, practical access is a necessary foundation for avoiding exclusion from an online public service.

This reasoning leads to the first hypothesis:

H₁: Better access to technology is associated with greater use of the online driver's license renewal training system.

2.3. Digital Literacy and E-Learning System Use

Digital literacy concerns the practical capacity to find, interpret, evaluate, and apply information through digital tools. Within the renewal-training platform, this capacity includes following on-screen instructions, moving through the interface, handling routine technical difficulties, and engaging appropriately with learning materials [27]. Citizens who can perform these tasks with less difficulty should be more able to complete the online requirement without outside assistance.

H₂: Higher digital literacy is associated with greater use of the online driver's license renewal training system.

2.4. Facilitating Conditions and E-Learning System Use

Facilitating conditions represent the practical support surrounding system use. In the present context, they include platform stability, understandable instructions, assistance channels, user guidance, and help with technical difficulties. These resources matter in a citizen-facing service because users cannot be assumed to share the same familiarity with online learning. Earlier studies have found that the availability of support and enabling conditions is related to intention and continued use of e-learning platforms [30, 31].

When help is easy to locate and the service operates reliably, users can address problems before those problems cause them to abandon the process. In a government setting, visible and responsive support may also improve confidence in the digital service itself.

The third hypothesis is therefore stated as follows:

H₃: Stronger facilitating conditions are associated with greater use of the online driver's license renewal training system.

2.5. Technology Self-Efficacy and E-Learning System Use

Technology self-efficacy refers to confidence in one's ability to carry out tasks using digital technology. A confident user is more likely to explore an unfamiliar function, persist after a minor problem, and finish a digital task without assistance. Conversely, low confidence can limit effective use even when the necessary device, connection, and platform are available.

Evidence from online learning links self-efficacy with engagement and effective participation [24, 32]. It has also been associated with continued use because confident users tend to approach unfamiliar functions with fewer perceived barriers and greater willingness to persist [33, 34]. In driver's license renewal training, this confidence may determine whether a citizen can locate content, follow the required steps, and complete the online session independently.

On this basis, the final hypothesis is:

H₄: Higher technology self-efficacy is associated with greater use of the online driver's-license renewal training system.

Figure 1 presents the proposed model. It treats technology access, digital literacy, facilitating conditions, and technology self-efficacy as four separate predictors of citizens' use of the online renewal-training service.

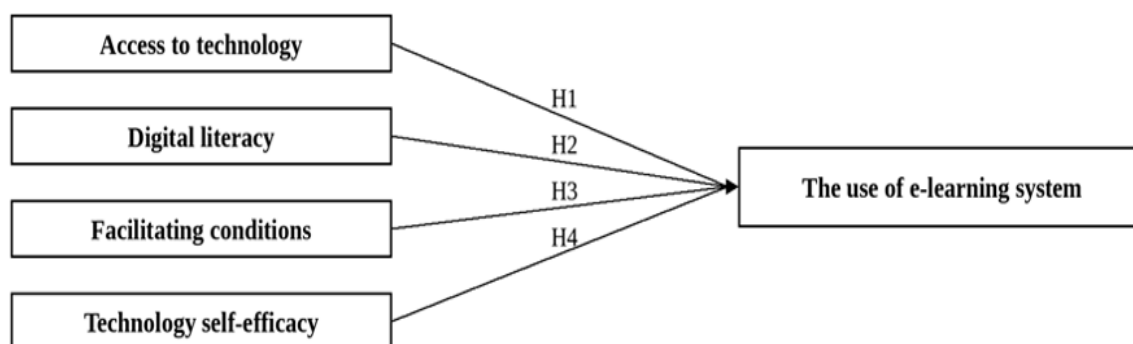


Figure 1.
Conceptual framework of the study.

3. Methodology

3.1. Research Design

The study used a quantitative cross-sectional design to estimate the relationships specified in the conceptual model. Four explanatory variables were examined: access to technology, digital literacy, facilitating conditions, and technology self-efficacy, and system use served as the outcome variable.

Questionnaire measures were developed from the theoretical and empirical literature reviewed above and adapted to the driver's license renewal setting. Responses from people with prior experience of the online training service were then summarized and tested using descriptive statistics, Pearson correlation coefficients, and multiple regression.

3.2. Population and Sample

The population of interest was made up of people in Thailand who had already used or completed the Department of Land Transport's online training for driver's license renewal. The analysis therefore focused on the individual citizen as an experienced user of the service.

A total of 320 complete questionnaires were retained for analysis. Participants were recruited through convenience sampling because eligibility required direct experience with the specific service during the study period. This approach enabled access to the relevant user group, but it does not provide the representativeness that probability-based sampling offers.

3.3. Research Instrument

Information was obtained through a structured questionnaire tailored to the renewal-training context. The items covered five constructs: technology access, digital literacy, facilitating conditions, technology self-efficacy, and use of the e-learning service.

Responses were recorded on a five-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). A Likert-type format was used because it provides a practical way to quantify attitudes and perceptions in social and behavioral research [35].

3.4. Validity and Reliability

Before the main survey, three experts assessed the questionnaire for content relevance, clarity, and coverage of the intended constructs. Their comments were used to revise the wording and improve the instrument prior to pilot testing.

The revised questionnaire was piloted with 30 users of the e-learning platform. Reliability was assessed with Cronbach's alpha, which yielded an overall value of 0.949. This level indicates very strong internal consistency and is well above the commonly used 0.70 criterion [36, 37].

3.5. Data Collection

Only respondents who reported previous use of the online renewal-training service were invited to complete the questionnaire, and incomplete forms were not included. The resulting dataset contained 320 usable cases. Participation was voluntary; no personally identifiable information was reported, and analysis was conducted at an aggregate level. The protocol was reviewed by the Research Ethics Committee of King Mongkut's Institute of Technology Ladkrabang and received an exemption determination (Study Code: EC-KMITL-69150); no continuing review was required.

3.6. Data Analysis

Analysis began with frequencies, percentages, means, and standard deviations, followed by Pearson correlations to evaluate the direction and magnitude of pairwise associations among the study constructs. The correlation matrix was also examined for potentially problematic overlap among predictors before multivariable analysis.

Multiple regression was then used to estimate the unique association of each predictor with system use while the remaining predictors were held constant. In addition to the omnibus F test, R^2 , adjusted R^2 , standardized coefficients, and root mean squared error (RMSE) were used to describe model performance. To improve interpretation beyond statistical significance, 95% confidence intervals for unstandardized coefficients and squared semi-partial correlations (sr^2) were calculated from the reported regression output, and tolerance and variance inflation factor (VIF) statistics were derived from the predictor correlation matrix. Conventional collinearity criteria described in guidance on multivariate analysis were used as diagnostic benchmarks [37]. Statistical significance was evaluated at $\alpha = .05$; p-values reported as .000 by the software were expressed as $p < .001$. Given the cross-sectional design, regression coefficients were interpreted as adjusted associations rather than causal effects.

4. Results

4.1. Respondent Profile

The analysis included 320 citizens with prior experience with the Department of Land Transport's online renewal-training system. Table 1 summarizes their demographic characteristics.

Of the respondents, 172 were women (53.75%), compared with 148 men (46.25%). The largest age group was 21-30 years (35.63%), followed by 31-40 years (25.00%), 41 years or older (24.06%), and 18-20 years (15.31%). Most participants held a bachelor's degree (62.50%); 23.44% had an education above the bachelor's level, and 14.06% had lower qualifications.

Table 1.
Profile of survey respondents.

Variable	Category	Frequency	Percentage
Gender	Male	148	46.25
	Female	172	53.75
Age	18–20 years	49	15.31
	21–30 years	114	35.63
	31–40 years	80	25.00
	41 years and above	77	24.06
Education level	Below bachelor's degree	45	14.06
	Bachelor's degree	200	62.50
	Higher than bachelor's degree	75	23.44

4.2. Descriptive Statistics and Correlation Analysis

Table 2 reports the distribution of the five study constructs together with their bivariate correlations. The mean system-use score was 3.92 (SD = 1.22). Technology self-efficacy produced the highest mean among the predictors (M = 3.94, SD = 1.23), followed closely by digital literacy (M = 3.93, SD = 1.19), access to technology (M = 3.92, SD = 1.22), and facilitating conditions (M = 3.90, SD = 1.17). The narrow range of means indicates that respondents rated all four enabling conditions relatively highly.

All pairwise correlations were positive and statistically significant, with coefficients ranging from 0.357 to 0.578. The strongest bivariate association with system use was observed for digital literacy ($r = 0.578$), followed by technology self-efficacy ($r = 0.569$), access to technology ($r = 0.514$), and facilitating conditions ($r = 0.497$). Correlations among the four predictors ranged from 0.357 to 0.540, indicating that the constructs were related but not redundant. No predictor pair approached a very high bivariate correlation, supporting their simultaneous entry into the regression model; formal collinearity diagnostics are reported below.

Table 2.
Descriptive statistics and correlation matrix.

Variable	Mean	Std. Deviation	UA	TSE	DL	FC	AT
The use of the e-learning system (UA)	3.92	1.22	1.000				
Technology Self-Efficacy (TSE)	3.94	1.23	0.569**	1.000			
Digital literacy (DL)	3.93	1.19	0.578**	0.540**	1.000		
Facilitating conditions (FC)	3.90	1.17	0.497**	0.500**	0.467**	1.000	
Access to Technology (AT)	3.92	1.22	0.514**	0.461**	0.474**	0.357**	1.000

4.3. Regression Analysis

Multiple regression was used to determine whether the four proposed factors contributed independently to variation in the use of the online renewal-training system. Model-level significance was first evaluated using analysis of variance (ANOVA).

The results in Table 3 show that the overall regression was significant, $F[4, 315] = 79.419$, $p < 0.001$. The model explained 50.2% of the observed variance in system use ($R^2 = 0.502$), with an adjusted R^2 of 0.496 and RMSE of 0.869. The small difference between R^2 and adjusted R^2 indicates limited shrinkage after accounting for the four predictors and sample size. The significant omnibus test supported the examination of the individual regression coefficients reported in Table 4.

Table 3.

Analysis of variance for the regression model.

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	240.110	4	60.027	79.419	< 0.001
Residual	238.088	315	0.756		
Total	478.198	319			

Note: a. Dependent Variable: The use of the e-learning system

b. Predictors: (Constant), Access to Technology, digital literacy, facilitating conditions, Technology Self-Efficacy

4.4. Hypothesis Testing

The coefficient estimates in Table 4 show that every proposed predictor retained a positive and statistically significant adjusted association with system use. Consequently, H1 through H4 were supported. The standardized coefficients indicate relative strength within this model, whereas the confidence intervals and unique-variance statistics reported below provide additional information about precision and incremental contribution. Technology access supported H1 ($\beta = 0.206$, $t = 4.374$, $p < 0.001$). Digital literacy supported H2 ($\beta = 0.251$, $t = 4.917$, $p < 0.001$). Facilitating conditions supported H3 ($\beta = 0.164$, $t = 3.433$, $p = 0.001$). Technology self-efficacy supported H4 and had the largest standardized coefficient ($\beta = 0.284$, $t = 5.510$, $p < 0.001$).

The ordering of standardized coefficients was technology self-efficacy, digital literacy, access to technology, and facilitating conditions. Notably, digital literacy had the strongest bivariate correlation with system use ($r = 0.578$), whereas technology self-efficacy had the largest coefficient after the predictors were considered simultaneously ($\beta = 0.284$). This shift suggests that digital literacy and self-efficacy share some explanatory variance, while self-efficacy retains the stronger unique association after adjustment for access, literacy, and facilitating conditions.

Table 4.

Multiple-regression coefficients.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.308	0.212		1.454	0.147
Access to Technology (X ₁)	0.207	0.047	0.206	4.374	<0.001
Digital literacy (X ₂)	0.257	0.052	0.251	4.917	<0.001
Facilitating conditions (X ₃)	0.172	0.050	0.164	3.433	0.001
Technology Self-Efficacy (X ₄)	0.283	0.051	0.284	5.510	<0.001

Note: a. Dependent Variable: The use of the e-learning system

R² = 0.502; adjusted R² = 0.496; RMSE = 0.869; model $p < 0.001$.

4.5. Model Robustness and Unique Contributions

As shown in Table 5, collinearity diagnostics indicated that the regression estimates were not dominated by excessive overlap among predictors. VIF values ranged from 1.41 to 1.68, and tolerance values ranged from 0.595 to 0.710, all within conventional acceptable ranges [37]. The 95% confidence intervals for each predictor's unstandardized coefficient excluded zero. Squared semi-partial correlations further showed that technology self-efficacy accounted for the largest unique increment in explained variance ($sr^2 = 0.048$), followed by digital literacy (0.038), access to technology (0.030), and facilitating conditions (0.019). These sr^2 values represent incremental, not total, importance because the predictors also share explanatory variance.

Table 5.
Regression precision, collinearity diagnostics, and unique contributions.

Predictor	95% CI for B	Tolerance	VIF	sr ²
Access to Technology	[0.115, 0.299]	0.710	1.41	0.030
Digital literacy	[0.155, 0.359]	0.609	1.64	0.038
Facilitating conditions	[0.074, 0.270]	0.689	1.45	0.019
Technology Self-Efficacy	[0.183, 0.383]	0.595	1.68	0.048

Note: Confidence intervals use 95% coverage. Tolerance and VIF were derived from the predictor correlation matrix; sr² values were calculated from the reported t statistics, residual degrees of freedom, and model R².

The fitted unstandardized regression equation was:

$$Y = .308 + .207X_1 + .257X_2 + .172X_3 + .283X_4$$

In the equation, Y denotes system use; X1, X2, X3, and X4 denote access to technology, digital literacy, facilitating conditions, and technology self-efficacy, respectively. Figure 2 visualizes the standardized regression coefficients and their relative magnitudes.

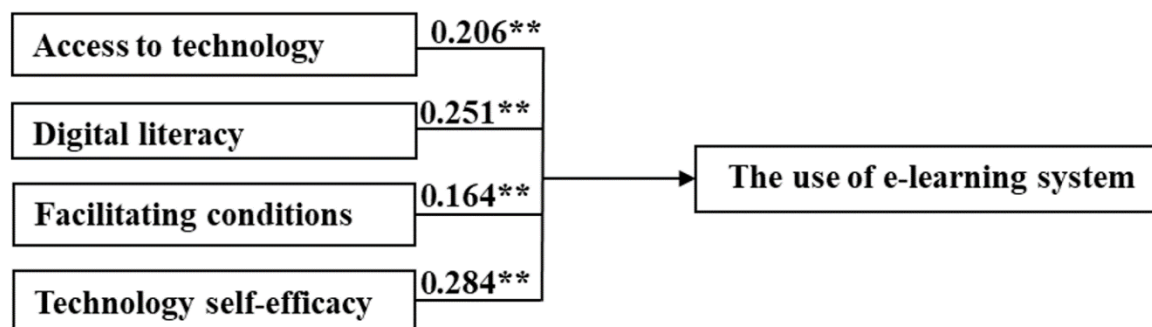


Figure 2.
Standardized regression coefficients in the final model.
Note: Standardized regression coefficients are reported. **p < 0.01.

Figure 2 summarizes the relative size of the standardized regression coefficients. Technology self-efficacy ranked first ($\beta = 0.284$), digital literacy second ($\beta = 0.251$), access to technology third ($\beta = 0.206$), and facilitating conditions fourth ($\beta = 0.164$). The pattern indicates that reported system use is associated with both individual capability and the conditions surrounding access and support rather than with a single technological factor.

Overall, the regression evidence supports all four hypotheses and explains just over half of the measured variation in system use ($R^2 = 0.502$; adjusted $R^2 = 0.496$). The remaining 49.8% of the variance indicates substantial room for additional technological, service-quality, motivational, trust, or behavioral factors. The present model should therefore be viewed as a focused digital-inclusion model rather than a complete theory of public-service technology use.

5. Discussion

5.1. Interpretation of Key Findings

Technology self-efficacy showed the largest adjusted association with system use ($\beta = 0.284$) and the largest unique contribution ($sr^2 = 0.048$). This finding means that confidence in handling digital tasks remained informative even after technology access, digital literacy, and facilitating conditions were considered simultaneously. The result is consistent with research linking self-efficacy to online-learning engagement, strategy use, satisfaction, and continuance intention [24, 32-34], but it adds a public-service interpretation: confidence may influence whether citizens persist through unfamiliar

screens, authentication steps, or minor technical problems until a required administrative learning task is completed. For a citizen-facing service, self-efficacy is therefore not merely a learner characteristic; it can function as an inclusion resource that determines how effectively available infrastructure is converted into successful use.

Digital literacy had the strongest bivariate correlation with system use ($r = 0.578$) but the second-largest adjusted coefficient ($\beta = 0.251$; $sr^2 = 0.038$). This distinction is analytically important. It suggests that part of the simple relationship between literacy and use overlaps with self-efficacy and other enabling conditions, while practical digital competence still contributes independently. Prior research similarly connects digital literacy with effective online learning engagement [24, 27]. In public services, the result sharpens the distinction between availability and usability: a platform can be technically accessible yet remain functionally exclusionary when users cannot interpret instructions, navigate the interface, or recover from routine digital problems.

Access to technology also retained an independent positive association with use ($\beta = 0.206$; $sr^2 = 0.030$), consistent with evidence that suitable devices and reliable connectivity support participation in online learning [29]. This result is noteworthy because every respondent had already used the service at least once. Even within an experienced-user sample, variation in device suitability and connection quality remained associated with reported use. The finding fits the digital-inclusion perspective, which distinguishes meaningful access from the simple existence of an online channel [5, 26]. At the same time, the sampling design limits the conclusion: people who could not access the platform at all were not represented, so the study may underestimate the full importance of access barriers for initial adoption.

Facilitating conditions had the smallest standardized coefficient ($\beta = 0.164$; $sr^2 = 0.019$), but the association remained statistically significant. This supports the enabling role proposed in UTAUT and recent e-learning studies [20, 30, 31]. The comparatively smaller unique coefficient should not be read as evidence that support is unimportant. Platform stability, clear guidance, and reachable assistance may share variance with users' confidence and literacy or may become especially important when a problem occurs. In other words, facilitating conditions may operate as background infrastructure that prevents failure, even when their incremental statistical contribution is smaller than that of individual capability variables.

Taken together, the findings support a layered view of digital inclusion. Access represents the opportunity to reach the service; digital literacy represents the ability to understand and operate it; facilitating conditions represent the support environment; and self-efficacy represents the confidence to persist. The four dimensions are correlated but not interchangeable, and each retains a significant adjusted association with system use. This is the study's central analytical contribution: successful digital public-service delivery appears to depend on the conversion of access into capability, supported by an enabling service environment and sufficient user confidence. The model therefore extends e-learning adoption evidence from conventional educational settings into a citizen-facing regulatory process in which completion has direct administrative consequences.

5.2. Comparison with Recent Thai Technology-Adoption Evidence

Recent Thai technology-adoption evidence provides a useful contrast. It found facilitating conditions to be the strongest direct adoption driver ($\beta = 0.473$) for smart/automated parking systems among SME commuters in Bangkok, whereas facilitating conditions were the smallest significant adjusted coefficient in the present driver's-license e-learning model ($\beta = 0.164$) and technology self-efficacy was the strongest ($\beta = 0.284$). The contrast is theoretically informative rather than contradictory. Smart-parking adoption is infrastructure-intensive and organizationally dependent, so external resources and enabling conditions plausibly carry greater weight. By comparison, completing online renewal training is an individual digital procedure performed through already-available infrastructure, making confidence and practical digital capability more salient. This context dependence cautions against transferring coefficient rankings mechanically across technology-adoption settings and

strengthens the rationale for combining external enabling conditions with individual digital-inclusion variables in public-service research.

5.3. Theoretical Contribution and Sustainability Interpretation

The study makes three theoretical contributions. First, it integrates material access, practical digital literacy, facilitating conditions, and technology self-efficacy within one public-service model, bridging digital-inclusion research with UTAUT-related enabling conditions. Second, it distinguishes bivariate prominence from unique multivariable contribution: digital literacy had the strongest zero-order correlation with use, whereas self-efficacy had the largest adjusted coefficient and squared semi-partial correlation. Third, the comparison with recent Thai adoption evidence indicates that the relative importance of external enabling conditions and individual capability is context-dependent. Together, these findings support a layered socio-technical account of digital public-service use rather than a one-factor explanation. The observed pattern is consistent with a practical interplay between knowing how to perform digital tasks and believing that one can complete them successfully, although the present cross-sectional model did not test mediation or moderation directly.

The sustainability interpretation should also be stated carefully. The study did not measure environmental outcomes, cost savings, travel reduction, administrative workload, or service resilience directly. It therefore does not demonstrate that the e-learning system is sustainable in an outcome sense. Instead, the results identify conditions under which a digital public service is more likely to remain accessible and usable across a heterogeneous population. Such inclusive usability is a prerequisite for realizing potential sustainability benefits such as reduced travel, lower congestion at service offices, continuity during disruptions, and more efficient use of public resources [4–6]. Future research should measure these outcomes explicitly rather than infer them from system use alone.

5.4. Policy Implications

The results translate into several practical directions for agencies that deliver mandatory or high-volume services online. Because the four predictors jointly explain 50.2% of system-use variance and share explanatory variance, implementation should not focus only on the single largest coefficient. First, the interface should be designed for people with different levels of education, digital experience, and familiarity with government platforms. Accessibility, plain-language instructions, predictable navigation, and clear error recovery should be treated as core service-quality requirements rather than optional design features.

Second, the service should remain usable across common devices and varying connection quality. Mobile optimization is particularly relevant because smartphones are a major route to online services, and mobile access can increase the reach and perceived value of digital public services [25, 29]. Registration, login, learning, and completion steps should be kept as simple as the regulatory process permits.

Third, agencies can reduce skill-related barriers by providing concise guidance at the point of need. Short videos, illustrated instructions, frequently asked questions, and stepwise prompts can help users complete the process without requiring advanced digital knowledge. Future usability testing should specifically examine older adults, first-time users, and citizens with lower digital readiness rather than assuming that the same interface performs equally well for all demographic groups.

Fourth, support should be available through more than one channel. A combination of help desk services, telephone assistance, automated chat support, and trained frontline staff would give users options when technical problems arise. Rapid assistance can prevent small difficulties from becoming reasons to abandon the digital process.

Finally, the service should be designed to strengthen users' sense of competence. Clear feedback, visible progress, predictable navigation, and understandable learning materials can make successful completion more likely and may increase confidence for future digital interactions. Because technology

self-efficacy produced the largest coefficient in this study, confidence-building features deserve particular attention in sustainable and inclusive service design [13, 26].

6. Limitations and Future Research

The findings should be interpreted within several boundaries. First, the research examined one specific Department of Land Transport service in Thailand. Relationships observed in this setting may not transfer directly to other agencies, regulatory tasks, or populations with different service characteristics.

Second, all measurements were collected at one point in time. The cross-sectional design identifies adjusted associations but cannot establish temporal order or causality. Longitudinal or repeated-measures studies could test whether changes in access, literacy, support, or self-efficacy precede changes in actual service use as users gain experience or as the platform evolves.

Third, respondents were recruited through convenience sampling, and eligibility required previous use of the online training system. The sample therefore represents experienced users rather than the full population of renewal applicants. Citizens who were unable or unwilling to initiate the digital process, potentially those facing the greatest access or literacy barriers, were not observed. Future research should include non-users and unsuccessful users and apply probability-based or stratified sampling across regions, age groups, and levels of digital readiness.

Fourth, the predictors and outcome were measured through the same self-report questionnaire at the same time. Recall, interpretation, social desirability tendencies, and common-method variance may therefore inflate observed relationships.

Future studies should combine survey measures with platform logs, objective completion records, help-desk data, interviews, or focus groups and, where possible, separate predictor and outcome measurements by time or source.

Fifth, reliability was reported as an overall Cronbach's alpha for the questionnaire rather than as construct-specific reliability estimates within a full measurement model.

Future studies should report reliability for each construct and evaluate convergent and discriminant validity using confirmatory factor analysis or an appropriate structural equation framework before estimating structural relationships.

The model can also be expanded to include perceived usefulness, ease of use, system and information quality, trust in digital government, security and privacy concerns, satisfaction, and service quality. Cross-agency and cross-country comparisons, as well as tests of mediation or moderation, could clarify which mechanisms are context-specific and which are general features of inclusive digital public-service delivery.

7. Conclusion

This study examined four dimensions of digital inclusion associated with reported use of Thailand's online driver's license renewal training. All four factors remained significant in the multivariable model, which explained 50.2% of the variance in system use.

Technology self-efficacy showed the largest adjusted coefficient and unique contribution, while digital literacy showed the strongest bivariate correlation. Access to technology and facilitating conditions also retained independent associations. The combined pattern indicates that online availability alone does not constitute inclusive service delivery; citizens must also be able to access the platform reliably, understand how to use it, obtain support when needed, and feel confident that they can complete the process.

For public agencies, the implication is to design digital services as socio-technical systems rather than as websites alone. Investment in mobile-compatible access, clear guidance, user support, digital-skill scaffolding, and confidence-building interface features can improve the conditions under which citizens use mandatory online services.

These findings inform the inclusive-delivery dimension of sustainability, but they do not directly measure sustainability outcomes. More representative studies, including non-users, longitudinal evidence, objective usage logs, construct-level measurement validation, and direct measures of cost, travel, workload, and service resilience are needed before broader causal or sustainability claims can be made.

Abbreviations:

ANOVA, analysis of variance; AT, access to technology; DL, digital literacy; FC, facilitating conditions; TSE, technology self-efficacy; UA, e-learning system use.

Institutional Review Board Statement:

The Research Ethics Committee of King Mongkut's Institute of Technology Ladkrabang reviewed the study and issued an exemption determination (Study Code: EC-KMITL-69150). No continuing review was required.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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