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From Broadband Access to Continuance: Quality of Experience, Satisfaction, and Perceived Value in Malaysian Public Higher Education

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ABSTRACT

As higher education becomes increasingly digital, broadband availability alone provides limited insight into whether connectivity adequately supports academic and administrative activities. This study examines how broadband usage conditions shape users' quality of experience (QOE) and how QOE relates to satisfaction, perceived value, broadband service preference, and continuance intention in Malaysian public higher education institutions. Drawing on Task–Technology Fit theory and the Expectation-Confirmation Model, data were collected over three months using online and paper-based surveys, yielding 461 usable responses from 480 submissions. QOE was modeled as a reflective–formative higher-order construct comprising coverage, service performance quality, reliability, and usability and assessed using PLS-SEM. Primary usage location and broadband type showed selective but small associations with QOE. QOE positively predicted satisfaction, perceived value, and service preference but had no significant direct effect on continuance intention. Digital literacy positively predicted service preference, although preference did not significantly predict continuance. Instead, satisfaction and perceived value were the strongest antecedents of continuance intention. The model explained 43.1% of the variance in continuance intention, highlighting the importance of managing broadband as an experienced rather than merely available infrastructure.

Keywords: Broadband quality of experience; Continuance intention; User satisfaction; Perceived value; Public higher education

INTRODUCTION

Malaysia's broadband challenge is increasingly less about whether people are connected and more about what users can actually do with that connection. In 2024, Internet use reached 98.0% of individuals and 96.8% of households, suggesting that the conventional access gap has narrowed substantially. Yet household Internet access remained lower in rural areas (90.3%) than in urban areas (98.8%), while penetration statistics reveal little about whether connections are consistently fast, stable, reliable, and usable during actual use (Department of Statistics Malaysia [DOSM], 2025). This distinction reflects a broader shift in digital-divide research from inequalities in access toward differences in capabilities, quality of use, and outcomes after access has been obtained (Mirazchiyski, 2025). High broadband penetration, therefore, does not necessarily imply an equally satisfactory connectivity experience.

This distinction is particularly consequential in higher education. Malaysia's *Digitalisation of Higher Education Policy 2025–2030* positions digital infrastructure, institutional readiness, digital competencies, and technology-enabled education as central to higher-education transformation while simultaneously acknowledging persistent infrastructure and capability gaps (Ministry of Higher Education [MOHE], 2025). Learning-management systems, online assessments, video conferencing, cloud applications, digital libraries, research databases, and administrative platforms may appear to represent separate innovations, but their functioning ultimately depends on reliable connectivity. Digital infrastructure has similarly been identified as a foundational condition for technology-enabled higher education, with disparities persisting even as institutional digitalisation expands

(Vishnu et al., 2024). Thus, universities may invest extensively in digital platforms while the educational value of those investments remains constrained by the broadband infrastructure through which users access them.

The problem is that broadband availability and broadband adequacy are not equivalent. A connection may technically exist while being unsuitable for the task it is expected to support. High nominal speed offers limited benefit if video conferences repeatedly disconnect; extensive campus coverage is inadequate when lecture theatres or hostels contain unstable zones; and technically capable infrastructure may still generate poor experiences when authentication or troubleshooting is difficult. Recent higher-education evidence reinforces this distinction. Skinner et al. (2024) identified meaningful variation in broadband access among undergraduate populations, while Michikyan et al. (2025) showed that even broadly connected students differ in access to fast and reliable Internet, with connectivity relating differently to educational engagement and motivation. The relevant issue is therefore no longer captured adequately by a binary distinction between having and not having broadband, but by the quality of experience (QoE) generated during use.

QoE becomes especially complex in public higher educational institutions (PHEIs), where connectivity is consumed under heterogeneous spatial and technological conditions. Students, faculty, and administrators move between lecture theatres, libraries, administrative buildings, cafeterias, hostels, and off-campus accommodation while relying on public Wi-Fi, fixed broadband, or mobile broadband. These environments differ in congestion, coverage, mobility, capacity, and network stability. The continued use of the Broadband Quality of Experience Survey by the Malaysian Communications and Multimedia Commission (MCMC, 2025) further reflects the policy relevance of evaluating broadband through experienced quality rather than penetration alone. Yet existing broadband research remains fragmented across access, technical performance, service quality, satisfaction, and technology choice. Such fragmentation makes it difficult to explain why technically available connectivity may still generate markedly different user experiences across locations and service types.

This problem also challenges conventional interpretations of digital inequality. Recent research increasingly rejects the assumption that physical access eliminates the digital divide because inequalities can persist through connectivity quality, skills, engagement, and users' capacity to exploit digital resources (Michikyan et al., 2025; Mirazchiyski, 2025). Broadband experience is therefore not exclusively a network property. Digital literacy may affect users' ability to configure connections, troubleshoot routine difficulties, compare service options, and exploit the capabilities of different broadband technologies. Likewise, the location and type of broadband service alter the conditions under which connectivity is experienced. Considering these elements separately can obscure the more consequential question of why broadly available digital infrastructure produces different experiences for different users and usage settings.

A further conceptual issue concerns the behavioral outcome. Broadband research has often emphasized adoption; however, adoption is temporally inappropriate when respondents are already experienced users who can evaluate service quality, reliability, usability, satisfaction, and value. Adoption logically precedes such accumulated post-use evaluations rather than resulting from them. The Expectation-Confirmation Model (ECM) distinguishes initial acceptance from post-adoption continuance by explaining how evaluations formed through prior use shape satisfaction and subsequent continuance intention (Bhattacherjee, 2001). Contemporary evidence likewise identifies satisfaction as a key determinant of continued use of established digital services (Vafaei-Zadeh et al., 2024). Accordingly, for existing broadband users in public higher education institutions (PHEIs), continuance intention is a more theoretically appropriate behavioral outcome than adoption.

ECM, however, is better suited to explaining how accumulated experience translates into post-use evaluations and continuance than to explaining why broadband experiences vary across users and settings. Task–Technology Fit (TTF) theory provides a useful contextual rationale for this upstream variation by suggesting that technology-related outcomes depend on the alignment between technological capabilities, individual requirements, and the tasks being performed (Goodhue & Thompson, 1995). This logic is especially relevant to broadband use because synchronous lectures, video conferencing, large-file uploads, learning-management-system access, research-database use, administrative tasks, and routine web browsing impose different demands on capacity, reliability, latency, mobility, and coverage. Likewise, institutional Wi-Fi, mobile broadband, and fixed broadband do not provide identical combinations of these capabilities across lecture theatres, hostels, administrative buildings, common spaces, and off-campus accommodation.

The present study, however, uses TTF as a contextual lens rather than as a complete empirical test of task–technology fit. Primary usage location and broadband service type represent observable conditions under which broadband experience develops, but they are not direct measures of task characteristics, technology characteristics, or perceived fit. Thus, the study does not claim to estimate the full TTF mechanism. Instead, it examines whether broad spatial and service-use conditions are associated with variations in broadband Quality of Experience (QoE), while ECM explains how accumulated QoE is translated into satisfaction, perceived value, service preference, and continuance intention.

Broadband QoE is therefore conceptualized as users' combined experience of coverage, service performance quality, reliability, and usability, rather than as a single technical indicator. Usage location and broadband type provide broad contextual conditions that may shape this experience, while digital literacy and demographic characteristics may help explain heterogeneity in service preference. The model consequently distinguishes between the contextual formation of QoE and its post-use consequences. The central problem is not simply whether broadband access exists, but why users in an increasingly connected higher-education system experience connectivity differently and how those experiences are subsequently evaluated as satisfactory, valuable, and worth continuing.

LITERATURE REVIEW

Broadband Quality of Experience as a Context-Dependent Post-Use Evaluation

Digital higher education increasingly depends on connectivity that is not merely available but sufficiently stable, responsive, and usable for technology-mediated academic activities. Recent evidence shows that weaknesses in digital infrastructure continue to constrain effective online participation even where access is nominally available (Vishnu et al., 2024). This distinction is particularly relevant to PHEIs because broadband is experienced across heterogeneous settings—lecture spaces, hostels, administrative areas, common spaces, and off-campus locations—where congestion, mobility, coverage, and network capacity differ. Accordingly, recent PHEI research conceptualizes broadband QOE through coverage, service quality, reliability, and usability rather than treating connectivity or speed as sufficient indicators of user experience (Che Sobry et al., 2024).

The resulting experience is unlikely to be uniform across either locations or access technologies. This heterogeneity is consistent with Task–Technology Fit (TTF), which argues that technological outcomes depend on how well technological capabilities correspond to the requirements surrounding their use (Goodhue & Thompson, 1995). More recent higher-education applications similarly show that technology effectiveness varies with the fit among technological characteristics, user requirements, and learning tasks rather than technology availability alone (Liu et al., 2023; Al-Mamary et al., 2024). Broadband has received considerably less attention from this perspective than learning platforms or educational applications. Yet the same logic is pertinent: institutional Wi-Fi, mobile broadband, and fixed broadband provide different combinations of mobility, stability, capacity, and accessibility, while digitally intensive activities impose unequal connectivity demands. TTF therefore provides a bounded contextual explanation for why broadband type, usage location, and users' digital capability may be associated with different QOE and service evaluations; it is used here as a contextual lens rather than as a complete test of task–technology fit because task characteristics and perceived fit are not directly modeled.

Explaining how QOE is formed, however, does not explain whether users maintain a broadband service. Telecommunications research increasingly shows that favorable service experiences influence subsequent behavior through users' evaluations rather than through technical performance alone. Ribeiro et al. (2024), for example, demonstrate that telecommunications customer experience is closely connected with satisfaction and switching responses, while Jo (2024) shows that accumulated mobile-telecommunication experiences shape satisfaction and subsequently continuance intention. This distinction is particularly important for existing broadband users because continuance is conceptually different from initial adoption. Once a technology has been used, users evaluate whether accumulated performance remains satisfactory and sufficiently beneficial to justify continued use.

This downstream process corresponds with the Expectation-Confirmation Model (ECM), in which post-use satisfaction provides a proximal basis for continuance rather than assuming that favorable technology characteristics directly sustain behavior (Bhattacherjee, 2001). Recent ECM applications continue to show that satisfaction is central to continuance across established digital services, although its antecedents and accompanying evaluations vary by context (Vafaei-Zadeh et al., 2024; Khahar et al., 2025). Perceived value adds a distinct evaluative consideration because users may regard broadband as technically satisfactory yet question whether its benefits justify monetary and non-monetary sacrifices. Service preference is similarly distinguishable from continuance: preferring one broadband option relative to alternatives does not necessarily imply an intention to remain with it when cost, availability, switching constraints, or competing services are considered.

The literature therefore suggests a two-stage explanatory sequence. Upstream, broadband type, location, and user capability provide contextual conditions under which QOE is formed, consistent with TTF reasoning. Downstream, QOE informs satisfaction, perceived value, and service preference, while continuance depends more proximally on users' post-use evaluations, consistent with ECM. This separation avoids treating infrastructure quality and continued use as the same phenomenon and provides the theoretical basis for examining why apparently adequate broadband may generate heterogeneous experiences and why favorable QOE may not necessarily translate directly into continued use.

Theoretical Underpinning

This study integrates Task–Technology Fit (TTF) theory and the Expectation-Confirmation Model (ECM) to explain two theoretically distinct stages of broadband use in public higher educational institutions (PHEIs). TTF-informed reasoning motivates attention to the contextual conditions under which broadband experiences may differ, whereas ECM explains how accumulated experience is translated into satisfaction and continuance intention. This distinction is important because technology outcomes are shaped not only by favorable perceptions of a technology but also by the extent to which technological capabilities are suited to the requirements surrounding its use (Goodhue & Thompson, 1995; Howard & Hair, 2023). Likewise, once users have accumulated experience, continued use is conceptually distinct from initial acceptance and is more appropriately explained through post-use evaluations such as satisfaction (Bhattacherjee, 2001; Islam et al., 2017). Accordingly, the study uses TTF to provide a contextual rationale for heterogeneous broadband experience and ECM to explain the post-use evaluative processes associated with continuance intention.

TTF proposes that technological benefits depend on the correspondence among technology characteristics, task requirements, and individual characteristics, rather than on technology availability alone (Goodhue & Thompson, 1995). This logic is particularly relevant to broadband because connectivity is enabling infrastructure whose adequacy depends on users' actual requirements. Synchronous conferencing, large-file transfer, learning-management-system access, online assessment, administrative activities, and routine browsing do not impose identical requirements for network capacity, reliability, mobility, latency, or coverage. Consequently, the same broadband service may produce different user experiences across settings and activities. Higher-education research supports this broader conditionality: TTF has been associated with learning performance under differing residential and technological conditions (Elçi & Abubakar, 2021), while task and technology characteristics have been linked to fit and technology readiness among educators (Almusawi & Durugbo, 2024). Digital competence has also been positioned as an individual condition that may shape the relationship between educational tasks and technology use (Hizam et al., 2021).

In the present study, however, TTF is used as a contextual lens rather than as a complete empirical test of task–technology fit. The model does not estimate task characteristics, technology characteristics, or perceived task–technology fit as latent constructs. Instead, primary usage location and broadband service type are treated as observable contextual conditions under which broadband QoE may develop. Public Wi-Fi, mobile broadband, and fixed broadband provide different combinations of mobility, stability, accessibility, and capacity; similarly, lecture theatres, hostels, administrative facilities, common areas, and off-campus settings expose users to different coverage, congestion, and usage conditions. Digital literacy represents an additional user-side condition because users' ability to configure, troubleshoot, and effectively exploit connectivity may shape how they evaluate broadband services and develop service preferences.

This positioning does not imply that usage location, broadband type, and digital literacy are direct substitutes for the complete TTF construct domain. Rather, they provide a theoretically informed way to examine broad conditions that may be associated with heterogeneous broadband QoE. Recent TTF applications in higher education have largely concentrated on identifiable educational technologies, including virtual learning environments, wearable technologies, and emerging digital applications (Hizam et al., 2021; Almusawi & Durugbo, 2024; Al-Mamary et al., 2024).

The present study extends attention to the infrastructural layer that enables these applications. Its theoretical concern is therefore not simply whether broadband is available, but whether differing connectivity arrangements are associated with variations in users' experienced coverage, performance, reliability, and usability. Direct measurement of academic and administrative task requirements, as well as perceived task–technology fit, remains an important direction for future research.

TTF-informed contextual reasoning alone does not explain why favorable broadband experience should lead to continued use after users have already adopted a service. ECM addresses this downstream issue by distinguishing initial technology acceptance from post-adoption continuance (Bhattacherjee, 2001). Within ECM, prior use generates evaluations that influence satisfaction, and satisfaction becomes a proximal determinant of continuance intention. Subsequent research has strengthened this logic by showing that post-use characteristics, including usability, can contribute to satisfaction and continuance (Islam et al., 2017).

More recent educational studies similarly indicate that confirmation and favorable post-use evaluations enhance satisfaction and continued technology use across MOOCs, cloud-based learning, and immersive learning environments (Cheng, 2023; Di Natale et al., 2024). A meta-analysis of 219 studies also identified satisfaction as one of the strongest correlates of learners' continuance intention, supporting the robustness of the post-adoption mechanism across digital-learning contexts (Dai et al., 2024).

ECM therefore provides a stronger basis than TAM for the present study's behavioral endpoint. Respondents are not considering whether to use broadband for the first time; they already possess prior usage experience from which satisfaction, value judgments, and future-use intentions can be formed. Accordingly, continuance intention, rather than adoption, is the theoretically appropriate dependent variable. QoE extends the standard ECM logic by representing the accumulated experienced performance of broadband through coverage, service quality, reliability, and usability.

This extension is consistent with evidence showing that specific quality evaluations can operate upstream of satisfaction in continuance models (Cheng, 2023), as well as evidence that usability remains consequential after initial acceptance (Islam et al., 2017). QoE is therefore not treated as a generic technology-acceptance belief, but as the experienced service assessment from which users form post-use judgments.

The model further incorporates perceived value and service preference as complementary evaluative routes rather than as separate theoretical frameworks. Satisfaction captures users' overall post-use response; perceived value captures whether experiential benefits justify monetary and non-monetary sacrifices; and service preference reflects the relative attractiveness of the focal broadband service compared with feasible alternatives. These evaluations recognize that continuance may be associated with satisfaction, perceived value, or comparative preference.

The model thus preserves a parsimonious division of explanatory roles: TTF-informed reasoning motivates the inclusion of broad usage-context variables associated with QoE, while ECM explains how accumulated QoE is linked to satisfaction, perceived value, and continuance intention. Prior work suggests that fit-oriented and continuance-oriented perspectives can be used complementarily in technology-use settings (Cheng, 2022), provided that the study does not overstate contextual proxies as a direct empirical test of task–technology fit.

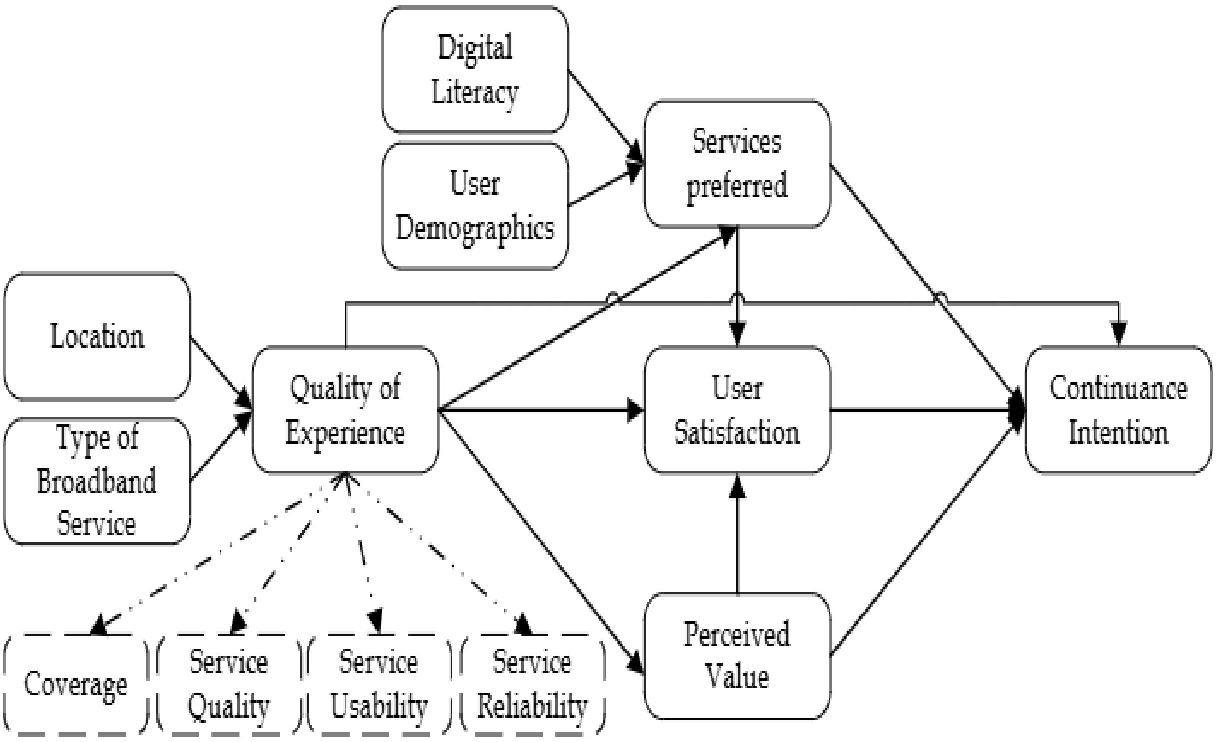

Figure 1: Research model.

Hypothesis Development

Contextual Determinants of Broadband Quality of Experience

Broadband quality of experience (QoE) is shaped not only by the technical characteristics of a service but also by the conditions under which that service is used. Usage location can alter signal strength, network congestion, infrastructure availability, and coverage consistency, meaning that the same broadband arrangement may generate different experiences across physical settings. Prior research documents substantial spatial variation in broadband accessibility and network performance, indicating that connectivity quality cannot be inferred from service availability alone (Adarsh et al., 2021; Schwind et al., 2019; Zahnd et al., 2022). Within public higher educational institutions, these differences may be particularly salient because users access broadband across lecture theatres, hostels, administrative buildings, common areas, and off-campus accommodation, each of which presents different connectivity demands and constraints.

Broadband service type may create further variation in QoE. Institutional Wi-Fi, mobile broadband, and fixed broadband differ in mobility, network capacity, stability, accessibility, and susceptibility to congestion or disruption. Although bandwidth and nominal speed contribute to service performance, users' experienced quality also depends on whether a connection remains sufficiently reliable and usable under actual usage conditions (Flamm & Varas, 2022; Junaidi, 2021; Massarczyk & Winzer, 2020). Usage location and broadband type are therefore treated as contextual antecedents of QoE rather than as direct proxies for broadband quality.

- **H1a:** Primary broadband usage location is significantly associated with broadband quality of experience.
- **H1b:** Broadband service type is significantly associated with broadband quality of experience.

Consequences of Broadband Quality of Experience

QoE represents users' accumulated evaluation of broadband through coverage, service performance quality, reliability, and usability. These experienced characteristics should influence how users subsequently evaluate the service. When connectivity is consistently available, sufficiently fast, reliable, and easy to use, users are more likely to judge the service favorably; conversely, interruptions, unstable coverage, and performance deficiencies can undermine post-use evaluations. Previous broadband research similarly associates network and service quality with user satisfaction (Li et al., 2019; Schwind et al., 2019; Thu & Hue, 2022). Accordingly, favorable QoE should increase satisfaction with the focal broadband service.

QoE may also influence continuance intention. Existing users form future-use judgments from accumulated service experience rather than from expectations preceding adoption. Consistent with the post-adoption logic of the Expectation-Confirmation Model (ECM), favorable experience should therefore provide a basis for maintaining use, although its effect may operate partly through subsequent evaluative judgments such as satisfaction and perceived value.

Beyond satisfaction and continuance, QoE should influence broadband service preference. Service preference is conceptualized here as the relative attractiveness of, and preference for, the focal broadband service compared with available alternatives, rather than as a categorical choice among broadband technologies. Users who experience stronger reliability, coverage, convenience, and performance should be more inclined to regard their focal broadband service as preferable to competing alternatives. Previous studies indicate that broadband preferences are informed by multiple accumulated service attributes rather than by speed or price alone (Malik, 2020; Švigelj & Hrovatin, 2019; Thu & Hue, 2022).

QoE should similarly enhance perceived value. Perceived value reflects whether the benefits received from a broadband service justify its monetary and non-monetary sacrifices. Reliable coverage, satisfactory performance, and ease of use increase the benefits users receive from connectivity and should therefore strengthen perceptions that the service is worthwhile. Prior research likewise connects service quality with stronger customer-value evaluations (Akinlabi & Dahunsi, 2022; Teoh et al., 2022).

- **H2a:** Broadband quality of experience positively influences user satisfaction.
- **H2b:** Broadband quality of experience positively influences continuance intention.
- **H2c:** Broadband quality of experience positively influences broadband service preference.
- **H2d:** Broadband quality of experience positively influences perceived value.

Digital Literacy and Broadband Service Preference

Broadband service preference may also depend on users' capability to understand, evaluate, and interact with digital technologies. Digital literacy encompasses the knowledge, skills, and confidence required to navigate digital environments, troubleshoot routine difficulties, evaluate technological alternatives, and make effective use of available digital services. Users with stronger digital literacy may therefore be better positioned to recognize differences in broadband performance, assess the suitability of available alternatives, and determine which service more effectively meets their connectivity requirements.

Evidence across digital-service settings indicates that digital competence influences how users engage with and evaluate technology-enabled services (Campanozzi et al., 2023; Graupner et al., 2021; Noh & Hong, 2022). In the broadband context, digitally literate users should consequently be better able to form differentiated evaluations of the focal service relative to available alternatives. Digital literacy is therefore expected to strengthen broadband service preference.

H3: Digital literacy positively influences broadband service preference.

Determinants of Continuance Intention

Continuance intention reflects users' willingness to maintain future use of an existing broadband service. Because respondents have prior experience with the service, their continuance decisions should depend on post-use evaluations rather than on initial acceptance beliefs alone. Three evaluations are particularly relevant in the present model: service preference, satisfaction, and perceived value.

Service preference reflects the relative attractiveness of the focal broadband service compared with available alternatives. Users who regard their current broadband service as better suited to their needs should be more inclined to maintain its use, whereas unfavorable comparisons may encourage consideration of competing services. Switching-related research similarly suggests that dissatisfaction with service reliability, performance, or price can increase users' willingness to seek alternatives (Pugh, 2019). A stronger preference for the focal service should therefore support continuance intention.

Satisfaction provides a more direct post-use evaluation. Within ECM, satisfaction represents a central determinant of continuance because users compare accumulated experience with what they expected from the service and form an overall judgment about whether continued use remains desirable. Existing broadband research similarly associates satisfaction with continued usage and favorable behavioral responses (Li et al., 2019; Yazdani et al., 2020). Users who are more satisfied with their broadband experience should therefore exhibit stronger intentions to continue using the service.

Perceived value provides a complementary economic and experiential evaluation. A broadband service may perform adequately but still be unattractive if users believe that its benefits do not justify the monetary cost, time, inconvenience, or other sacrifices associated with obtaining it. Conversely, when users perceive that service quality, reliability, convenience, and other benefits outweigh these sacrifices, continued use becomes more defensible. Prior research identifies perceived value as an important determinant of continued technology and service use (Duy & Ai, 2019; Kok et al., 2022). Thus, preference, satisfaction, and perceived value represent related but distinct bases for maintaining use of an existing broadband service.

- **H4a:** Broadband service preference positively influences continuance intention.
- **H4b:** User satisfaction positively influences continuance intention.
- **H4c:** Perceived value positively influences continuance intention.

METHODOLOGY

Research Design, Population and Sampling

A quantitative cross-sectional survey was conducted among broadband users in Malaysian public higher education institutions (PHEIs). The individual user constituted the unit of analysis because the study examined users' experienced broadband quality, post-use evaluations, and continuance intention. Eligible respondents comprised students, academic staff, and administrative staff who used institutional Wi-Fi, mobile broadband, or fixed broadband for university-related academic, teaching, research, or administrative activities.

To ensure that all subsequent evaluations referred to the same service, respondents were first asked to identify the broadband service they used most frequently for their university-related activities. This service was treated as the focal broadband service throughout the questionnaire. Respondents also identified the location in which they primarily used that service. All subsequent measures of coverage, service performance quality, reliability, usability, satisfaction, perceived value, service preference, and continuance intention were answered with reference to the focal service.

A stratified sampling framework was used to capture variation across the Malaysian public higher-education system. PHEIs were classified into Research Universities, Comprehensive Universities, and Focused Universities according to their institutional missions and characteristics. Respondents were recruited across these institutional categories and across student, academic, and administrative roles to reduce excessive concentration in the substantially larger student population and to capture heterogeneous broadband-use conditions.

An a priori power analysis was conducted using G*Power 3.1 based on the largest regression equation in the structural model. The QoE equation contained six predictors after categorical variables were represented through four primary-location contrasts and two broadband-type contrasts. Assuming a conservative small effect size of $f^2 = .05$, $\alpha = .05$, and statistical power of .95, the minimum required sample was approximately 424 respondents.

Data collection continued for three months using both online and paper-based questionnaires. A total of 480 responses were received. Following data screening, 19 responses were excluded because of completion-related problems, resulting in a final analytical sample of 461 respondents, which exceeded the minimum sample requirement.

Measures

The questionnaire comprised measures of broadband usage conditions, QoE, digital literacy, service preference, perceived value, satisfaction, continuance intention, and respondent characteristics. Broadband quality of experience (QoE) was conceptualized as a higher-order construct comprising coverage, service performance quality, service reliability, and service usability. Coverage was informed by ITU-T Recommendation G.1030, service performance quality by ITU-T P.10/G.100, reliability by IEEE 802.16-2004, and usability by ISO/IEC 25010:2011. The corresponding items captured signal availability and consistency, broadband speed and performance, service interruptions and recovery, and ease of accessing and interacting with the service.

The four QoE dimensions were specified as reflective lower-order constructs that jointly formed the higher-order QoE construct. This specification recognizes that coverage, performance, reliability, and usability represent distinct but complementary aspects of broadband experience rather than interchangeable manifestations of a single dimension (Sarstedt et al., 2019). User satisfaction represented respondents' overall post-use evaluation of the broadband service, consistent with the Expectation-Confirmation Model (Bhattacherjee, 2001). Perceived value captured the trade-off between benefits obtained from the service and the costs or sacrifices associated with its use, consistent with Zeithaml (1988). The value items therefore reflected whether broadband performance, reliability, and overall benefits justified its associated costs. Continuance intention represented respondents' willingness to maintain future use of the broadband service and replaced initial adoption as the behavioral outcome because respondents were already experienced users. Digital literacy captured users' capability and confidence in dealing with digital technologies, while broadband service type, primary usage location, institutional role, age, and gender were recorded independently rather than combined into artificial latent constructs.

Data Screening and Common Method Assessment

The 480 returned questionnaires were screened before model estimation. Nineteen responses were removed because of completion-related problems, leaving 461 observations for the final analysis. The retained data were subsequently examined for missing values, response consistency, unusual response patterns, and potential multicollinearity. Common method bias was assessed using the full-collinearity approach, with variance inflation factor (VIF) values below 3.3 indicating that substantial common method contamination was unlikely (Kock, 2015). This statistical assessment was considered alongside the separation of conceptually distinct constructs within the questionnaire rather than relying on Harman's single-factor test as the primary diagnostic.

Data Analysis

The data were analyzed using SPSS and SmartPLS 4. SPSS was used for preliminary data screening, descriptive analysis, and respondent profiling, whereas partial least squares structural equation modeling (PLS-SEM) was employed to evaluate the measurement and structural models. PLS-SEM was suitable for estimating the hierarchical QoE construct and the network of relationships involving satisfaction, perceived value, service preference, and continuance intention (Hair et al., 2022).

Results

Respondent Profile

Table 1 summarizes the demographic, institutional, and broadband-use characteristics of the 461 respondents retained for analysis. Students represented 65.3% of the sample, while academic staff and administrative staff accounted for 20.8% and 13.9%, respectively. The gender distribution was relatively balanced, with 53.6% male and 45.1% female respondents, while 1.3% preferred not to disclose their gender. The sample was concentrated in the younger age groups, with 41.4% aged 18–24 years and 30.8% aged 25–34 years, although respondents aged 35 years and above remained represented.

Table 1. Respondent characteristics and broadband-use profile

Characteristic	Category	*n*	%
Institutional role	Student	301	65.3
	Academic staff	96	20.8
	Administrative staff	64	13.9
Gender	Male	247	53.6
	Female	208	45.1
	Prefer not to say	6	1.3
Age	18–24 years	191	41.4
	25–34 years	142	30.8
	35–44 years	79	17.1
	≥45 years	49	10.6
PHEI type	Research university	219	47.5
	Comprehensive university	131	28.4
	Focused university	111	24.1
Main broadband type	Institutional Wi-Fi	198	43.0
	Mobile broadband	173	37.5
	Fixed broadband	90	19.5
Primary usage location	Lecture theatre	127	27.5
	Hostel	109	23.6
	Administrative block	83	18.0
	Cafeteria/common area	48	10.4
	Off-site accommodation	94	20.4

Respondents were distributed across all three PHEI categories, with 47.5% from research universities, 28.4% from comprehensive universities, and 24.1% from focused universities. Institutional Wi-Fi was the most frequently identified focal broadband service (43.0%), followed by mobile broadband (37.5%) and fixed broadband (19.5%). Primary usage conditions were similarly heterogeneous: 27.5% primarily used their focal service in lecture theatres, 23.6% in hostels, 20.4% in off-site accommodation, 18.0% in administrative blocks, and 10.4% in cafeteria or common areas. The sample therefore captured users evaluating different broadband technologies under varied institutional and spatial usage conditions rather than a single connectivity environment.

Reflective Measurement Model

The reflective measurement model was assessed through indicator reliability, internal consistency reliability, and convergent validity. As reported in Table 2, indicator loadings ranged from .674 to .892. Although several indicators were slightly below the conventional .708 benchmark, none exhibited critically weak loadings, and the corresponding constructs retained satisfactory reliability and convergent validity. Indicators in the .40–.70 range should not be removed mechanically when their retention preserves construct content and the associated composite reliability and AVE remain adequate (Hair et al., 2019).

Table 2. Reflective measurement model assessment

Construct	Items	Loading range	α	rho_A	CR	AVE
COV	5	.686–.842	.823	.829	.876	.586
SPQ	5	.721–.872	.866	.870	.904	.654
REL	5	.698–.855	.846	.850	.890	.620
USA	5	.674–.831	.812	.819	.870	.573

DL	4	.702–.844	.792	.801	.865	.617
SAT	4	.744–.886	.842	.849	.894	.679
PV	5	.701–.861	.854	.860	.897	.637
SP	4	.688–.842	.776	.785	.856	.599
CI	4	.755–.892	.854	.860	.903	.699

Internal consistency was satisfactory across all constructs. Cronbach's alpha ranged from .776 for SP to .866 for SPQ, while rho_A ranged between .785 and .870 and composite reliability between .856 and .904. These values exceeded the commonly recommended .70 level without approaching excessively high levels that could indicate item redundancy. Convergent validity was also supported, with AVE values ranging from .573 for USA to .699 for CI, all exceeding the .50 criterion. Thus, each construct explained more than half of the variance in its indicators on average (Hair et al., 2019).

Among the QoE dimensions, SPQ showed the strongest overall measurement properties (CR = .904, AVE = .654), whereas USA exhibited comparatively weaker but still satisfactory measurement performance (CR = .870, AVE = .573). The remaining constructs similarly showed adequate reliability and convergence. Collectively, these results supported proceeding to the assessment of the higher-order QOE specification and subsequently the structural model.

Higher-Order QOE Construct

QOE was specified as a reflective–formative higher-order construct, with COV, SPQ, REL, and USA representing distinct dimensions that jointly constitute users' overall broadband experience. Higher-order formative constructs are evaluated primarily through collinearity and the relative and absolute contributions of their lower-order components rather than through conventional internal-consistency measures (Sarstedt et al., 2019).

Table 3. Formative assessment of the higher-order QOE construct

Dimension	Weight	Loading	VIF	t	p	95% CI
COV → QOE	.283	.809	2.06	4.41	<.001	[.157, .405]
SPQ → QOE	.391	.882	2.48	6.23	<.001	[.267, .511]
REL → QOE	.246	.834	2.31	3.79	<.001	[.119, .371]
USA → QOE	.128	.718	1.87	1.72	.086	[−.018, .274]

As shown in Table 3, collinearity was not problematic, with VIF values ranging from 1.87 to 2.48. The formative weights revealed unequal contributions of the four dimensions to QOE. SPQ made the strongest relative contribution ($\beta = .391$, $t = 6.23$, $p < .001$), followed by COV ($\beta = .283$, $t = 4.41$, $p < .001$) and REL ($\beta = .246$, $t = 3.79$, $p < .001$). These findings suggest that users' overall broadband experience was shaped most strongly by perceived service performance, while coverage and reliability also made distinct contributions.

USA showed a smaller formative weight ($\beta = .128$) that did not reach statistical significance at the .05 level ($t = 1.72$, $p = .086$). However, its outer loading remained substantial at .718, indicating meaningful absolute correspondence with QOE. For formative specifications, a non-significant relative weight does not automatically justify removing a component when its absolute contribution remains meaningful and the dimension represents a theoretically distinct aspect of the higher-order construct (Sarstedt et al., 2019). USA was therefore retained as part of QOE. Overall, the higher-order results indicate that QOE was not dominated by a single broadband characteristic. SPQ carried the greatest relative importance, but COV and REL contributed independently, while USA retained substantive relevance despite its weaker relative weight. This pattern supports treating broadband QOE as a multidimensional experience rather than reducing it to network speed or performance alone.

Structural, Explanatory, and Predictive Assessment

The structural model revealed a more differentiated pattern than would be expected from a simple assumption that better access conditions automatically produce better broadband outcomes. As reported in Table 4, primary usage location was only selectively associated with QOE. Relative to lecture theatres, QOE was lower in hostels ($\beta = -.121$, $t = 2.58$, $p = .010$) and cafeteria/common areas ($\beta = -.094$, $t = 2.04$, $p = .041$), whereas administrative blocks ($\beta = .071$, $p = .112$) and off-site accommodation ($\beta = .036$, $p = .411$) showed no significant differences. H1a was therefore partially supported. Broadband type produced a similarly uneven pattern: fixed broadband generated higher QOE than institutional Wi-Fi ($\beta = .114$, $t = 2.43$, $p = .015$), but mobile broadband did not differ significantly ($\beta = .058$, $p = .190$), providing partial support for H1b. These findings are consistent with the emerging view that broadband problems in PHEIs concern the quality experienced under particular conditions rather than access alone. Recent work in the same context has similarly identified coverage, service quality, reliability, and usability as distinct components of broadband experience and highlighted persistent variation in Internet quality among PHEI users (Che Sobry et al., 2024).

Table 4. Structural model and hypothesis testing

Hyp.	Relationship	β	t	p	95% CI	f²
H1a	Hostel → QOE	−.121	2.58	.010	[−.210, −.030]	.013
	Administrative block → QOE	.071	1.59	.112	[−.017, .158]	.004
	Cafeteria/common area → QOE	−.094	2.04	.041	[−.185, −.004]	.008
	Off-site accommodation → QOE	.036	.82	.411	[−.050, .123]	.001
H1b	Fixed broadband → QOE	.114	2.43	.015	[.023, .205]	.012
	Mobile broadband → QOE	.058	1.31	.190	[−.029, .146]	.003
H2a	QOE → SAT	.487	9.68	<.001	[.387, .581]	.310
H2b	QOE → CI	.083	1.88	.060	[−.004, .169]	.009
H2c	QOE → SP	.254	4.73	<.001	[.148, .356]	.068
H2d	QOE → PV	.516	11.22	<.001	[.425, .602]	.362
H3	DL → SP	.231	4.18	<.001	[.123, .339]	.057
H4a	SP → CI	.074	1.66	.097	[−.013, .160]	.006
H4b	SAT → CI	.317	6.11	<.001	[.215, .416]	.082
H4c	PV → CI	.289	5.47	<.001	[.184, .391]	.070

However, the contextual effects were small, with f^2 values not exceeding .013, and primary usage location and broadband service type collectively explained only 10.4% of the variance in QoE ($R^2 = .104$; adjusted $R^2 = .092$). This modest explanatory power is substantively informative. Location and service type help identify where QoE vulnerabilities are more likely to occur—for example, in hostels and cafeteria/common-area settings—but they do not fully explain why users within apparently similar connectivity environments report different experiences. The result indicates that broad spatial categories and access technologies are useful contextual markers, but they are insufficient proxies for the proximal technical, task-related, and user-side determinants of QoE.

This finding should not be interpreted as evidence that contextual conditions are unimportant. Rather, it suggests that the formation of QoE is multi-determined. Users' experiences may additionally depend on actual bandwidth availability, latency, packet loss, peak-time congestion, connection drops, device capability, authentication processes, affordability, task intensity, and the specific academic or administrative activities being performed. Thus, replacing institutional Wi-Fi with another access mode would not necessarily resolve QoE problems if congestion, reliability, usability, device limitations, or task-specific requirements remain unaddressed. The modest upstream R^2 therefore provides a clear rationale for future studies to combine subjective QoE assessments with objective technical-performance indicators and direct measures of task requirements.

The result is also consistent with the bounded role assigned to TTF in this study. TTF-informed reasoning motivates attention to the conditions surrounding actual broadband use, but the present model does not directly estimate task characteristics, technology characteristics, or perceived task–technology fit as latent constructs. Accordingly, location and broadband type should be interpreted as broad contextual conditions associated with QoE rather than as a complete empirical representation of the TTF mechanism. Future research should directly assess the connectivity demands of distinct tasks, such as synchronous video conferencing, online assessment, research-database access, large-file transfer, learning-management-system use, and routine browsing, and examine whether perceived fit explains or moderates QoE.

The effects of QoE became considerably stronger once users' evaluative responses were examined. QoE positively influenced satisfaction (SAT; $\beta = .487$, $t = 9.68$, $p < .001$, $f^2 = .310$) and perceived value (PV; $\beta = .516$, $t = 11.22$, $p < .001$, $f^2 = .362$), supporting H2a and H2d. The QoE–PV relationship was the strongest path in the structural model, while QoE explained 23.7% of the variance in SAT and 26.6% of the variance in PV. These results suggest that broadband performance becomes most consequential when users translate their experience into judgments of whether the service is satisfactory and whether its benefits justify the associated monetary and non-monetary sacrifices. This pattern is compatible with telecommunications research suggesting that service encounters and network-related experiences gain behavioral relevance primarily through downstream customer evaluations rather than as isolated technical attributes. Jo (2024), for example, found that multiple telecommunication-experience dimensions shaped satisfaction, which subsequently predicted continuance intention.

QoE also positively influenced service preference (SP; $\beta = .254$, $t = 4.73$, $p < .001$), supporting H2c, although the effect was smaller ($f^2 = .068$). Digital literacy (DL) independently predicted SP ($\beta = .231$, $t = 4.18$, $p < .001$, $f^2 = .057$), supporting H3. Together, QoE and DL explained 17.1% of the variance in SP ($R^2 = .171$; adjusted $R^2 = .167$). This modest explanatory power indicates that service preference cannot be reduced to broadband performance or digital capability alone. Preference may additionally reflect price structures, contractual conditions, switching barriers, device compatibility, peer influence, availability of substitutes, habitual use, and institutional provisioning arrangements. Contemporary telecommunications research similarly depicts service choice and loyalty as multi-attribute judgments rather than direct consequences of network quality alone (Jo & Park, 2024).

The most consequential finding concerns continuance intention (CI). Contrary to H2b, QoE did not exert a statistically significant direct effect on CI ($\beta = .083$, $t = 1.88$, $p = .060$, 95% CI [−.004, .169]), and its effect size was negligible ($f^2 = .009$). SP likewise did not significantly predict CI ($\beta = .074$, $t = 1.66$, $p = .097$, $f^2 = .006$), resulting in rejection of H4a. These findings challenge a simple service-quality explanation in which a favorable broadband experience, or even stated relative preference, automatically translates into an intention to maintain future use. Users may evaluate a service positively or prefer it to available alternatives, yet still refrain from forming a strong continuance intention once broader post-use evaluations are considered.

Instead, CI was primarily associated with SAT ($\beta = .317$, $t = 6.11$, $p < .001$) and PV ($\beta = .289$, $t = 5.47$, $p < .001$), supporting H4b and H4c. This pattern is consistent with ECM, which positions satisfaction as a proximal basis for continued use after initial adoption. Napitupulu et al. (2024) found satisfaction to be the strongest predictor of continuance in an established digital-service context, while perceived usefulness did not retain a significant direct relationship with continuance. Similarly, telecommunications evidence indicates that satisfaction formed through accumulated service encounters predicts continuance intention among existing users (Jo, 2024). The significant PV–CI relationship further suggests that users' willingness to continue depends not only on whether broadband performs adequately but also on whether its ongoing benefits justify the costs, inconvenience, and effort associated with maintaining access (Ha et al., 2025).

Taken together, these results shift the interpretation of broadband continuance away from technical performance as an endpoint and toward user evaluation as the process through which technical experience acquires behavioral meaning. QoE strongly shaped SAT and PV but did not retain a significant direct association with CI once these evaluative constructs were included. The pattern is therefore consistent with an indirect evaluative process, in which favorable coverage, performance, reliability, and usability contribute to continuance because they enhance satisfaction and perceived value. However, this interpretation should be presented as formal mediation only if the bootstrapped indirect effects of QoE through SAT and PV are statistically significant and reported separately.

The model explained 43.1% of the variance in CI ($R^2 = .431$; adjusted $R^2 = .425$), substantially more than it explained in QoE, SAT, PV, or SP. This difference reinforces the layered nature of the framework. Broad contextual variables offer only a partial explanation of experienced broadband quality, whereas combining QoE with users' satisfaction and value judgments produces considerably greater explanatory power for continued use. The result is therefore not that QoE is unimportant; rather, its role appears primarily upstream, where it shapes the post-use evaluations more proximal to CI.

The predictive assessment broadly supported this interpretation without indicating unrealistically uniform predictive strength. All indicator-level Q^2_{predict}values for SAT, PV, SP, and CI were positive, indicating predictive relevance relative to a naïve indicator-average benchmark. However, the PLS model outperformed the linear-model RMSE benchmark for only three of four SAT indicators, four of five PV indicators, two of four SP indicators, and three of four CI indicators. Under PLSpredict, positive Q^2_{predict}establishes predictive relevance, whereas comparison with the linear-model benchmark provides a more demanding assessment of predictive accuracy. The findings therefore indicate moderate predictive capability for SAT, PV, and CI, but weaker predictive performance for SP rather than uniformly strong predictive superiority across all outcomes.

Table 5. Explanatory and predictive performance

Endogenous construct	R^2	Adjusted R^2	Q^2predict	PLS RMSE < LM RMSE
QOE	.104	.092	—	—
SAT	.237	.235	.142–.213	3/4 indicators
PV	.266	.264	.129–.205	4/5 indicators
SP	.171	.167	.047–.102	2/4 indicators
CI	.431	.425	.185–.257	3/4 indicators

Overall, Tables 4 and 5 reveal a coherent but non-uniform process. Usage location and broadband type help identify contexts in which QoE problems may emerge, but they do not fully account for the technical, task-related, and user-side mechanisms through which QoE is formed. QoE, in turn, strongly informs satisfaction and perceived value, while CI is more directly associated with these post-use evaluations than with QoE or service preference alone. The unsupported QoE →CI and SP →CI paths are therefore substantively meaningful rather than anomalous. They indicate that broadband continuance in PHEIs is not simply a function of better infrastructure or stated preference, but depends on whether broadband experience is converted into satisfactory and valuable outcomes for users.

Implications

Theoretical Implications

The findings offer several theoretical implications within the boundaries of Task–Technology Fit (TTF) theory and the Expectation-Confirmation Model (ECM). TTF proposes that technology outcomes depend on the correspondence between technological capabilities and task requirements (Goodhue & Thompson, 1995). The present study did not directly measure task characteristics or perceived task–technology fit; therefore, the effects of usage location, broadband type, and DL should not be interpreted as a full test of TTF. Rather, they provide contextual evidence consistent with its core premise that technological outcomes are conditional rather than uniform.

This is reflected in the modest explanatory power of contextual variables. Usage location and broadband type explained only 10.4% of QOE, with lower QOE in hostels and cafeteria/common areas, while fixed broadband outperformed institutional Wi-Fi but mobile broadband did not. These results challenge an infrastructure-deterministic view in which access mode or physical location alone should explain broadband experience. Instead, they are consistent with TTF logic: the same technology may generate different outcomes depending on the conditions under which it is used. The modest effects also reveal the theoretical boundary of the present model, because users operating in similar locations or using similar broadband services may still face different academic tasks and connectivity requirements.

The findings correspond more directly with ECM's post-adoption logic. ECM distinguishes initial acceptance from continuance and positions satisfaction as a proximal determinant of continued technology use (Bhattacherjee, 2001). In this study, QOE strongly predicted SAT ($\beta = .487$), and SAT subsequently predicted CI

(β = .317), whereas the direct QOE → CI path was not significant. This suggests that favorable technical experience does not automatically sustain use; rather, its behavioral relevance emerges through users' post-use evaluations. However, the study should not be presented as a complete validation of ECM because confirmation and post-acceptance perceived usefulness were not included.

PV also played an important role, with QOE strongly predicting PV (β = .516) and PV subsequently predicting CI (β = .289). Because PV is not part of the original ECM, this relationship should be interpreted as a complementary evaluative route rather than an ECM extension. SAT captures whether users found the experience satisfactory, whereas PV captures whether that experience was worth the associated costs and sacrifices. Taken together, the two theories perform distinct roles: TTF explains why broadband experience may vary across technological and spatial conditions, whereas ECM explains why favorable experience affects continuance primarily through post-use evaluation rather than directly.

Practical Implications

The findings suggest that PHEIs should move beyond broad institution-wide connectivity upgrades toward location-specific QoE management. Hostel and cafeteria/common-area use were associated with lower QoE, whereas administrative blocks and off-site accommodation did not differ significantly from lecture theatres. Rather than assuming that all campus locations require the same intervention, institutions should develop QoE heatmaps combining user feedback with technical diagnostics by building, floor, peak-use period, and high-density zone. Initial diagnostic attention should be directed to hostels and common areas, with particular attention to congestion, access-point density, interference, backhaul limitations, authentication delays, and recurring connection disruptions.

The formative QoE results also provide a prioritisation logic. Service performance quality (SPQ) made the strongest contribution to QoE (weight = .391), followed by coverage (COV; weight = .283) and reliability (REL; weight = .246); usability (USA) had a weaker relative weight but retained a substantial loading (.718). PHEIs should therefore prioritise performance, coverage consistency, and reliability while treating usability as a minimum service requirement rather than a secondary concern. In practice, institutional monitoring should separately track peak-period throughput, latency, packet loss, signal dead zones, outage frequency, reconnection difficulty, authentication failures, and recurring user complaints instead of relying on a single overall Internet-satisfaction score.

The higher QoE associated with fixed broadband should not be interpreted as a recommendation to replace institutional Wi-Fi. Instead, fixed broadband can serve as a performance benchmark against which institutional wireless services are evaluated. Where Wi-Fi performance falls substantially below this benchmark, the ICT unit should determine whether the bottleneck arises from insufficient access-point density, poor placement, inadequate backhaul capacity, overloaded authentication systems, interference, or weak peak-load management. Likewise, the non-significant mobile-broadband effect cautions against assuming that directing users toward mobile networks will resolve institutional connectivity deficiencies.

Most importantly, QoE did not have a significant direct effect on continuance intention, whereas satisfaction and perceived value did. This indicates that expanding bandwidth or installing additional access points is not sufficient unless users experience the resulting service as satisfactory and worthwhile. PHEIs should therefore evaluate network investments through a combined technical-and-user-experience framework that tracks QoE, satisfaction, perceived value, complaint recurrence, and service-recovery effectiveness. The non-significant service-preference-to-continuance relationship further suggests that institutions should focus less on making a service comparatively attractive and more on delivering a consistently satisfactory and valuable connectivity experience.

To operationalise these implications, each PHEI should establish a PHEI-QoE scorecard under a cross-functional digital-infrastructure committee. The committee should include the ICT or network division, academic affairs, student affairs, library or digital-learning services, institutional planning, procurement or finance, and student and staff representatives. The scorecard should combine objective indicators—such as throughput, latency, packet loss, connection-drop rate, outage duration, signal strength, authentication failures, helpdesk tickets, and repair times—with recurring user assessments of QoE, satisfaction, perceived value, and task-specific difficulties.

The ICT unit should review core technical indicators weekly and prepare a location-level report each month. User-experience indicators should be collected through a short pulse survey at least quarterly and before high-demand periods, such as online examinations, registration periods, and intensive teaching weeks. When a building or zone shows repeated poor throughput, elevated connection drops, low QoE ratings, or recurring complaints across two consecutive reporting periods, the committee should require a diagnostic review and corrective action plan. Depending on the source of the problem, actions may include increasing access-point density, improving backhaul capacity, changing access-point placement, reducing interference, strengthening network redundancy, simplifying authentication procedures, or providing targeted technical support.

The scorecard should also assess whether the network supports the tasks for which users need it. Short task-specific questions can identify whether users face problems during synchronous video conferencing, learning-management-system access, online assessment, large-file uploads, research-database use, or administrative transactions. This enables institutions to distinguish a general connectivity problem from one caused by a mismatch between network capability and a high-demand academic or administrative task. It also responds to the present study's bounded use of TTF by encouraging future institutional monitoring of task requirements without claiming that task–technology fit was directly tested in the current model.

Finally, the committee should communicate outcomes through a brief quarterly "you said, we did" update. For example, if hostel users report repeated evening disconnections and poor video-conferencing quality, the institution should report the diagnosed cause, the specific intervention undertaken, the expected completion date, and subsequent changes in technical and user-experience indicators. Such feedback closes the service-recovery loop, makes ICT investment decisions transparent, and ensures that broadband is managed as experienced educational infrastructure rather than merely as a technical utility.

Policy Implications

The findings are relevant to Malaysia's higher-education digitalisation agenda because they distinguish connectivity provision from connectivity experience. Institutions may meet infrastructure targets while users in particular locations continue to face poor performance. A useful policy innovation would be a PHEI-QOE scorecard incorporated into digital-maturity monitoring. Rather than reporting only bandwidth capacity, coverage, or numbers of access points, institutions could periodically report COV, SPQ, REL, and USA across major campus environments such as lecture areas, residential colleges, administrative zones, and shared student spaces.

Such a scorecard should function as a diagnostic tool rather than a ranking mechanism. It could also complement national broadband-quality monitoring by creating comparable user-experience measures for higher education. Coordination between MOHE, MCMC, and participating universities could establish consistent reporting standards and distinguish institution-specific infrastructure weaknesses from broader service-provider problems.

Funding and procurement could likewise become more outcome-oriented. Rather than allocating broadband budgets mainly for institution-wide capacity expansion, targeted remediation could be linked to repeatedly identified QOE deficits. Managed-network contracts could include performance requirements for peak-load stability, recovery time, recurring interruption, and user-experience monitoring alongside conventional throughput targets. The lower QOE found in hostels is particularly important because residential connectivity should be treated as academic infrastructure, not merely a student amenity, when learning increasingly extends beyond scheduled classroom hours.

Future Research

Future research should directly examine the Task–Technology Fit (TTF) mechanism rather than relying primarily on broad contextual proxies such as usage location and broadband type. The present study used TTF as a contextual lens, but it did not measure task characteristics, technology characteristics, or perceived task–technology fit as latent constructs. Future studies should therefore distinguish among academic and administrative activities with different connectivity requirements, including synchronous video conferencing, cloud collaboration, online assessment, learning-management-system access, research-database use, large-file transfer, and routine browsing. Measuring both task requirements and users' perceived fit between those requirements and available broadband capabilities would allow researchers to determine whether task–technology fit explains QoE more effectively than location and access type alone.

The modest explanatory power of the QoE equation also indicates that broadband experience is shaped by determinants not included in the present model. Future research should incorporate objective and subjective network-related factors, including actual download and upload throughput, latency, jitter, packet loss, connection drops, access-point load, peak-time congestion, signal strength, and authentication delays. Researchers should also consider device characteristics, such as device age, processing capability, Wi-Fi compatibility, battery performance, and operating-system constraints, because users in the same physical location may experience the same network differently depending on their devices. Integrating these variables would provide a more complete explanation of why QoE varies across users and settings.

Future studies should also examine economic, behavioural, and contextual factors that may influence service preference and continuance intention. Relevant variables include actual monetary cost, data-plan affordability, perceived price fairness, switching costs, contractual restrictions, habit, security and privacy concerns, institutional dependence, prior service failures, alternative-service availability, and compatibility with users' devices and learning activities. Such factors may be especially important for explaining the modest variance in service preference and the non-significant relationship between service preference and continuance intention. A user may prefer a service relative to alternatives but still lack the financial, contractual, practical, or institutional conditions needed to sustain future use.

A fuller ECM specification would also strengthen the explanatory sequence. Future research could include confirmation and post-acceptance perceived usefulness alongside QoE, satisfaction, perceived value, and continuance intention. This would clarify whether QoE operates primarily as an experienced performance input that shapes confirmation, whether confirmation subsequently drives satisfaction and value perceptions, and whether these evaluations transmit the effect of QoE to continuance. Such a model would provide a more direct empirical assessment of the post-adoption mechanism proposed by ECM.

Longitudinal and mixed-method designs are particularly important because the cross-sectional design used in the present study cannot establish temporal ordering or causal sequence. A three-wave design could assess contextual conditions, task requirements, and QoE at Time 1; satisfaction, perceived value, confirmation, and service preference at Time 2; and continuance intention, actual usage, retention, or switching behaviour at Time 3. Linking survey responses with objective technical indicators—such as latency, throughput, interruption logs, access-point congestion, authentication failures, and connection-drop records—would also reveal whether subjective QoE converges with measured network performance.

Qualitative methods could complement such designs by explaining why users report different experiences despite apparently similar technical conditions. Interviews, digital diaries, focus groups, or critical-incident reports could identify task-specific frustrations, device limitations, coping strategies, hidden costs, authentication problems, and service-recovery experiences that may not be fully captured through structured survey items. This mixed-method approach would be particularly useful for understanding whether low QoE originates from network infrastructure, task–technology mismatch, user capability, service-support processes, or a combination of these factors.

Finally, the data structure supports multilevel and comparative research. Because users are nested within specific locations and PHEIs, future studies could use multilevel modelling to distinguish individual-level perceptions from genuine building-, campus-, or institution-level differences in broadband conditions. Researchers could also compare public and private universities, rural and urban campuses, residential and non-residential users, and institutions across countries with different digital-infrastructure conditions. Such replications would clarify the boundary conditions of the proposed contextual-QoE-continuance framework and establish whether the observed relationships are specific to Malaysian PHEIs or generalisable to broader higher-education settings.

CONCLUSION

This study reframes broadband in public higher education from a question of whether connectivity exists to whether it works well enough, where it is needed, to generate satisfactory and worthwhile experiences. Location and broadband type mattered selectively: hostels and common areas showed lower QOE, while fixed broadband performed more favorably than institutional Wi-Fi. Yet contextual factors explained only a modest share of QOE, indicating that broadband experience cannot be inferred from access mode or location alone.

More importantly, QOE strongly improved SAT and PV but did not directly predict CI. Continued use was instead associated primarily with SAT and PV, while SP also failed to predict CI. The findings therefore suggest that technical experience becomes behaviorally consequential only when users interpret it as satisfactory and valuable. Within the limits of the original theories, this pattern is consistent with TTF's contextual view of technology outcomes and ECM's post-adoption emphasis on satisfaction and continuance. For PHEIs and policymakers, the implication is clear: broadband should be managed not only through capacity and coverage targets, but through evidence of where experience deteriorates, which QOE dimension is responsible, and whether remediation produces improvements users actually value.

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APPENDIX

Table A1. Measurement items and sources

Please answer the following statements with reference to the broadband service you use most frequently for your university-related academic, teaching, research, or administrative activities. Throughout the questionnaire, "this broadband service" refers to that service.

Construct	Code	Revised measurement item	Source/basis
Coverage (COV)	COV1	This broadband service is available in the locations where I normally need to use it.	ITU-T G.1030
	COV2	This broadband service provides consistent coverage across my usual usage locations.	
	COV3	I experience few or no locations where this broadband service becomes unavailable.	
	COV4	The signal strength of this broadband service remains adequate across my usual usage locations.	
	COV5	This broadband service provides sufficient coverage for my university-related activities.	
Service Performance Quality (SPQ)	SPQ1	This broadband service consistently provides sufficiently high Internet speed.	ITU-T P.10/G.100 Amendment 1
	SPQ2	Video streaming and file downloads using this broadband service are generally smooth and free from excessive buffering or delay.	
	SPQ3	Web pages and online platforms load quickly when I use this broadband service.	
	SPQ4	This broadband service provides adequate audio and video quality during video calls or online meetings.	
	SPQ5	This broadband service performs adequately when I use applications that require substantial bandwidth.	
Reliability (REL)	REL1	This broadband service is available when I need to use it.	IEEE 802.16-2004
	REL2	This broadband service operates consistently without frequent unexpected interruptions.	
	REL3	When a disruption occurs, this broadband service usually returns to normal operation quickly.	
	REL4	The performance of this broadband service remains reasonably stable during my usual usage periods.	
	REL5	I can depend on this broadband service for my university-related activities.	
Usability (USA)	USA1	Connecting to this broadband service is straightforward.	ISO/IEC 25010:2011
	USA2	Accessing and using this broadband service requires little unnecessary effort.	
	USA3	I can usually resolve routine connection problems with this broadband service without substantial difficulty.	
	USA4	The procedures required to access or manage this broadband service are easy to understand.	
	USA5	Overall, interacting with this broadband service is easy and convenient.	
Satisfaction (SAT)	SAT1	Overall, I am satisfied with this broadband service.	Adapted from Bhattacherjee (2001)

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	SAT2	My experience with this broadband service has been satisfactory.	
	SAT3	This broadband service meets my expectations.	
	SAT4	Overall, I am pleased with this broadband service.	
Perceived Value (PV)	PV1	Considering what I receive and what I give up to use it, this broadband service provides good overall value.	Adapted from Zeithaml (1988)
	PV2	The benefits I obtain from this broadband service outweigh the costs, effort, or other sacrifices associated with using it.	
	PV3	The quality of this broadband service is worthwhile relative to what I give up to use it.	
	PV4	Using this broadband service is worthwhile for my university-related activities.	
	PV5	Overall, this broadband service provides good value to me.	

Appendix Table A2. Individual indicator loadings

Construct	Indicator	Loading
COV	COV1	.686
	COV2	.739
	COV3	.762
	COV4	.789
	COV5	.842
SPQ	SPQ1	.721
	SPQ2	.782
	SPQ3	.815
	SPQ4	.846
	SPQ5	.872
REL	REL1	.698
	REL2	.756
	REL3	.793
	REL4	.826
	REL5	.855
USA	USA1	.674
	USA2	.721
	USA3	.756
	USA4	.794
	USA5	.831
DL	DL1	.702
	DL2	.764
	DL3	.823
	DL4	.844
SAT	SAT1	.744
	SAT2	.806
	SAT3	.854
	SAT4	.886
PV	PV1	.701
	PV2	.766
	PV3	.809
	PV4	.842
	PV5	.861
SP	SP1	.688

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	SP2	.749
	SP3	.807
	SP4	.842
CI	CI1	.755
	CI2	.823
	CI3	.868
	CI4	.892

Appendix Table A3. HTMT discriminant validity assessment

	COV	SPQ	REL	USA	DL	SAT	PV	SP	CI
COV	—								
SPQ	.721	—							
REL	.758	.813	—						
USA	.667	.742	.713	—					
DL	.381	.414	.396	.462	—				
SAT	.612	.807	.784	.689	.372	—			
PV	.579	.748	.711	.636	.351	.762	—		
SP	.441	.503	.474	.548	.596	.518	.497	—	
CI	.553	.691	.665	.608	.342	.846	.803	.571	—

Appendix Table A4. Full-collinearity VIF assessment

Construct	Full-collinearity VIF
QOE	2.74
DL	1.58
SAT	2.89
PV	2.66
SP	1.93
CI	3.07

Appendix Table A5. Demographic control-variable effects

These are controls, not H3b hypotheses.

Outcome	Control	β	t	p
SP	Age	.048	1.08	.280
SP	Male	.028	.62	.536
SP	Prefer not to say	−.021	.48	.633
SP	Academic staff	.043	.95	.342
SP	Administrative staff	.061	1.29	.197
CI	Age	.063	1.41	.159
CI	Male	.019	.45	.653
CI	Prefer not to say	−.027	.61	.542
CI	Academic staff	.035	.79	.430
CI	Administrative staff	−.046	1.02	.308

Appendix Table A6. Detailed PLSpredict assessment

Construct	Indicator		Q^2predict	PLS RMSE	LM RMSE	Better model
SAT	SAT1		.161	.782	.795	PLS
	SAT2		.195	.741	.756	PLS
	SAT3		.142	.806	.800	LM

	SAT4		.213	.721	.735	PLS
PV	PV1		.129	.812	.821	PLS
	PV2		.176	.776	.789	PLS
	PV3		.205	.748	.752	PLS
	PV4		.151	.793	.787	LM
	PV5		.184	.769	.781	PLS
SP	SP1		.061	.884	.879	LM
	SP2		.083	.851	.863	PLS
	SP3		.047	.906	.898	LM
	SP4		.102	.842	.849	PLS
CI	CI1		.185	.741	.755	PLS
	CI2		.232	.708	.722	PLS
	CI3		.196	.735	.731	LM
	CI4		.257	.689	.702	PLS

Appendix Table A7. Specific indirect and total effects

Effect	β	t	p	95% CI
QOE → SAT → CI	.154	5.12	<.001	[.099, .215]
QOE → PV → CI	.149	4.89	<.001	[.095, .209]
QOE → SP → CI	.019	1.48	.139	[−.005, .047]
Total indirect QOE → CI	.322	7.35	<.001	[.239, .410]
Direct QOE → CI	.083	1.88	.060	[−.004, .169]
Total QOE → CI	.405	7.80	<.001	[.305, .507]