Broadband Services Quality of Experience on Public Higher Educational Institution Users: A Research Direction

*Suheil Che Sobry, Muhammad Zarunnaim Wahab Wahab, Mohd Hilal Muhammad, Mohd Hilal Muhammad, Ruzita Manshor, Mohd Shahid Azim Mohd Saufi, Muhammad Khairul Zharif Nor A'zam
Universiti Teknologi Mara, Malaysia
*suheil@uitm.edu.my, zarunnaim@uitm.edu.my, hilalmuhd@uitm.edu.my, saifulislam@uitm.edu.my, ruzitamanshor@uitm.edu.my, azimsaufi@uitm.edu.my, khairulzharif@uitm.edu.my
Corresponding Author: Suheil Che Sobry

Abstract: Internet access is crucial in facilitating effective learning and communication. However, disparities in internet quality persist, especially within Public Higher Educational Institutions (PHEIs). Despite efforts by broadband providers to enhance services, complaints regarding quality persist among students and staff. Thus, this research aims to investigate users' Quality of Experience (QoE) with broadband services in PHEI campuses, focusing on coverage, service quality, reliability, and usability. Additionally, it seeks to identify user preferences and usage patterns, correlate broadband quality with user satisfaction, and propose improvements. A comprehensive methodology integrating qualitative and quantitative approaches, including surveys, and interviews is proposed. The implications of this research extend to regulatory and policy actions, including infrastructure improvement, ensuring quality of service, supporting online learning, and encouraging research and innovation in broadband technologies. This study aims to inform stakeholders and contribute to enhancing broadband access and quality in PHEIs, ultimately improving educational outcomes and experiences.

Keywords: *Internet Coverage, Quality of Experience (QoE), Broadband Infrastructure, Higher Education, User Satisfaction*

1. Introduction

In today's digital age, strong internet coverage has become an indispensable aspect of daily life. The internet profoundly influences how people work, communicate, learn, shop, and seek entertainment. Its pervasive presence and transformative capabilities have revolutionized virtually every aspect of modern society, shaping the way of interacting with the world.

Equally important, strong internet coverage is equally crucial for students, particularly in the surrounding areas of campuses where students and faculty from Public Higher Educational Institutions (PHEI) utilize broadband services (Asio et al, 2021). Many teaching and learning processes within universities heavily rely on robust internet access. Whether it's accessing online resources, participating in virtual classes, collaborating on group projects, or conducting research, students depend on uninterrupted internet connectivity to effectively engage with their academic pursuits (Coman et al., 2020). Strong internet coverage not only enhances the quality of education but also prepares students for the digital-driven world they will encounter in their future careers. It enables universities to embrace innovative teaching methods, adapt to evolving educational trends, and provide a dynamic and interactive learning environment that empowers students to thrive academically and professionally (Nordrum & Gracia, 2023; Rahiman & Kodikal, 2023).

However, despite the widespread importance of internet access for students, it's undeniable that they often encounter negative experiences, particularly when utilizing broadband devices. These challenges can range from slow connection speeds and frequent disruptions to limited bandwidth and unreliable network coverage (George et al., 2023). Besides, a study by Gong (2020) revealed that many universities, particularly those in rural and semi-urban areas, face significant challenges with inconsistent internet connectivity and insufficient Wi-Fi coverage. This lack of reliable access affects students' ability to engage in digital learning and utilize online resources effectively. Moreover, the research highlighted that limited bandwidth further aggravates the situation, with the existing infrastructure unable to accommodate the high demand during peak usage periods, often resulting in slow or unstable connections. In addition to these infrastructural limitations, the digital divide between urban and rural areas persists, leaving students in less developed regions at a disadvantage in accessing high-speed internet compared to their urban counterparts.

Socioeconomic disparities also play a crucial role in compounding these challenges. Students from low-income households often cannot afford personal high-speed internet connections, especially when off-campus (Mahdzan et al., 2022). This issue was amplified during the COVID-19 pandemic, as universities across Malaysia shifted to remote learning, placing additional strain on internet services and exposing the inequalities in digital access among students. Faculty members also encountered similar challenges, particularly in delivering online classes and conducting research. Inadequate internet infrastructure hindered their ability to provide quality instruction and collaborate on academic projects (Jafar et al., 2022).

The pandemic has further underscored the inadequacies of existing online learning platforms, many of which are ill-equipped to support the multimedia content and interactive elements essential for modern education. Frequent disruptions caused by poor campus internet infrastructure led to frustration for both students and faculty members (Rathinam et al., 2023). Additionally, concerns over the cost of internet services remain prevalent, as high data costs continue to burden students and staff accessing online learning materials off-campus, particularly those from the B40 income group (Ali et al., 2024).

Such issues can significantly impede students' ability to engage effectively with online learning resources, participate in virtual classrooms, and collaborate on digital platforms. Moreover, these connectivity issues can lead to frustration, and stress, and ultimately hinder academic performance and progress (Cullinan et al., 2021; Korkmaz et al., 2022). PHEI must address these challenges and strive to provide reliable, high-speed internet access to ensure that students can fully leverage the benefits of digital learning tools and resources. By addressing these connectivity issues, PHEI can enhance the overall learning experience and empower students to succeed in their academic endeavors.

Therefore, this research is conducted to study the quality of broadband services and factors influencing their adoption among users of PHEI. This study is important because it addresses the critical need to understand the experiences of users in accessing broadband services within educational settings. By exploring the quality of experience and adoption factors, this research aims to identify potential areas for improvement in broadband services provision and inform strategies for enhancing digital connectivity in educational environments. Ultimately, the findings of this study can contribute to optimizing broadband services to better support teaching, learning, and research activities in PHEI, thereby facilitating the advancement of education in the digital age.

2. Literature Review

Internet Service Coverage and Quality of Experience (QoE)
A previous study on internet coverage in Malaysia aimed to trace the diffusion of the internet in the country. The research focused on understanding how internet access has evolved in Malaysia. Moreover, another source highlighted that Malaysia has achieved significant progress in expanding its 4G broadband coverage to reach 96% of populated areas as of 2022 (Statista, 2024).

This achievement reflects the country's efforts to bridge the digital divide and improve internet access for rural and remote communities. The study emphasized the importance of diverse policy options and a flexible regulatory framework to support initiatives aimed at enhancing last-mile connectivity in underserved regions. Overall, these studies shed light on Malaysia's advancements in internet coverage, addressing challenges faced by rural and remote communities while emphasizing the need for inclusive policies to ensure widespread access to digital resources across the country (Nayan, Hashim, Saleh & Mahat, 2016).

The correlation between internet coverage and QoE is a critical aspect in assessing user satisfaction with internet services. QoE refers to the delight or annoyance a user experiences with a service, focusing on the overall service experience from the user's perspective (Staelens, Moens, den Broeck, Mariën, & Vermeulen, 2010; Xu & Zhang, 2019). QoE encompasses various factors, including system, human, and contextual influences that contribute to a user's perceived quality of a system or service (Xu & Zhang, 2019).

Internet coverage plays a significant role in shaping the QoE for users. Adequate internet coverage ensures reliable connectivity, faster speeds, and seamless access to online services, which are essential for enhancing

user satisfaction and overall experience. Studies have shown that network-related factors, such as bandwidth, delay, and jitter, directly impact the QoE of users accessing Internet services (Ahmad, Wahab, Schormans, & Arnab, 2023).

The availability of a stable network connection in different locations is crucial for maintaining a positive QoE. Furthermore, research has highlighted the importance of understanding the relationship between Quality of Service (QoS) metrics and QoE to improve internet services by assessing network traffic type-based QoE and utilizing methods like flow features extraction and QoS metrics evaluation, service providers can enhance the overall quality of user experience (Reichl, Egger, Schatz, D'Alconzo, 2010; Ahmad et al., 2023). There is a positive correlation between internet coverage and quality of experience. Reliable internet coverage contributes to improved QoE by ensuring consistent connectivity, faster speeds, and better access to online services. Service providers can leverage this understanding to optimize their networks and enhance user satisfaction with Internet services.

Service Quality and User Satisfaction

Service quality is a critical measure that reflects how well an organization meets or exceeds customer expectations in its service delivery. It encompasses the overall experience a customer has with a service provider, influencing customer satisfaction, loyalty, and the organization's reputation (Parasuraman et al., 1985). Together, technical/outcome and process-related elements play a vital role in shaping the overall perception of the quality of internet services (Mansoor & Khan, 2022)

The primary determinant of internet access quality is the speed of download and upload connections (Gerpott, 2018). Connection bandwidth significantly influences customer satisfaction with internet providers (Grzybowski et al., 2018). Consequently, connection speed is a vital factor. Customers can utilize testing tools to evaluate the delivery rates from their internet service providers (Zhang & Wang, 2023). When customers perceive a failure to deliver the promised connection bandwidth, they experience a psychological loss (Hashim et al., 2022). Repeated failures can lead to a decrease in perceived value and service quality, ultimately resulting in diminished consumer loyalty towards internet service providers (Hashim et al., 2022; Ikhsan et al., 2022).

Yusof et al. (2022) examine the relationship between service quality, price, and consumer satisfaction perceptions. Their research indicates a significant correlation between customer satisfaction and service quality. Nguyen et al. (2020) examined the relationships between service quality, customer value, customer satisfaction, and customer behavior intention in the context of mobile services and found that network quality is a critical dimension of service quality that significantly affects customer value and satisfaction.

Service Reliability

Online learning activities in higher education institutions are seriously affected by the reliability of Internet services. Approximately one out of every six students is strained to weak internet access and low-income students who are more likely to experience connection issues are disproportionately affected by this kind of disadvantage. (Cullinan et al., 2021). This digital divide leads to digital inequality which restricts student participation and limits online course offerings. Internet service quality including reliability and responsiveness is vital in determining students' satisfaction and academic achievement (Darawong & Widayati, 2021). To get control of these constraints, higher education institutions should adopt risk management strategies to identify, assess, and manage risks including the technological risks (Alexei, 2021). The improper ICT infrastructure and readiness including the internet access off-campus impact the delivery of online education and student engagement. To address these issues, higher education institutions should prioritize campus facility access in the less internet coverage areas (Cullinan et al., 2021) and invest in digital culture and equity (Ndibalema, 2022).

Service Usability

The usability of Internet services and their impact on higher education institutions has been a recent research focus. Studies have shown that e-learning software usability significantly affects student satisfaction in higher education institutions. (Al-Fraihat et al., 2020; Giray, 2021). Internet usage among university students has been associated with the application of social values in their communication with friends and family members. (Caldeiro-Pedreira, et al, 2021). Internet usability has been shown to have a significant correlation with

students' performance in academic in higher education institutions, despite difficulties in utilization. (Ladrón de Guevara Rodríguez et al., 2022). Research in Pakistan proved that internet usage positively affects students' academic achievement, with 60.4% of students reporting improved performance (Zamir et al, 2020). The Internet provides access to up-to-date information and research materials, enhancing students' learning experiences (Nawaz, 2021). To highlight the vitals of internet usage in higher education, usability issues must be addressed and promote responsible internet usage among students, balancing academic pursuits with entertainment and social media activities (Acut et al., 2016; Ladrón de Guevara Rodríguez et al., 2022; Shahibi, 2017).

Underpinning Theory
One of the prominent theories to explain the quality of experience (QoE) and the adoption of internet broadband is the Technology Acceptance Model (TAM). TAM was originally developed by Fred Davis in the 1980s and has been extended and adapted in various contexts since then.

The quality of experience (QoE) also falls under the umbrella of consistency theories in psychology and consumer behavior. These theories posit that if the actual performance of a product or service does not align with customers' expectations or predictions, it can lead to cognitive dissonance or tension. To reduce this tension, customers may adjust their perceptions of the product or service to align better with their expectations. Theories of consistency include assimilation theory, contrast theory, assimilation-contrast theory, and negativity theory, all of which offer insights into how individuals perceive and evaluate their experiences with products or services.

Figure 1: Proposed Research Framework
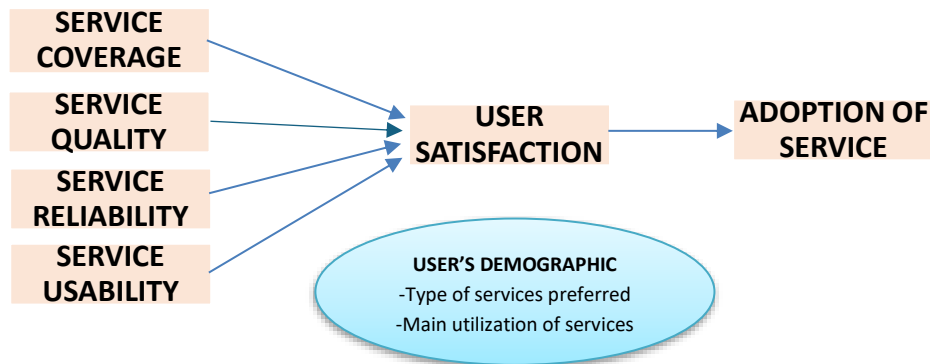
3. Research Methodology

To understand students and faculty staff's broadband services quality of experience (QoE) and adoption factors, a comprehensive research methodology incorporating either a qualitative or quantitative approach would be beneficial. First, existing literature on broadband services QoE and adoption factors, focusing on studies relevant to Public Higher Educational Institutions (PHEI) will be identified and reviewed. These include the identification of key concepts, theories, and methodologies used in previous research. Second, a survey questionnaire will be developed for data collection from students and PHEI staff. Descriptive questions on demographics, current broadband usage patterns, satisfaction levels, perceived benefits, challenges, and factors influencing adoption will be included.

There are twenty public universities in Malaysia, therefore for sampling technique, the target population potentially will be students and staff in Malaysia's PHEI. The sampling frame will be based on a directory from PHEI's Registrar Departments. Random sampling techniques may be employed to ensure the representativeness of the sample. Third, the questionnaire survey will be distributed via email or online platforms to reach a wide audience, for instance, Google Forms and Microsoft Forms which can be easily

accessed. We also will set a defined period for data collection to ensure timely responses.

Lastly, for data analysis, quantitative analysis using statistical techniques such as descriptive statistics, correlation analysis, and regression analysis will be utilized to identify patterns and relationships (SPSS or Smart-PLS). Additionally, qualitative analysis methods like thematic analysis may benefit in analyzing open-ended responses and identifying recurring themes and insights. Here, interviews with a subset of participants to gain deeper insights into their experiences and perceptions will be conducted. To ensure the confidentiality and anonymity of participants, their consent will be obtained before the data collection to adhere to ethical guidelines for research involving human subjects.

4. Implications of Study

This study may contribute through the body of knowledge in terms of instrument development in the questionnaire as well as providing insights on the elements of QoE that influence satisfaction among PHEI internet broadband users. Technological terms related to broadband services such as latency, bandwidth, speed, fiber, and data allowance may not be well understood by PHEI users.

In terms of managerial and policy implications, the findings of this study may indicate inadequate internet infrastructure or outdated technology on campuses, prompting regulatory bodies to invest in improving infrastructure to support the growing demands of higher education. In terms of quality of service, if the research highlights concern about the reliability or speed of internet broadband services, regulatory action may be necessary to set standards for service quality and hold providers accountable for meeting those standards.

Given the increasing reliance on online learning platforms, regulatory action may focus on ensuring that Internet broadband services meet the needs of students and staff engaged in distance learning, including measures to guarantee sufficient bandwidth and connectivity. Regulatory action can be taken to foster research and innovation in Internet broadband technologies, including incentives for the development of new solutions to improve access, speed, and reliability. Regulatory bodies may also facilitate partnerships between public higher education institutions, internet service providers, and other stakeholders to address challenges identified in the research collaboratively.

5. Conclusion and Limitations of Study

In conclusion, the article underscores the critical role of internet coverage and QoE in determining user satisfaction with internet services in Malaysia. The research highlights the significant progress Malaysia has made in expanding 4G/5G broadband coverage, particularly in rural and remote areas and the correlation between reliable internet access and improved QoE. The discussion extends to the impact of internet service quality on higher education, where connectivity issues can significantly hinder online learning. Furthermore, the study suggests that enhancing internet infrastructure and understanding the technological aspects of broadband services are essential for improving user satisfaction and academic achievement in higher education institutions. The findings also point to the need for regulatory action to ensure that internet services meet the evolving demands of users, particularly in the context of increasing reliance on online platforms for education and other critical services.

To address the persistent issues surrounding internet services in PHEIs, several actions and recommendations can be taken. First, there should be significant investment in upgrading the existing internet infrastructure, particularly in rural and semi-urban areas where connectivity is a recurring challenge. This can involve expanding Wi-Fi coverage on campuses and increasing bandwidth to accommodate peak usage times. Collaborations between universities, the government, and private telecommunications companies could expedite the development of more resilient Internet networks. By ensuring reliable and high-speed internet access, universities will be better equipped to support online learning, research, and other academic activities, thereby reducing the digital divide between urban and rural regions.

Additionally, policymakers and educational administrators must consider adopting comprehensive digital

inclusion strategies to address socioeconomic disparities in internet access. Financial assistance or subsidized broadband services should be provided for students from low-income households, ensuring that off-campus access to high-speed internet is available for all. Universities can also implement centralized digital resource hubs or provide low-cost mobile data plans in partnership with local internet service providers (ISPs). This would alleviate the burden of high data costs and improve equity in digital learning. By promoting both infrastructural improvements and inclusive policies, Malaysian PHEIs can foster a more supportive and equitable digital learning environment for students and faculty alike.

To enhance the effectiveness of online learning and research, PHEIS must prioritize the development and implementation of robust digital learning platforms and tools. Universities should invest in modern, scalable e-learning systems that are capable of supporting multimedia content and interactive features, which are essential for engaging students in a digital environment. Regular assessments and updates of these platforms should be conducted to ensure they meet the evolving needs of both students and faculty. Additionally, universities should provide training and support to staff and students to maximize their use of these digital tools, thereby improving overall user experience and academic outcomes. By addressing both the technological and educational aspects of digital learning, PHEIs can create a more dynamic and effective learning environment that adapts to the needs of the modern educational landscape.

There are a few possible limitations of this study. First, encouraging a high response rate can be challenging, as students and staff may be busy with academic or work-related commitments. Moreover, students and PHEI staff may have diverse needs and expectations regarding broadband services, depending on factors such as discipline, research requirements, and teaching methods. Tailoring research methodologies to capture this diversity can be demanding. To ensure accurate sample representativeness, certain groups of students or staff may be more likely to participate than others. Furthermore, urging participation by conveying the importance of the research and how the findings will be used might be very helpful, especially if the participants see direct benefits or incentives.

Second, students and staff may receive numerous survey requests, leading to survey fatigue and decreased willingness to participate. To overcome this, the number of items in the questionnaire survey will be short, focused, and designed concisely; it only includes essential questions relevant to research objectives. Limiting the number of questions reduces respondent burden and increases completion rates. Lastly, a different understanding of technological literacy among students and PHEI staff can affect their ability to articulate and interpret their broadband service experiences and adoption factors accurately. Some of them may struggle to express their needs or may not be aware of certain features or limitations. QoE is subjective and influenced by individual perceptions, making it challenging to quantify and analyze objectively. Users may have different interpretations of service quality, making it difficult to generalize findings. Thus, the questions will be simplified for easy understanding with less technical terms (layman's term).

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