A FUNCTIONAL SUITABILITY EVALUATION FRAMEWORK FOR LIBRARY OFF-CAMPUS ACCESS SYSTEMS

Kenneth Kariuki Kibithe

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DECLARATION

Student Declaration

I hereby declare that this thesis is my original work and has not been presented for a degree award at this university or any other university. I understand plagiarism and am aware of the University's policy in this regard. I understand that any false claim in respect of this work shall result in disciplinary action in accordance with the University's Anti-Plagiarism Policy.

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Kenneth Kariuki Kibithe Date

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Supervisors' Approval

The undersigned certify that they have read and hereby recommend for acceptance of Murang'a University of Technology a Thesis entitled "**A Functional Suitability Evaluation Framework for Library Off-Campus Access Systems**".

_____ _____

Dr. John Gichuki Ndia Date

Department of Information Technology

Murang'a University of Technology

_____ _____

Dr. Jane Wanjiru Njuki Date

Department of Information Technology

Murang'a University of Technology

DEDICATION

This work is dedicated to my beloved wife, Nelius Wanjiku, whose unwavering support, patience, and sacrifice made the pursuit of this Master's degree possible. Her constant encouragement and understanding, especially during the long hours devoted to this study, remain a debt of gratitude I can never fully repay. It is further dedicated to my dear daughters, Dolcey Wangari Kariuki and Dosia Wanjiku Kariuki, who graciously endured my absence throughout the course of this programme. May this work serve as an inspiration to them that with dedication and perseverance, no dream is beyond reach.

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ABSTRACT

Off-campus access systems enable library users to access subscribed electronic resources remotely. Systems such as EZproxy, MyLOFT, and eMaktaba are widely used in Kenyan universities to facilitate remote access to electronic resources by students and faculty. Despite their importance, users continue to face challenges, including unreliable authentication, intermittent system performance, and limited access to subscribed resources, which reduce user satisfaction and hinder effective utilisation. Thus, there is a need for a framework to evaluate the functional suitability of these off-campus access systems. However, there are limited evaluation frameworks specifically designed to assess the functional suitability of these systems in academic library environments. Therefore, this research aimed to develop a Functional Suitability Evaluation Framework for library off-campus access systems based on the ISO/IEC 25010 software quality model. The research focused on three functional suitability attributes: functional completeness, functional correctness, and functional appropriateness, to determine the extent to which these systems meet user requirements. A mixed-methods research design was adopted, incorporating a systematic literature review and surveys of users and technical personnel. Three institutions, Masinde Muliro University of Science and Technology (MMUST), Murang'a University of Technology (MUT), and Strathmore University (SU) were selected through purposive sampling. The target population comprised 36,016 registered off-campus access system users and 43 technical personnel across the three institutions. Simple random sampling was used to select 384 system users, while a census approach was applied to 43 technical personnel. A total of 371 responses were obtained, yielding a response rate of 86.9%. Data were analysed using descriptive statistics, thematic analysis, correlation analysis, Exploratory Factor Analysis (EFA), and multiple linear regression. The regression model demonstrated strong explanatory power ($R^2 = 0.848$), indicating that the three constructs explained 84.8% of the variance in functional suitability. Functional correctness (B = 0.411) had the strongest predictive influence, followed by functional appropriateness (B = 0.352) and functional completeness (B = 0.286). These coefficients were normalised to derive weights of 0.390, 0.340, and 0.270, which formed the basis of the Functional Suitability Index (FSI). Based on these findings, a Functional Suitability Evaluation Framework was developed and practically validated by technical personnel using five criteria: clarity, feasibility, adaptability, relevance, and completeness, which showed a composite mean of 4.18, indicating a high level of acceptance of the framework across the evaluated criteria. The main limitations of the research were its restriction to three Kenyan universities, its reliance on self-reported perception data, these were mitigated by selecting institutionally diverse universities, embedding reverse-coded questionnaire items and triangulating quantitative with qualitative data. The research concludes that functional completeness, functional correctness, and functional appropriateness are key determinants of effective off- campus access systems. It also concludes that the functional suitability of off-campus access systems can be evaluated via a framework. Lastly, the research concludes that the developed framework measures the attributes of off-campus access systems. It recommends that universities adopt the developed framework to guide system evaluation and improvement. Future research should extend the evaluation to additional ISO/IEC 25010 quality characteristics such as security, compatibility and reliability, and validate the framework across diverse institutional contexts.

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ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
APM	Application Performance Management
BPS	Board of Postgraduate Studies
CUE	Commission for University Education
CVI	Content Validity Index
EFA	Exploratory Factor Analysis
ERP	Enterprise Resource Planning
FApp	Functional Appropriateness
FAQs	Frequently Asked Questions
FCom	Functional Completeness
FCor	Functional Correctness
FSI	Functional Suitability Index
GOMS	Goals, Operators, Methods, and Selection Rules
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission
iOS	iPhone Operating System
IS	Information Systems
ISERC	Institutional Scientific and Ethics Review Committee
ISO	International Organisation for Standardisation
IT	Information Technology
KMO	Kaiser–Meyer–Olkin (Measure of Sampling Adequacy)
LMS	Learning Management System
MMUST	Masinde Muliro University of Science and Technology
MUT	Murang'a University of Technology
NACOSTI	National Commission for Science, Technology and Innovation
OCLC	Online Computer Library Centre
SPSS	Statistical Package for the Social Sciences

SSO	Single Sign-On
SU	Strathmore University
SUS	System Usability Scale
TAM	Technology Acceptance Model
UCSB	University of California, Santa Barbara
UNSW	University of New South Wales
UTAUT	Unified Theory of Acceptance and Use of Technology
UX	User Experience
VPN	Virtual Private Network
WAPM	Web Application Performance Model

OPERATIONAL DEFINITION OF TERMS

Attribute	It refers to the characteristics that define the functional suitability of an off-campus access system, including correctness, completeness, and appropriateness.
e-Resources	It refers to all the subscribed journals and eBooks in the academic libraries that require authentication to be accessed.
Evaluation	It refers to assessing the effectiveness of the off-campus access system.
Framework	A supporting structure that can be used to build an off-campus access system.
Functional Appropriateness	The degree to which the functions of the off-campus access system facilitate the efficient accomplishment of users' academic tasks.
Functional Completeness	The degree to which the off-campus access system provides all the functions required to support users' academic tasks.
Functional Correctness	The degree to which the off-campus access system performs its functions accurately and consistently, including authentication, link routing and full-text retrieval.
Functional Suitability	The off-campus access system can provide functions that meet users' needs under specified usage conditions.
Functional Suitability Index (FSI)	A weighted composite score (1–5) that aggregates the functional completeness, correctness and appropriateness scores to express the overall functional suitability of an off-campus access system.
Institutional Support	The policies, infrastructure, technical assistance and training that sustain the operation and effective use of the off-campus access system.
Off-Campus Access Systems	Academic libraries use software systems to enable students and faculty to access e-resources remotely.

Off-Campus Access User	The term in this study refers specifically to registered off-campus system users of the participating universities who access electronic resources remotely through institutional authentication tools such as EZproxy, MyLOFT, or eMaktaba. This group includes undergraduate and postgraduate students who rely on off-campus platforms for coursework, research, assignments, and academic activities.
Perceived Usefulness	Perceived usefulness evaluates how effectively the off-campus access system supports academic library users in achieving their learning and research goals.
Suitability	The appropriateness of an off-campus access system for a particular purpose.
System Accuracy	Refers to the off-campus access system's reliability in delivering correct, expected results for library users.
System Interoperability	Interoperability assesses the off-campus access system's ability to integrate and interact with other platforms or systems used by the academic library.
System Operability	The ability of the off-campus access system to remain functional, stable and controllable across different browsers, devices and network conditions.
System Security	Refers to the measures for protecting user data and ensuring secure access to library resources.
Technical Personnel	These are the people based in the academic libraries, such as systems librarians and ICT directorate personnel concerned with the operations of the off-campus access system, who are also referred to as experts in the study.
User Experience Level	The degree of familiarity, digital literacy and skill with which a user interacts with the off-campus access system.
User Interactivity	The term refers to the ability of the off-campus access system to facilitate communication between users and library electronic resources.

Validation	The process of confirming, through expert judgement and empirical evidence, that the developed framework is clear, relevant, feasible, complete and adaptable for its intended purpose.

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

The rapid advancement of digital technologies has fundamentally transformed higher education worldwide. Universities increasingly rely on digital systems to deliver instruction, facilitate research, and support scholarly communication. Traditional print collections are progressively being complemented and, in many cases, replaced by electronic databases, e- books, e-journals, institutional repositories, and digital learning platforms [1]. These digital resources enable timely access to scholarly materials, enhance research productivity, and support flexible learning models, such as blended, distance, and fully online. Consequently, academic libraries have transitioned from primarily physical service points to hybrid and digitally driven knowledge hubs [2].

As teaching and learning shift beyond the confines of physical classrooms, the demand for uninterrupted access to academic resources outside the institutional network has intensified. Students and faculty increasingly engage in research and coursework from homes, workplaces, field sites, and remote regions. However, most licensed electronic resources are restricted to authorised institutional IP ranges due to contractual and licensing agreements with publishers [3]. This creates a significant access barrier for users operating off-campus. Without appropriate remote authentication mechanisms, students and researchers cannot access subscribed electronic resources, thereby limiting academic continuity and productivity.

To address this challenge, universities have adopted library off-campus access systems designed to authenticate users remotely and extend institutional access privileges beyond campus boundaries [4]. These systems function as intermediaries between users and licensed databases, verifying credentials and routing requests through authorised institutional networks. Thus, they simulate on-campus access and ensure compliance with licensing agreements. Library off-campus access systems, therefore, serve as critical infrastructure components that bridge the gap between physical campus networks and geographically dispersed users. Common off-campus access solutions include EZproxy, MyLOFT, and locally developed solutions such as eMaktaba [5], [6], [7]. These systems vary in architecture and functionality but

generally provide remote authentication, resource linking, usage tracking, and administrative control features. Their adoption reflects a strategic effort by universities to promote equitable access to library-subscribed electronic resources regardless of physical location.

Despite their widespread implementation, library off-campus access systems are not without challenges. Users frequently report functional limitations that hinder seamless access to library electronic resources. Common issues include slow response times, intermittent system outages, complicated multi-step authentication procedures, broken or misdirected resource links, and compatibility problems across browsers and devices [3]. In contexts where internet connectivity is unstable or unevenly distributed, such as in many regions of Kenya, these challenges are further exacerbated. Fluctuating bandwidth, reliance on mobile data, and varying device capabilities significantly influence user experience and system reliability [8].

These functional shortcomings have direct implications for academic performance and research productivity. When library off-campus access systems fail to authenticate users efficiently or maintain stable connections, students may be unable to access required readings, submit assignments, or conduct timely literature reviews [9]. Researchers may experience delays in accessing journals and databases critical to ongoing projects [3]. Consequently, the reliability and effectiveness of library off-campus access systems are not merely technical concerns; they are central to academic success and institutional competitiveness [4].

The performance of these systems can be examined through the lens of software quality evaluation, particularly functional suitability. Functional suitability refers to the degree to which a software system provides functions that meet stated and implied user needs under specified conditions. According to the ISO/IEC 25010, functional suitability comprises three key attributes: functional completeness, functional correctness, and functional appropriateness. Functional completeness concerns whether all required functions are present. Functional correctness assesses the accuracy and reliability of those functions. Functional appropriateness assesses how well the functions facilitate the efficient accomplishment of user tasks [10].

In the context of library off-campus access systems, functional completeness may encompass authentication mechanisms, support for multiple databases, device compatibility, and integration with institutional systems. Functional correctness relates to accurate credential verification, consistent database routing, and stable session management. Functional appropriateness reflects the ease of login, intuitive navigation, minimal steps to access content, and smooth user workflows [3]. Together, these dimensions determine whether an off-campus access system genuinely supports remote academic engagement.

Functional suitability was prioritised over the other ISO/IEC 25010 quality characteristics, including performance efficiency, because it addresses the primary purpose for which off-campus access systems exist: enabling users to find, authenticate to and retrieve subscribed electronic resources. A system may respond quickly and use resources efficiently, yet still fail to authenticate users, omit core databases or route users to broken links, rendering it functionally unusable. Performance efficiency therefore only becomes meaningful once the required functions are present, accurate and appropriate for user tasks. In addition, characteristics such as performance efficiency, security and reliability are already substantially addressed by the mature technologies underlying these systems, whereas their functional suitability in academic library contexts remains largely unexamined [10], [11].

ISO/IEC 25010 provides a robust conceptual foundation for evaluating software quality and its application to library-specific systems; however, it presents certain limitations. The standard was developed as a generalised model for diverse software systems and does not explicitly address the contextual realities of academic library environments [10]. For example, it does not directly account for licensing constraints, publisher-specific authentication workflows, or the variability of internet infrastructure common in developing countries. Consequently, while the model offers theoretical guidance, it requires contextual adaptation to evaluate library off-campus access systems effectively.

Existing evaluation approaches for information systems often emphasise usability, system design, or technical performance in isolation. Some studies employ user satisfaction surveys, while others rely on technical performance metrics such as

uptime and response latency. However, no framework integrates these perspectives into a comprehensive, structured evaluation framework specifically tailored to library off-campus access systems. Moreover, limited empirical evidence exists regarding the relative contribution of functional completeness, correctness, and appropriateness to the functional suitability of library off- campus access systems in academic library contexts [4].

In many institutions, system evaluation remains informal and reactive, often triggered by user complaints or service disruptions rather than guided by systematic evaluation frameworks. Without structured evaluation tools, decision-makers may lack objective criteria for comparing alternative systems and prioritising improvements. This absence of context-specific evaluation frameworks restricts universities' ability to optimise their library off-campus access systems strategically [4].

The Kenyan higher education landscape provides a particularly relevant setting for examining these challenges. Rapid expansion in university enrollment, increasing digitalisation of curricula, and growing reliance on remote learning platforms have heightened the importance of reliable off-campus library access systems [9]. At the same time, disparities in internet access and technological infrastructure present additional operational constraints. In such environments, ensuring functional suitability becomes critical for maintaining equitable access to library-subscribed electronic resources.

Against this backdrop, there is a clear need for a structured, empirically grounded framework to evaluate the functional suitability of library off-campus access systems in their operational context. Such a framework should translate abstract quality constructs into measurable indicators, incorporate user experiences, and generate actionable insights for institutional improvement [12]. It should also align with recognised international standards while remaining sensitive to local infrastructural realities.

This research responds to this need by proposing a Functional Suitability Evaluation Framework tailored specifically to library off-campus access systems. Grounded in the functional suitability dimension of ISO/IEC 25010 and informed by user experiences and empirical analysis, the framework operationalises functional

completeness, correctness, and appropriateness into measurable constructs [10]. It further integrates weighted evaluation criteria and interpretive guidelines to support systematic evaluation.

The proposed framework seeks to bridge the gap between theoretical software quality models and the practical evaluation needs of academic libraries' off-campus access systems. The research aims to enhance institutional capacity for evidence-based decision-making, system optimisation, and equitable access to electronic resources by having a context-sensitive evaluation framework [12]. Improving the functional suitability of library off-campus access systems contributes not only to technical performance but also to the broader mission of higher education: enabling inclusive, reliable, and effective access to knowledge [13].

1.2 Statement of the Problem

The growing reliance on online and distance learning in higher education has made remote access to library electronic resources essential for effective teaching, learning, and research. Thus, universities have implemented library off-campus access systems that enable students and researchers to access subscribed e-resources remotely [4]. Despite their widespread adoption, many of these systems fail to deliver a functionally reliable user experience. Users frequently encounter slow system performance, complex authentication procedures, browser and device incompatibility, broken resource links, and limited technical support. These challenges disrupt academic activities and undermine the intended purpose of library off- campus access systems [9].

The effectiveness of these systems depends on their functional suitability, the extent to which they perform required functions accurately, reliably, and appropriately under diverse usage conditions. Although established software quality models such as ISO/IEC 25010 provide a foundation for evaluating functional completeness, correctness, and appropriateness, they do not sufficiently address the operational realities of remote authentication, unstable connectivity, and heterogeneous user environments [10]. Other approaches, including Fuzzy Logic–based models, Goal-Oriented Requirements Engineering, and User-Centred Design, address aspects of uncertainty and usability but lack integrated functional suitability evaluation specific to library off-campus access systems [14], [15], [16], [17]. Consequently, there is no

context-specific framework for systematically evaluating the functional suitability of off- campus access systems in academic libraries.

Empirical evidence from the Kenyan context underscores this gap where users of the systems in the universities continue to report missing databases, authentication failures and inefficient access workflows despite institutional investment in these platforms [9], [11]. This research therefore contributes a context-specific, empirically weighted evaluation framework, grounded in ISO/IEC 25010, that translates functional completeness, functional correctness and functional appropriateness into a measurable Functional Suitability Index (FSI) for library off-campus access systems.

1.3 Objectives of the Study

1.3.1 General Objective

The main objective of this research was to implement a framework for evaluating the functional suitability of library off-campus access systems.

1.3.2 Specific Objectives

To achieve the main objective, the research was guided by the following specific objectives:

i. To identify the attributes that impact the functional suitability of library off-campus access systems.
ii. To develop a weighted functional suitability evaluation framework for library off-campus access systems.
iii. To validate the proposed functional suitability evaluation framework for the library's off-campus access systems.

1.4 Research Questions

To fully achieve the stated objectives, the research sought to answer the following research questions:

i. What attributes influence the functional suitability of library off-campus access systems?
ii. What are the components, weights and structure of a functional suitability evaluation framework for library off-campus access systems?

iii. How can the proposed functional suitability evaluation framework for library off-campus access systems be validated?

1.5 Significance of the Study

The research provides a substantive contribution and improvement of the provision of services by academic libraries in the digital era. Although library off-campus access systems are adopted in most universities, academic research has not systematically assessed their functional suitability [18]. The research fills this gap by offering a framework for evaluating their functional suitability to enhance the effectiveness of these systems. The implications will be of interest to librarians, information technology personnel, and university management who are obligated to maintain and increase access to library electronic resources. Moreover, the research contributes to the current literature on digital literacy and fair access to academic materials. In the current technological learning environment, off-campus access to library electronic resources goes beyond being a convenience to a necessity. The adoption of open and distance eLearning by universities has made library electronic resources indispensable for eLearning [19].

1.6 Scope of the Study

The study was confined to three existing library off-campus access systems currently used in universities in Kenya, namely, EZproxy at Strathmore University, Emaktaba at Masinde Muliro University of Science and Technology, and MyLOFT at Murang'a University of Technology. These systems were chosen because they are the most widely implemented off-campus access systems in academic libraries and offer a wide range of features and technological solutions to aid access to library electronic resources. The research was guided by the ISO/IEC 25010 software quality model, with the evaluation focusing on three functional suitability attributes: functional correctness, functional appropriateness, and functional completeness.

1.7 Limitations of the Study

Despite the rigour applied throughout the research, the following limitations, organised by research phase, should be acknowledged together with the measures taken to mitigate them.

The descriptive, cross-sectional design captured the functional suitability of the systems at a single point in time and in only three selected universities in Kenya, namely Masinde Muliro University of Science and Technology (MMUST), Murang'a University of Technology (MUT), and Strathmore University (SU). The findings may therefore not be fully generalisable to all universities in Kenya or to countries with different infrastructural capacities. This was mitigated by purposively selecting institutions with diverse contexts, public and private, that operate three different off-campus access systems, thereby enhancing the representativeness of the findings.

The research relied primarily on self-reported questionnaire data from students and technical personnel, which is subject to perceptual and recall biases, agreement bias and individual interpretations of system performance. This was mitigated by embedding reverse-coded items within each questionnaire to detect and reduce agreement bias, piloting the instruments before the main study, and triangulating quantitative ratings with open-ended qualitative responses.

Validation was based on expert judgement by technical personnel from the three participating universities rather than a longitudinal institutional deployment. This was mitigated by using five established validation criteria (clarity, relevance, feasibility, completeness and adaptability), combining quantitative ratings with thematic analysis of expert feedback, and demonstrating the framework through a worked application of the Functional Suitability Index.

1.8 Contributions of the Thesis

This study makes both theoretical and practical contributions to the evaluation of library off- campus access systems. It advances existing knowledge by contextualising established software quality models while also providing a framework that can be applied in academic library environments.

1.8.1 Contribution to Theory

The research extends the application of the ISO/IEC 25010 software quality model by contextualising its functional suitability dimension within academic library off-campus access systems. While ISO/IEC 25010 provides a general software quality framework, this study adapts and operationalises its constructs: functional completeness, functional correctness, and functional appropriateness within library

off-campus access systems. This contextual refinement contributes to software quality evaluation literature by demonstrating how international standards can be empirically tailored to sector-specific systems. Additionally, the study contributes methodologically by integrating Exploratory Factor Analysis (EFA), multiple linear regression, and normalisation of unstandardized coefficients to derive weighted evaluation metrics. The development of a composite Functional Suitability Index (FSI) provides a structured, measurable, and replicable approach to evaluating system functional suitability.

1.8.2 Contribution to Practice

Practically, the study provides universities with a structured decision-support tool for assessing, comparing, and improving library off-campus access systems. The validated framework enables institutions to identify functional weaknesses, prioritise system improvements, enhance user experience, and promote equitable access to electronic scholarly resources. Within the Kenyan university context, where internet instability and device diversity influence remote access experiences, the framework offers a context-sensitive evaluation approach. Consequently, the study contributes to improving the reliability, usability, and sustainability of library off-campus access system services.

1.9 Organisation of the Thesis

This thesis is organised into five chapters. Chapter Two presents the literature review on library off-campus access systems, functional suitability, theoretical frameworks, and the conceptual framework. Chapter Three outlines the research methodology, including research design, sampling procedures, data collection instruments, validity and reliability testing, data analysis techniques, and ethical considerations. Chapter Four presents the data analysis, results, and interpretation. It discusses the identification of functional-suitability attributes, the development of the proposed Functional Suitability Evaluation Framework for Library Off- Campus Access Systems, and the framework's validation. Chapter Five provides a summary of the findings, conclusions drawn from the research, practical recommendations for stakeholders, and suggestions for future work.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature relevant to evaluating the functional suitability of library off-campus access systems. Guided by the research objectives, the review provides the theoretical and empirical foundation for identifying functional-suitability attributes, developing a functional-suitability evaluation framework, and validating the proposed framework. The chapter is organised into library off-campus access systems in academic libraries; existing models and approaches for evaluating information systems; the functional suitability of information systems, including the attributes that impact library off-campus access systems; software quality frameworks; the theoretical framework; the conceptual framework; and a chapter summary. To align the review with the research objectives, Section 2.2 and the functional suitability attributes examined in Section 2.4.5 address Objective One by examining library off-campus access systems and the attributes that impact their functional suitability; Sections 2.3, 2.4 and 2.5 address Objective Two by critically reviewing existing evaluation models and approaches, the application of functional suitability across information systems, and software quality frameworks, thereby informing the design of the framework; and Section 2.6, in particular Section 2.6.3, addresses Objective Three by presenting the theoretical foundations and the principles used to validate the framework.

2.2 Off-Campus Access Systems for Academic Libraries

Library off-campus access systems have become an essential component of academic libraries, enabling students, faculty, and researchers to access subscribed electronic resources beyond the university network. With the increasing adoption of digital, blended, and distance-learning models, ensuring seamless and secure remote access to electronic resources has become a critical requirement for universities globally [3]. These systems support the continuity of teaching, learning, and research by allowing authorised users to access electronic journals, databases, and e-books regardless of their physical location. Consequently, academic libraries have implemented various technical solutions to enforce licensing agreements, maintain information security, and provide user experiences comparable to on-campus access [4].

Several technologies have been adopted to facilitate off-campus access. One widely used approach is the Virtual Private Network (VPN), which enables users to connect securely to the institutional network, effectively replicating on-campus access conditions. For instance, institutions such as the University of Florida provide VPN services that allow users to access library electronic resources remotely [20]. Studies generally agree that VPNs offer a high level of security and reliability in remote authentication. However, they also require additional configuration, technical support, and user expertise, which may limit their usability, particularly among users with low technical proficiency.

Another common approach is the use of proxy servers, which authenticate users and route their requests through institutional IP addresses. Proxy-based access is particularly effective for resources restricted by IP authentication. Institutions such as the University of California, Santa Barbara (UCSB), and Duke University Libraries rely on proxy systems to provide controlled remote access to electronic resources [20]. While proxy servers are widely recognised for their efficiency and ease of deployment compared to VPNs, some studies highlight challenges, including broken links, authentication failures, and a reliance on consistent system configuration.

Despite the widespread adoption of VPNs and proxy servers, institutional practices vary significantly across regions and universities. For example, some institutions, such as Princeton University, provide seamless access via embedded authentication links on library platforms, whereas others restrict access strictly to registered users, as at the University of California, Riverside. Similarly, universities such as the University of New South Wales (UNSW) offer multiple access options to accommodate diverse user needs [20]. These variations demonstrate that, while existing technologies provide foundational solutions for off-campus access, their implementation and effectiveness vary by institutional policies and infrastructure.

However, although these technologies enable remote access, they do not fully address all functional challenges users experience. Issues such as complex authentication procedures, system incompatibility, and inconsistent access experiences persist, particularly in environments with limited infrastructure. This suggests that while existing solutions provide technical access mechanisms, there remains a need for a

structured framework to evaluate their functional suitability for effectively supporting user needs [11].

2.2.1 EZproxy

EZproxy is a well-established off-campus access system designed by the Online Computer Library Centre (OCLC), a library cooperative worldwide. EZproxy was released in the late 1990s and has achieved widespread usage due to its reliability, scalability, and ease of use [5]. The system is compatible with institutional authentication systems and allows users to access licensed electronic materials using standard web browsers without installing any software or browser extensions. EZproxy was initially implemented as an on-premises solution that used IP-based authentication. Later, in 2021, OCLC moved EZproxy to a full cloud-hosted service. Its wide variety of customisation options and its ability to be used across a range of platforms, combined with strong vendor support, have helped it remain in use in academic libraries.

While EZproxy is widely adopted and valued for its reliability, scalability, and ease of deployment, several limitations affect its functional suitability in contemporary off-campus access environments. Its IP-based authentication and browser-based access reduce the need for client-side installations; however, the system often relies on complex URL rewriting and proxy redirection mechanisms, which result in broken links, looping authentication, or access failures when publisher platforms change their URL structures [21]. This implies that, despite its widespread adoption, EZproxy may fail to provide reliable, seamless access to electronic resources consistently, thereby highlighting functional limitations that warrant a structured evaluation of its suitability for supporting user requirements.

Additionally, EZproxy's configuration and maintenance require a relatively high level of technical expertise, placing a significant administrative burden on library and IT staff, particularly in institutions with limited technical capacity. Despite OCLC's transition to a cloud-hosted service, challenges related to session timeouts, mobile device compatibility, and performance under unstable internet conditions persist, especially in low-bandwidth contexts. These limitations suggest that while EZproxy is functionally robust, its effectiveness depends heavily on institutional support, infrastructure stability, and ongoing system configuration, making it necessary to

evaluate its functional suitability in specific operational and contextual environments rather than assuming universal effectiveness [22].

2.2.2 MyLoft

MyLoft is an on-demand, off-campus access control system using a cloud platform, created in 2020 by Eclat Engineering Limited in India. The system was designed to enable access to library e-resources, especially during the COVID-19 era, when remote learning was widely adopted [6]. MyLoft requires users to be registered and issued with authentication credentials to access the library's electronic resources remotely. Moreover, the MyLoft system can only be accessed on Google Chrome and Microsoft Edge browsers and relies on a browser extension for its functionality. Despite MyLoft providing a mobile application, it does not work on older Android and iOS devices and requires users to use a VPN to access resources on their mobile devices.

While MyLOFT offers a cloud-based, analytics-rich solution for library off-campus access, several limitations affect its functional suitability across diverse academic environments. The system's reliance on specific browsers and mandatory browser extensions introduces compatibility constraints that can hinder access for users operating on unsupported browsers or restricted institutional devices [23]. This dependency reduces functional appropriateness, particularly for users with limited technical skills or those accessing resources from shared or public computers. Although MyLOFT provides a mobile application, its lack of support for older Android and iOS versions, coupled with the requirement to use a VPN on mobile devices, undermines access continuity and limits usability in low-resource settings. These constraints are significant in contexts where users depend heavily on mobile devices and experience unstable internet connectivity.

While the platform's rich usage analytics enhance administrative oversight and service optimisation, the access restrictions and additional technical requirements negatively impact user experience and overall functional suitability [24]. Consequently, MyLOFT's effectiveness is strongly influenced by user device capability, browser compatibility, and institutional support structures, highlighting the need for context-specific evaluation of its functional suitability rather than assuming uniform effectiveness across institutions.

2.2.3 eMaktaba

eMaktaba is an off-campus access system for libraries, created in 2023 by EduSurf Limited in Kenya and one of the first locally developed African solutions for academic libraries [7]. The system was designed to meet the unique requirements of universities, offering seamless integration with institutional authentication systems and advanced accessibility for various user groups. eMaktaba offers on-premises and cloud-based hosting, IP authentication, and integration with other institutional systems to facilitate authentication operations. It also has a discovery tool that allows the user to search various library resources through a single interface and can be integrated with a learning management system like Moodle. eMaktaba supports all browsers and mobile devices, and also provides complete usage statistics to aid service appraisal and optimisation [25].

eMaktaba presents a contextually responsive solution tailored to academic libraries; several considerations affect its practical functionality. The system's strengths lie in its flexible deployment options, broad browser and mobile device compatibility, and deep integration with institutional systems, including authentication services, discovery tools, and learning management platforms. These features enhance functional completeness and appropriateness by reducing access barriers and supporting diverse user needs [10].

However, as a relatively new system developed by EduSurf Limited, eMaktaba's long-term reliability and scalability remain largely dependent on continued institutional investment, vendor support, and sustained system maintenance. In addition, the effectiveness of its advanced features, such as discovery services and system integrations, may vary across institutions depending on existing infrastructure, staff technical capacity, and configuration quality [1]. While the system demonstrates strong potential for addressing functional suitability challenges in low-resource and mobile-first environments, its performance and stability require ongoing evaluation as usage scales and institutional demands evolve [26], [27]. Consequently, eMaktaba's functional suitability should be assessed empirically within specific operational contexts rather than inferred solely from its feature set.

2.2.4 Other Library Off-Campus Systems

In addition to widely adopted systems such as EZproxy, MyLOFT, and eMaktaba, several other technologies and platforms have been developed to facilitate off-campus access to library electronic resources in academic institutions. These systems vary in architecture, authentication mechanisms, and deployment models, reflecting the diverse needs and technological capacities of universities [24].

One prominent approach is the use of federated identity management systems such as OpenAthens and Shibboleth, which enable users to authenticate using institutional credentials without relying on IP-based access. These systems support Single Sign-On (SSO) and allow seamless access to multiple resources across different platforms. Studies indicate that federated authentication enhances user convenience, improves security, and supports interoperability across systems [23]. However, other studies highlight challenges related to implementation complexity, dependency on institutional identity providers, and the need for robust technical infrastructure, which may limit adoption in resource-constrained environments [24].

Another approach uses Virtual Private Network (VPN) hybrids, in which VPN access is combined with proxy or federated authentication systems to enhance flexibility and security. Hybrid models allow institutions to leverage the strengths of different technologies, providing secure network-level access alongside user-level authentication mechanisms. While these systems improve accessibility and redundancy, studies report that they may introduce additional configuration complexity, higher maintenance requirements, and usability challenges for end users [9].

Additionally, some institutions have adopted cloud-based access platforms that integrate authentication, resource discovery, and usage analytics within a single interface. These platforms aim to streamline access workflows and enhance user experience. Although such systems provide advanced features such as personalised dashboards and usage tracking, they may present limitations related to subscription costs, vendor dependency, and compatibility with existing institutional systems [1].

Despite the availability of these alternative solutions, no single system fully addresses the diverse functional requirements of academic library off-campus access

environments. Variations in infrastructure, user capabilities, and institutional support significantly influence system effectiveness. This suggests that while multiple technological solutions exist, their functional suitability cannot be assumed and must be evaluated within specific operational contexts. Consequently, there remains a need for a structured and context-sensitive framework to assess the functional suitability of library off-campus access systems across different institutional environments [12].

2.3 Existing Models and Approaches for Evaluating Information Systems

Several models have been developed to evaluate information systems, focusing on different dimensions such as user acceptance, system success, usability, and technical performance. These models provide valuable insights into system effectiveness; however, their applicability to library off-campus access systems remains limited. Most existing frameworks evaluate system characteristics in isolation and do not adequately capture the functional requirements specific to remote access environments. This section reviews key frameworks used in information systems evaluation and critically examines their limitations in the context of library off-campus access systems [12].

It is important to note that the Technology Acceptance Model, the Unified Theory of Acceptance and Use of Technology and the DeLone and McLean model reviewed below are theoretical models of user acceptance and information systems success rather than dedicated software evaluation frameworks: they explain adoption and success but do not provide criteria for evaluating functional suitability as defined by ISO/IEC 25010 [10]. They are reviewed here, in line with Objective Two, to establish what existing approaches can and cannot address, and thereby to justify the need for a dedicated functional suitability evaluation framework for library off-campus access systems.

2.3.1 Technology Acceptance Model

The Technology Acceptance Model (TAM), proposed by Fred Davis, explains system adoption based on two primary constructs: perceived usefulness and perceived ease of use [28]. The model has been widely applied in studies of digital libraries and online information systems to understand how users interact with and accept technological platforms. In the context of library off-campus access systems, TAM has been used to examine whether students and researchers perceive remote access platforms as useful

for supporting their academic tasks and whether the systems are easy to navigate and operate.

In off-campus access environments, perceived usefulness may relate to how effectively a system enables users to retrieve scholarly resources, such as e-journals, databases, and e-books, from remote locations. Perceived ease of use, on the other hand, reflects how simple it is for users to authenticate, navigate interfaces, and access full-text resources without technical difficulties. Studies applying TAM in digital library contexts generally find that users are more likely to adopt systems that are easy to use and that enhance their academic productivity. This suggests that TAM provides valuable insights into user perceptions of off-campus access systems and helps explain variations in system usage across different user groups [28] [29].

However, despite its strengths, TAM has significant limitations when applied to evaluating library off-campus access systems. The model is primarily concerned with user perception and behavioural intention, rather than actual system functionality. In off-campus access systems, critical challenges often arise from backend processes, including authentication mechanisms, proxy routing, database linking, and system integration with publisher platforms. TAM does not provide mechanisms for evaluating whether these functions are complete, accurate, or appropriate for user tasks. For instance, a system may be perceived as useful and easy to use, yet still experience authentication failures, broken links, or incomplete access to subscribed resources [25].

Furthermore, TAM does not account for contextual factors that significantly influence off- campus access systems, such as unstable internet connectivity, device compatibility, and institutional infrastructure. In environments where users rely on mobile devices or experience fluctuating network conditions, system performance may be affected independently of user perception. As a result, TAM may overestimate system effectiveness by focusing on perceived usability while overlooking functional deficiencies that directly impact access to electronic resources [30].

Therefore, while TAM is valuable in explaining user acceptance of off-campus access systems, it is insufficient as a standalone framework for evaluating their effectiveness. Its focus on perception rather than functionality limits its ability to assess whether

systems meet essential functional requirements. This highlights the need for complementary evaluation frameworks that explicitly examine functional suitability attributes, including functional completeness, functional correctness, and functional appropriateness, to provide a more comprehensive assessment of library off-campus access systems [10].

2.3.2 Unified Theory of Acceptance and Use of Technology

The Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Viswanath Venkatesh, extends earlier models such as TAM by incorporating four key constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions [31]. The model has been widely applied to evaluate technology adoption across domains, including digital libraries and e-learning platforms. In the context of library off-campus access systems, UTAUT is useful in explaining how users' expectations of system performance, ease of use, peer influence, and institutional support affect their willingness to adopt and use remote access platforms.

Within off-campus access environments, performance expectancy relates to users' belief that the system will enhance their ability to access academic resources efficiently. Effort expectancy reflects how easy it is for users to log in, navigate, and retrieve information. Social influence may include encouragement from peers, lecturers, or librarians to use off-campus systems, while facilitating conditions refer to the availability of technical support, internet connectivity, and institutional infrastructure. Studies applying UTAUT suggest that these factors significantly influence the adoption and continued use of digital systems, particularly in academic environments [31].

However, despite its broader scope compared to TAM, UTAUT remains limited in evaluating the functional performance of off-campus access systems. The model primarily focuses on user behaviour and external conditions rather than on the system's internal functionality. For example, while facilitating conditions acknowledge the importance of infrastructure and support, UTAUT does not evaluate whether the system itself provides complete access to subscribed resources or whether authentication processes function correctly. As a result, the model does not assess core system attributes such as functional completeness, correctness, or appropriateness [32].

In off-campus access systems, functional issues such as failed logins, broken proxy links, incomplete database coverage, and inconsistent access across devices are critical determinants of system effectiveness. These issues directly affect users' ability to perform academic tasks but are not explicitly captured within the UTAUT framework. Additionally, UTAUT does not distinguish between perceived system performance and actual system reliability, which may lead to discrepancies between user expectations and real system behaviour [11].

Therefore, while UTAUT provides a comprehensive understanding of factors influencing technology adoption, it is insufficient for evaluating the operational effectiveness of library off-campus access systems. Its emphasis on user perception and environmental conditions limits its ability to assess whether systems function accurately and reliably in practice. This underscores the need for evaluation approaches that incorporate both user-centred and functional dimensions to provide a holistic assessment of system suitability [10].

2.3.3 DeLone and McLean Information Systems Success Model

The DeLone and McLean Information Systems Success Model, developed by William H. DeLone and Ephraim R. McLean, provides a comprehensive framework for evaluating information systems, with dimensions including system quality, information quality, service quality, system use, user satisfaction, and net benefits [33]. The model has been widely adopted in assessing the success of digital systems, including library information systems, due to its ability to integrate both technical and user-oriented perspectives.

In the context of library off-campus access systems, system quality may relate to reliability, response time, and ease of use. In contrast, information quality refers to the relevance and accuracy of accessed resources. Service quality includes the level of technical support provided by the institution, and user satisfaction reflects the overall experience of accessing electronic resources remotely. The model therefore provides a broad framework for understanding the overall effectiveness and impact of off-campus access systems [33] [34].

However, despite its comprehensive nature, the DeLone and McLean model has limitations when applied to evaluating functional suitability. The model operates at a

high level of abstraction and does not explicitly define or measure specific functional attributes. For example, while system quality encompasses performance and reliability, it does not distinguish whether a system provides all necessary features (functional completeness), whether those features operate correctly (functional correctness), or whether they effectively support user tasks (functional appropriateness) [35].

In off-campus access systems, these distinctions are critical. A system may exhibit high system quality in terms of uptime and speed, but still fail to provide complete access to all subscribed resources. Similarly, users may report satisfaction despite experiencing occasional functional failures, leading to an overestimation of system effectiveness. The model's reliance on user satisfaction and system use as indicators of success may therefore mask underlying functional deficiencies [25].

Furthermore, the DeLone and McLean model does not explicitly account for the complexity of remote authentication processes, proxy configurations, and integration with external publisher systems, which are central to off-campus access environments. These factors significantly influence system functionality but are not directly evaluated within the model [26]. Therefore, although the DeLone and McLean model offers a valuable framework for assessing overall system success, it lacks the specificity required to evaluate the functional suitability of library off-campus access systems. This limitation highlights the need for more targeted evaluation frameworks that explicitly address functional attributes critical to remote access environments [12].

2.3.4 Usability Evaluation Frameworks

Usability evaluation frameworks provide structured approaches for assessing the ease of use, efficiency, and user interaction with information systems. Among the most widely referenced is the heuristic evaluation framework proposed by Jakob Nielsen, which identifies 10 usability principles, including visibility of system status, error prevention, and consistency, for diagnosing interface design problems [36]. Another prominent framework is the System Usability Scale (SUS), developed by John Brooke, which provides a standardised ten-item questionnaire for measuring perceived usability across a wide range of systems [37]. Additionally, the Goals, Operators, Methods, and Selection rules (GOMS) model offers a cognitive framework

for evaluating user efficiency by analysing the steps users take to accomplish tasks within a system [38]. These frameworks evaluate aspects such as interface design, navigation, consistency, error prevention, and user satisfaction, making them widely applicable in digital library environments.

In the context of library off-campus access systems, usability frameworks are particularly relevant in assessing how easily users can interact with system interfaces. This includes evaluating login processes, search functionality, navigation between resources, and overall user experience. A well-designed interface can significantly enhance user satisfaction and reduce barriers to accessing electronic resources [39]. However, usability frameworks primarily focus on front-end interaction and do not adequately address backend system functionality. Off- campus access systems rely heavily on complex backend processes such as authentication mechanisms, proxy routing, and database linking. These processes determine whether users can successfully access subscribed resources, yet they are not directly evaluated within usability frameworks [25] [38].

For instance, a system may have an intuitive, user-friendly interface but still fail to grant access due to authentication errors or broken links. Similarly, usability frameworks do not assess whether all required resources are available or whether system functions operate accurately and consistently. As a result, usability evaluation alone may lead to an incomplete assessment of system effectiveness [40]. Additionally, usability frameworks do not fully account for contextual challenges such as unstable internet connectivity, device variability, and institutional infrastructure, which significantly affect off-campus access systems. These factors influence system performance beyond interface design and require a broader evaluation approach [30].

Therefore, while usability frameworks are valuable for improving user experience, they are insufficient for evaluating the overall functionality of library off-campus access systems. A comprehensive evaluation must incorporate both usability and functional performance to ensure that systems not only provide a positive user experience but also deliver reliable and complete access to electronic resources [41] [42].

2.3.5 Technical Performance Evaluation Approaches

Technical performance evaluation approaches are reviewed as the final category of existing evaluation approaches because, unlike the perception-oriented models above, they represent the objective, metric-based tradition of system evaluation. Reviewing them completes the coverage of existing evaluation approaches required by Objective Two and demonstrates that even objective performance measurement does not capture functional completeness, functional correctness or functional appropriateness.

Technical performance evaluation approaches assess information systems using quantitative metrics such as system uptime, response time, throughput, and latency [20]. Several established approaches are used for this purpose. Load testing frameworks, such as Apache JMeter, evaluate system behaviour under varying levels of concurrent user demand by measuring response times and throughput under simulated real-world conditions [43]. Application Performance Management (APM) approaches, exemplified by tools such as New Relic and Dynatrace, provide continuous monitoring of system health, resource utilisation, and error rates in live environments [44]. Additionally, the Web Application Performance Model (WAPM) provides a structured approach to evaluating the end-to-end performance of web-based systems, incorporating metrics such as latency, bandwidth utilisation, and server response times [45]. These approaches provide objective measures of system efficiency and are widely used in evaluating the performance of digital systems.

In library off-campus access systems, technical performance metrics are important in determining how quickly and reliably users can access electronic resources. High system uptime ensures availability, while low response times improve user experience. These metrics are particularly relevant in environments with high user demand and limited bandwidth. However, technical performance evaluation approaches have significant limitations when used in isolation. They focus primarily on system efficiency and do not assess whether the system effectively meets user needs. For example, a system may demonstrate excellent performance in terms of speed and uptime but still fail to provide access to certain databases or may produce incorrect authentication results [32].

In off-campus access systems, functionality is not only about performance but also about the availability, accuracy, and appropriateness of system features. Technical

metrics do not capture whether the system provides complete access to resources, whether authentication processes are accurate, or whether the system supports efficient task completion. As a result, performance evaluation alone may overlook critical functional deficiencies [10]. Furthermore, technical performance approaches do not account for user experience or contextual factors, such as device compatibility and network variability, which significantly influence system effectiveness in remote environments. This limits their applicability in evaluating the overall suitability of off-campus access systems [44].

Therefore, while technical performance metrics are essential for assessing system efficiency, they do not provide a comprehensive evaluation of system functionality. A holistic evaluation framework must integrate performance metrics with functional and user-centred attributes to accurately assess the effectiveness of library off-campus access systems [35].

2.4 Functional Suitability of Information Systems

Functional suitability is a fundamental dimension in evaluating the effectiveness of information systems, as it determines the extent to which a system provides functions that meet user needs under specified conditions. According to the ISO/IEC 25010, functional suitability comprises three key attributes: functional completeness, functional correctness, and functional appropriateness. These attributes are essential in assessing whether systems deliver the required features, perform accurately, and support efficient task execution [10].

Functional suitability has been widely examined across different categories of information systems, including Enterprise Resource Planning (ERP) systems, Learning Management Systems (LMS), websites, and library management systems. While these systems operate in different domains, they share a common requirement: supporting user tasks effectively through reliable, complete functionality. This section reviews how functional suitability has been applied in these systems and highlights key limitations relevant to the evaluation of library off- campus access systems [45] [46].

Although the scope of this research is confined to library off-campus access systems, functional suitability studies dedicated to these systems are scarce. The review

therefore deliberately draws on these adjacent categories of information systems because they share the core requirement of delivering complete, correct and appropriate functions to users, and the lessons from their evaluation are transferable to library off-campus access systems within the scope already defined for this study.

2.4.1 Enterprise Resource Planning Systems

In Enterprise Resource Planning (ERP) systems, functional suitability is critical because they integrate multiple organisational processes, such as finance, human resources, procurement, and supply chain management. Functional completeness in ERP systems ensures that all necessary business processes are supported within a single integrated platform. Missing functionalities can lead to process inefficiencies and the need for external systems, thereby reducing overall system effectiveness [18]. Functional correctness focuses on the accuracy and reliability of outputs, including financial reports, transaction records, and operational data, where errors can have significant organisational consequences. Functional appropriateness evaluates how efficiently users can perform tasks, considering workflow design and system usability.

Despite their comprehensive capabilities, ERP systems often face challenges, including implementation complexity, misalignment with organisational processes, and high levels of customisation. Research by Ngai, Law, and Wat [35] demonstrated that functional misalignment between ERP systems and organisational needs is one of the most frequently cited causes of ERP implementation failure, highlighting that technical performance alone is insufficient to determine system effectiveness. These findings are particularly relevant to library off-campus access systems, where functional misalignment, such as authentication mechanisms that do not accurately verify user credentials or proxy configurations that fail to route users to the correct resources, can equally result in system failure despite adequate technical performance.

2.4.2 Learning Management Systems

Learning Management Systems (LMS) are designed to support teaching and learning activities, making functional suitability essential for effective educational delivery. Functional completeness in LMS platforms encompasses features such as course content management, assessments, discussion forums, grading systems, and communication tools. Functional correctness ensures that these features operate reliably, including accurate grading mechanisms, proper content delivery, and

consistent system performance during peak usage, while functional appropriateness evaluates how well the system supports learning processes, including ease of navigation, accessibility, and compatibility across devices [18].

However, studies indicate that many LMS platforms face challenges, including system overload, usability issues, and limited integration with other academic tools. Research by Cidral, Oliveira, Di Felice, and Aparicio [47] found that functional completeness and correctness were significant determinants of LMS success. At the same time, Al-Fraihat, Joy, Masa'deh, and Sinclair [48] demonstrated that functional appropriateness was a stronger predictor of perceived system effectiveness than technical performance metrics alone. These findings equally apply to library off-campus access systems, where incomplete resource coverage, authentication errors, and poorly designed access interfaces similarly undermine remote user satisfaction and system adoption.

Despite the relevance of LMS evaluation research, its direct applicability to library off-campus access systems is limited by important contextual differences. LMS platforms operate within structured, course-based institutional environments where users and content are predefined. In contrast, library off-campus access systems must support unstructured, self-directed information seeking across diverse databases and electronic resources from outside institutional networks. Nevertheless, the core functional suitability dimensions identified in LMS research, completeness, correctness, and appropriateness, remain transferable, providing a valuable theoretical basis for evaluating whether library off-campus access systems deliver reliable, accurate, and user-aligned access to subscribed electronic resources for remote users [18].

2.4.3 Academic Websites

Websites, particularly institutional and academic websites, are evaluated based on their ability to provide information and support user interaction. Functional completeness in websites includes features such as search, navigation, content accessibility, and interactive services. Functional correctness ensures that all website components work as intended, including links, content, and forms. In contrast, functional appropriateness evaluates how efficiently users can locate and use information, considering factors such as usability and interface design [39].

Research by Olsina and Rossi [49] established that functional suitability is a core quality dimension in website evaluation, showing that websites that fail to deliver complete and correct functionality experience significantly reduced user engagement and trust. Similarly, Fernandez, Insfran, and Abrahão [50] found that functional appropriateness, particularly the alignment between website features and user information-seeking behaviour, was a stronger determinant of perceived website quality than aesthetic design alone. These findings are directly relevant to library off-campus access systems, which share many characteristics with institutional websites, including the need for reliable navigation, accurate linking to electronic resources, and interfaces that efficiently support remote user information-seeking behaviour.

2.4.4 Library Management Systems

Library Management Systems, also referred to as Integrated Library Systems, are used to manage core library operations such as cataloguing, circulation, acquisitions, and user services. Functional completeness ensures that all essential library functions are supported within the system, while functional correctness focuses on the accuracy of bibliographic records, transaction processing, and system outputs. Functional appropriateness evaluates how efficiently librarians and users can interact with the system to perform tasks such as searching, borrowing, and managing resources [22].

Research by Breeding [51] highlighted that functional completeness and correctness are the most critical determinants of Library Management System effectiveness, noting that gaps in functionality and inaccuracies in bibliographic data significantly undermine institutional confidence in these systems. Furthermore, Kochtanek and Matthews [52] demonstrated that functional appropriateness, particularly the alignment between system workflows and actual library operational processes, was a key factor distinguishing successful from unsuccessful Library Management System implementations.

Although modern Library Management Systems provide extensive functionality, challenges such as system interoperability, data inconsistencies, and limited customisation options have been reported, which may affect their ability to meet user and institutional requirements fully [22]. These challenges are particularly instructive for library off-campus access systems, which must interoperate with multiple external

systems, including authentication servers, database platforms, and institutional networks.

2.4.5 Functional Suitability Attributes in Library Off-Campus Access Systems

The effectiveness of library off-campus access systems in academic libraries depends on whether they reflect a user-driven philosophy, achieve the identified academic goals, and align with institutional objectives. One of the most critical aspects in assessing such systems is functional suitability, defined by ISO/IEC 25010 as the degree to which a software system provides functions that meet the implied and stated needs when used under specified conditions [10].

The three ISO/IEC 25010 sub-characteristics, functional completeness, functional correctness and functional appropriateness, were selected as the framework's core dimensions because they jointly define functional suitability in ISO/IEC 25010 [10]; they map directly onto the failure modes most frequently reported for off-campus access systems, namely missing resources, inaccurate operations and inefficient workflows; and their selection was subsequently confirmed empirically, as each emerged as a distinct construct in this study's exploratory factor analysis (Section 4.4.1). User experience level and institutional support are additionally examined as contextual factors because prior studies show that they moderate how functionality is experienced [47], [53]. The following subsections discuss each of these five elements.

2.4.5.1 Functional Completeness

Functional completeness, as defined by ISO/IEC 25010, refers to the extent to which a system provides all required functionalities for users to accomplish their intended tasks effectively and without limitations [10]. In the context of library off-campus access systems, this attribute is critical because such systems are expected to replicate the full range of on-campus library services for remote users. This includes uninterrupted access to licensed electronic resources regardless of user location.

A functionally complete off-campus access system is therefore expected to incorporate key features, such as remote authentication mechanisms, federated identity systems, and Virtual Private Networks (VPNs), which enable secure, institutionally authorised access to electronic resources [11]. In addition, the system should provide an integrated digital library interface that supports advanced search,

filtering, browsing, citation management, and content export functionalities. Seamless integration across different resource types, including journal databases, e-books, digital course reserves, and open repositories, is also necessary to ensure continuity of access and effective academic engagement [51].

The strength of functional completeness lies in its ability to ensure comprehensive coverage of user needs. A system that fully replicates on-campus services reduces access inequalities and supports uninterrupted teaching, learning, and research activities. This is particularly important in higher education, where timely access to academic resources directly influences learning outcomes and research productivity. As noted by Chavan and Naikar [52], partial system deployment limits usability and undermines the effective utilisation of digital platforms, especially in academic environments where consistent access to information is essential.

However, despite its importance, functional completeness presents a key limitation: it assumes that the presence of features guarantees effective access. In practice, many off-campus access systems offer a broad set of functionalities but fail to deliver seamless user experiences due to poor integration, inconsistent resource coverage, or unreliable access mechanisms. For example, systems may support authentication and routing but still fail to provide full-text access across all subscribed resources or lack effective integration with institutional learning platforms. These gaps result in access disruptions, user frustration, and reduced system adoption [25].

This limitation highlights that functional completeness alone is insufficient for evaluating system effectiveness. A system may appear complete in design but remain functionally inadequate in practice. Within the proposed functional suitability evaluation framework, functional completeness is therefore treated as a foundational but not standalone attribute, requiring integration with functional correctness and functional appropriateness to ensure that system features are not only available but also reliable and efficient in supporting user tasks [10].

2.4.5.2 Functional Correctness

Functional correctness, as defined by the ISO/IEC 25010, refers to the ability of a system to perform its intended functions accurately and consistently [10]. In the context of library off- campus access systems, this involves the correct operation of

authentication mechanisms, database connectivity, file retrieval processes, link resolution, and metadata access. These functions form the backbone of remote access systems, and any failure, such as broken links, failed proxy redirects, or inaccurate authentication responses, can significantly disrupt access to electronic resources.

The strength of functional correctness lies in its role in ensuring system reliability and user trust. In academic environments, where users rely on timely, accurate access to information, system errors directly affect learning and research outcomes. As noted by Chopra, Sharma, and Singh [54], users tend to abandon systems that produce erroneous results, fail to provide full- text access, or crash during authentication processes. This demonstrates that correctness is not merely a technical requirement but a critical determinant of system usability and adoption.

Unlike functional completeness, which focuses on feature availability, functional correctness evaluates whether those features operate as intended. A system may provide access to multiple databases and services, but if these functionalities do not perform accurately and consistently, the system becomes ineffective. Therefore, correctness is essential in distinguishing between systems that are merely feature-rich and those that are operationally dependable. Maintaining high levels of functional correctness requires continuous system testing, monitoring, and quality assurance to ensure consistent performance across different devices, browsers, and network conditions [32].

However, functional correctness also presents limitations when considered in isolation. It primarily focuses on operational accuracy without addressing the availability or usability of system features. A system may execute its processes correctly but still fail to meet user needs if essential features are missing or difficult to access. Additionally, in off-campus access environments, perceived correctness may be affected by external factors such as unstable internet connectivity, device compatibility issues, and institutional infrastructure limitations, which are not directly controlled by the system itself [26].

In practice, functional correctness in off-campus access systems is frequently compromised by authentication failures, broken redirects, inconsistent access permissions, and unstable link resolution, even when systems are designed to perform

correctly [11]. These issues undermine reliability and erode user confidence, particularly in remote environments where users have limited alternatives for accessing academic resources.

Within the proposed functional suitability evaluation framework, functional correctness is therefore treated as a necessary but not sufficient attribute. While it ensures that system functions operate accurately, it must be evaluated alongside functional completeness and functional appropriateness to provide a comprehensive assessment of system effectiveness. In the Kenyan university context, where network instability and device diversity amplify the impact of system errors, assessing functional correctness is particularly critical in distinguishing between systems that merely provide access features and those that deliver consistent, dependable, and accurate access under real-world conditions [10].

2.4.5.3 Functional Appropriateness

Functional appropriateness, as defined by the ISO/IEC 25010, refers to the extent to which system functionalities enable users to accomplish tasks effectively and efficiently [10]. Unlike functional completeness and functional correctness, which focus on the availability and accuracy of features, functional appropriateness evaluates the relevance and efficiency of those features in supporting user tasks.

In the context of library off-campus access systems, this attribute is particularly important given the diversity of user needs across academic environments. Different user groups, such as students, faculty members, and researchers, interact with systems in different ways. For instance, researchers may require advanced filtering, citation export tools, and comprehensive database navigation, whereas students may prioritise simple search functionality and intuitive navigation. Functional appropriateness, therefore, ensures that system design aligns with these varying academic requirements [55] [56].

The strength of functional appropriateness lies in its focus on task efficiency and user productivity. Systems that streamline workflows, reduce unnecessary steps, and present information intuitively enhance the overall effectiveness of academic activities. As noted by Basak and Roy [51], systems may be technically robust but still ineffective if their functionalities do not align with user intentions. Features such as

mobile-friendly interfaces, seamless integration with learning management systems, and simplified authentication processes significantly improve system usability and efficiency.

However, functional appropriateness also presents notable limitations. It is inherently context- dependent and partially subjective, as perceptions of efficiency and usability may vary across different user groups and environments. What is considered efficient for an experienced researcher may be complex for a novice user. Additionally, inefficiencies may arise not only from system design but also from external constraints such as device limitations, bandwidth availability, or user digital literacy. As a result, evaluating functional appropriateness in isolation may lead to inconsistent or perception-based assessments [57].

In practice, many off-campus access systems demonstrate gaps in functional appropriateness despite being functionally complete and correct. Systems that require multiple authentication steps, depend on browser-specific extensions, or present non-intuitive navigation structures often discourage user engagement [54]. These inefficiencies can increase task completion time and reduce overall system adoption, particularly in environments where users operate under time or connectivity constraints.

Within the proposed functional suitability evaluation framework, functional appropriateness is therefore treated as a complementary but essential attribute, ensuring that system functionality is not only available and accurate but also aligned with real-world academic tasks. In the Kenyan university context, where users frequently rely on mobile devices and experience varying levels of connectivity, evaluating functional appropriateness is critical in determining whether off-campus access systems effectively support efficient and meaningful academic engagement [10].

2.5 Functional Suitability Frameworks

Software quality frameworks provide the formal structures within which functional suitability is defined and assessed. Three generations of quality models dominate the literature: McCall’s software quality model, the ISO/IEC 9126 quality model, and the

ISO/IEC 25010 product quality model. This section reviews the three frameworks and justifies the selection of ISO/IEC 25010 as the framework underpinning this research.

2.5.1 McCall's Software Quality Model

McCall's software quality model, developed by McCall, Richards and Walters in 1977, was among the earliest systematic attempts to define and measure software quality [64]. The model organises eleven quality factors into three perspectives: product operation (correctness, reliability, efficiency, integrity and usability), product revision (maintainability, flexibility and testability) and product transition (portability, reusability and interoperability). Each factor is decomposed into quality criteria, which are in turn assessed through metrics, establishing the factor–criteria–metric hierarchy that later quality standards inherited.

In the context of library off-campus access systems, McCall's correctness factor, defined as the extent to which a program satisfies its specifications and fulfils the user's mission objectives, anticipates the modern notion of functional suitability. However, the model presents significant limitations. Its measurement relies largely on subjective checklists scored by evaluators; it predates networked, cloud-hosted and browser-mediated systems and therefore offers no guidance on remote authentication, resource linking or cross-device access; and it provides no decomposition of functionality into the completeness, correctness and appropriateness dimensions required to diagnose the specific functional failures observed in off-campus access environments [32]. Consequently, while historically foundational, McCall's model is insufficient as an evaluation basis for this research.

2.5.2 The ISO/IEC 9126 Quality Model

The ISO/IEC 9126 quality model, first issued in 1991 and revised in 2001, defined software product quality through six characteristics: functionality, reliability, usability, efficiency, maintainability and portability, and distinguished among internal quality, external quality and quality in use [65]. Functionality was subdivided into suitability, accuracy, interoperability, security and compliance, marking the first standardised appearance of suitability as a measurable attribute of software functionality. The strength of ISO/IEC 9126 lay in its international consensus and its hierarchical decomposition of quality into sub-characteristics that could be mapped to metrics.

Nevertheless, the model exhibited weaknesses that limit its application to this research. Several of its sub-characteristics overlap and are ambiguously defined; security is treated as a mere sub-characteristic of functionality rather than a quality characteristic in its own right; and functional suitability is captured only partially through the single sub-characteristic of suitability, without separating functional completeness from functional appropriateness [35]. Moreover, ISO/IEC 9126 was withdrawn and superseded by the ISO/IEC 25000 (SQuaRE) series in 2011, meaning that reliance on it for the evaluation of present-day systems would anchor the study to an obsolete standard [32].

2.5.3 The ISO/IEC 25010 Product Quality Model

ISO/IEC 25010, part of the Systems and Software Quality Requirements and Evaluation (SQuaRE) series, replaced ISO/IEC 9126 in 2011 and was revised in 2023 [10]. It defines eight product quality characteristics: functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability. Crucially for this research, ISO/IEC 25010 elevates functional suitability to a full quality characteristic decomposed into three sub-characteristics: functional completeness, functional correctness and functional appropriateness, and promotes security and compatibility to stand-alone characteristics.

Compared with its predecessors, ISO/IEC 25010 is the only framework that satisfies the three requirements of this research: it is the current international standard for software product quality; it decomposes functionality into three separately diagnosable dimensions that map directly onto the failure modes reported for library off-campus access systems, namely missing resources (completeness), inaccurate operations (correctness) and inefficient workflows (appropriateness); and it is compatible with quantitative operationalisation through measurable indicators [10], [32], [35]. For these reasons, ISO/IEC 25010 was selected as the quality framework underpinning this research.

2.6 Theoretical Framework

This study is grounded in three complementary theoretical perspectives that guide both the conceptualisation and measurement of functional suitability in library off-campus access systems. ISO/IEC 25010 provides the primary conceptual foundation by defining functional suitability in terms of functional completeness, functional

correctness, and functional appropriateness. In addition, a composite index and normalisation approach informs the aggregation of these constructs into a single evaluative metric, enabling the development of the Functional Suitability Index (FSI) through weighted and normalised contributions. In addition, the DeLone and McLean Information Systems Success Model, reviewed in Section 2.3.3, is incorporated to explain how system quality translates into use, user satisfaction and net benefits, thereby situating functional suitability within the broader success of information systems [33]. To ensure the framework is applicable in real-world academic library environments, practical validation principles, namely clarity, relevance, feasibility, completeness, and adaptability, are incorporated to assess its usability and operational effectiveness [10], [66].

2.6.1 ISO/IEC 25010 Software Product Quality Model

This research adopts ISO/IEC 25010:2023 as the primary theoretical framework for defining functional suitability in off-campus access systems for libraries. ISO/IEC 25010 is part of the Systems and Software Quality Requirements and Evaluation (SQuaRE) series. It provides a comprehensive and structured model for describing software product quality through clearly defined characteristics and sub-characteristics [10]. The model identifies eight primary quality characteristics: functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability, each representing a distinct dimension of system quality. Collectively, these characteristics provide a holistic view of software performance, enabling a systematic understanding of how different attributes contribute to overall system effectiveness [10].

Within the context of library off-campus access systems, these quality characteristics can be interpreted in relation to how such systems are designed and deployed to support remote access to electronic resources. Several of these characteristics are already substantially addressed through established technologies and operational practices. For instance, security is embedded through authentication protocols, such as proxy servers, federated identity systems, and secure login mechanisms, to protect licensed resources and user credentials. Similarly, compatibility is achieved through browser-based access models and cross-platform support, enabling users to access resources across diverse devices and operating systems. Performance efficiency is

managed through server optimisation, caching, and bandwidth allocation strategies, ensuring acceptable response times even during peak academic periods. In addition, reliability is supported through system redundancy, session management, and fault-tolerant configurations that minimise service interruptions [10], [45].

Other characteristics, such as usability, maintainability, and portability, are also increasingly incorporated into modern off-campus access systems. Usability is enhanced through simplified interfaces and integration with library discovery tools, while maintainability is supported through modular configurations and centralised management of access rules. Portability is facilitated by cloud-based deployments and platform-independent architectures, enabling flexible implementation across institutions. These developments suggest that, to a considerable extent, existing off-campus access systems have evolved to address these broader software quality dimensions [32], [67].

Despite these advancements, a critical gap remains regarding functional suitability. While systems may be secure, compatible, and reliable, they do not always guarantee that users can access all required resources, retrieve accurate content, or complete tasks efficiently. Issues such as incomplete database coverage, broken authentication pathways, inconsistent link resolution, and inefficient access workflows continue to affect many implementations. This indicates that existing evaluations tend to emphasise supporting system qualities while underexamining whether the core functional purpose of the system, effective access to library electronic resources, is fully achieved [11], [68].

A major strength of ISO/IEC 25010 lies in its conceptual clarity and standardisation, which allows consistent interpretation of software quality across domains [32]. However, the model is inherently generic and does not explicitly address the specialised operational requirements of off-campus access systems, such as proxy routing and integration with external publisher platforms. Furthermore, ISO/IEC 25010 provides a conceptual classification rather than an operational framework, as it does not specify how quality characteristics should be measured or compared in practice [35]. This creates a gap between theoretical definition and empirical evaluation, particularly in contexts requiring quantifiable assessment.

Within this study, functional suitability is therefore selected as the primary quality characteristic because it directly reflects whether a system achieves its core objective: enabling effective access to library electronic resources. According to ISO/IEC 25010, functional suitability is defined as the degree to which a system provides functions that meet stated and implied user needs under specified conditions [10]. It is conceptualised through three interrelated sub-characteristics: functional completeness, functional correctness, and functional appropriateness, which together capture the breadth, accuracy, and efficiency of system functionality [10].

Functional completeness refers to the extent to which all required functions are available within the system. In off-campus access systems, this includes authentication mechanisms, access pathways to subscribed databases, integration with digital library platforms, and support for diverse resource types. Functional correctness focuses on the accuracy and consistency of these functions, ensuring reliable authentication, correct database routing, and stable retrieval of full- text resources. Functional appropriateness evaluates how effectively these functions support efficient task completion, emphasising streamlined workflows and intuitive access processes across different devices and environments [45].

Although these sub-characteristics provide a structured lens for understanding system functionality, they are interdependent and cannot independently capture overall functional suitability. A system may be complete but incorrect, correct but inefficient, or appropriate but lacking essential features. This reinforces the need for an integrated approach that considers all three dimensions simultaneously [35].

Therefore, while ISO/IEC 25010 offers a robust theoretical foundation for conceptualising software quality, its limitations in domain specificity and operational guidance necessitate adaptation. This study addresses this gap by focusing on functional suitability and contextualising its sub-characteristics within library off-campus access systems, thereby providing a targeted and context-sensitive basis for evaluating system effectiveness [32]. Figure 2.1 illustrates the ISO/IEC 25010 and its eight software quality characteristics, which collectively define overall system effectiveness. In the context of library off-campus access systems, these characteristics can be interpreted in terms of their support for off-campus access to subscribed electronic resources [10].



Figure 2.1: ISO/IEC 25010 software quality diagram

2.6.2 Composite Index and Normalisation Approach

While the ISO/IEC 25010 provides a conceptual basis for defining functional suitability, it does not specify how its constructs can be quantitatively combined to support comparative evaluation. To address this limitation, this study adopts a composite index and normalisation approach, which is widely used in evaluation research to aggregate multiple dimensions into a single interpretable measure [66].

In this research, functional suitability is conceptualised as a multidimensional construct comprising functional completeness, functional correctness, and functional appropriateness. Composite index approaches allow these dimensions to be integrated into a unified measure, enabling systematic comparison of system performance across different contexts [69]. A key strength of this approach is its ability to move beyond descriptive assessment by providing a structured and quantitative basis for evaluation, particularly in cases where multiple interrelated factors influence overall system effectiveness.

Normalisation plays a critical role in this process by ensuring that individual components contribute proportionally to the overall measure. Through normalisation, weights derived from empirical relationships are expressed on a common scale, allowing meaningful aggregation of constructs that may differ in magnitude or

measurement units [70]. This enhances interpretability and supports consistent comparison across systems.

However, the composite index and normalisation approach also present limitations. First, composite measures may mask underlying variation among individual constructs, potentially obscuring specific areas of system strength or weakness. Second, the approach assumes that multiple dimensions can be meaningfully aggregated, which may oversimplify complex relationships between system attributes [69]. Additionally, normalisation procedures, while improving comparability, are sensitive to the choice of method and underlying data distribution, which may influence the resulting weights and interpretations [70]. Despite these limitations, the approach provides a practical mechanism for operationalising multidimensional constructs, addressing the gap between conceptual models and measurable evaluation frameworks. In this study, this approach provides a theoretical basis for representing functional suitability as a composite construct that captures the combined influence of functional completeness, functional correctness, and functional appropriateness [71] [72].

2.6.3 Practical Validation of the Framework

To ensure that the proposed functional suitability evaluation framework is applicable in real- world academic library environments, this study adopts practical validation principles derived from design science and information systems evaluation literature. Design science research emphasises that artefacts must demonstrate both theoretical soundness and practical utility within their intended context [73], [74]. Accordingly, this study evaluates the framework using five key principles: clarity, relevance, feasibility, completeness, and adaptability.

Clarity refers to the extent to which the framework is logically structured, well-defined, and easily understood by its intended users. A clear framework enhances interpretability and supports consistent application by librarians, system administrators, and decision-makers. Hevner et al. [73] emphasise that clarity is essential for effective communication and the use of design artefacts. However, clarity also presents a limitation: a framework may be well- structured and easy to understand yet still lack depth or fail to capture critical evaluation dimensions. In this sense, clarity

improves usability but does not guarantee analytical robustness or completeness of evaluation [75].

Relevance assesses whether the framework addresses the actual operational challenges of library off-campus access systems, including authentication, resource accessibility, and user interaction patterns. Venable et al. [74] highlight that artefacts must align closely with the problem context to ensure practical value. The strength of relevance lies in its ability to keep the framework meaningful and applicable to real-world environments. However, relevance is inherently context-dependent, meaning that a framework designed for one institutional setting may not fully reflect the priorities or constraints of another. This limits generalizability and requires careful contextual interpretation during application.

Feasibility evaluates whether the framework can be realistically implemented within existing institutional constraints, including technical infrastructure, human capacity, and available resources. A feasible framework is more likely to be adopted and sustained in practice. Hevner et al. [73] argue that practical applicability is a key determinant of the success of artefacts. However, feasibility may also constrain the depth and sophistication of a framework. In resource-limited environments, simplifying a framework to ensure feasibility may result in reduced analytical rigour or omission of important evaluation dimensions.

Completeness, in the context of validation, refers to the extent to which the framework captures all essential aspects needed to evaluate functional suitability. A complete framework ensures comprehensive coverage of relevant constructs and reduces the risk of overlooking critical system attributes. Venable et al. [74] note that adequate coverage of the problem domain is necessary for meaningful evaluation. However, completeness comes at a trade-off: as frameworks become more comprehensive, they may also become more complex and harder to apply. This complexity can reduce usability and discourage adoption, particularly among users with limited technical expertise.

Adaptability considers the extent to which the framework can be applied across different institutional contexts, system configurations, and technological environments. In academic libraries, where infrastructure and user needs vary widely,

adaptability enhances the framework's long-term relevance and applicability. Design science literature emphasises that adaptable artefacts are more likely to achieve sustained use across diverse contexts [73]. However, increased adaptability may reduce standardisation, making it more difficult to compare results across institutions. This creates a tension between flexibility and consistency in evaluation outcomes.

These principles strengthen the framework by ensuring that it is not only theoretically grounded but also practically usable. However, their limitations highlight that practical validation alone cannot guarantee evaluation accuracy. These principles are inherently qualitative and context- sensitive, meaning they must be complemented by theoretical grounding and quantitative measurement approaches. In this study, they serve as supporting criteria that enhance the usability and applicability of the framework without replacing the core functional suitability constructs or the composite measurement approach [76] [77].

2.7 Conceptual Framework

The conceptual framework adopted in this research is grounded in the ISO/IEC 25010 software product quality model, specifically its functional suitability dimension. According to ISO/IEC 25010, functional suitability consists of three sub-characteristics: functional completeness, functional correctness, and functional appropriateness [10]. These constructs form the independent variables in this research. Functional completeness refers to the extent to which off-campus access systems provide all required features for off-campus academic tasks. Functional correctness concerns the accuracy and reliability of authentication, routing, and content access processes. Functional appropriateness evaluates whether the system enables efficient and effective task completion with minimal procedural complexity. Together, these constructs determine the overall functional suitability of off-campus access systems, which serves as the dependent variable in this research.

In addition, the framework incorporates two moderating variables: user experience level and institutional support [53], [12]. User experience level is operationalised through digital literacy, ease of use, and device compatibility, reflecting how individual capabilities influence system utilisation. Institutional support includes technical assistance, staff responsiveness, training, and system maintenance practices that sustain operational effectiveness. These moderating variables are hypothesised to

influence the strength and direction of the relationship between the functional suitability components and system performance. The framework, therefore, proposes that functional completeness, functional correctness, and functional appropriateness significantly influence the functional suitability of off-campus access systems and that this relationship is shaped by user experience level and institutional support. Figure 2.2 presents the conceptual framework guiding this research.

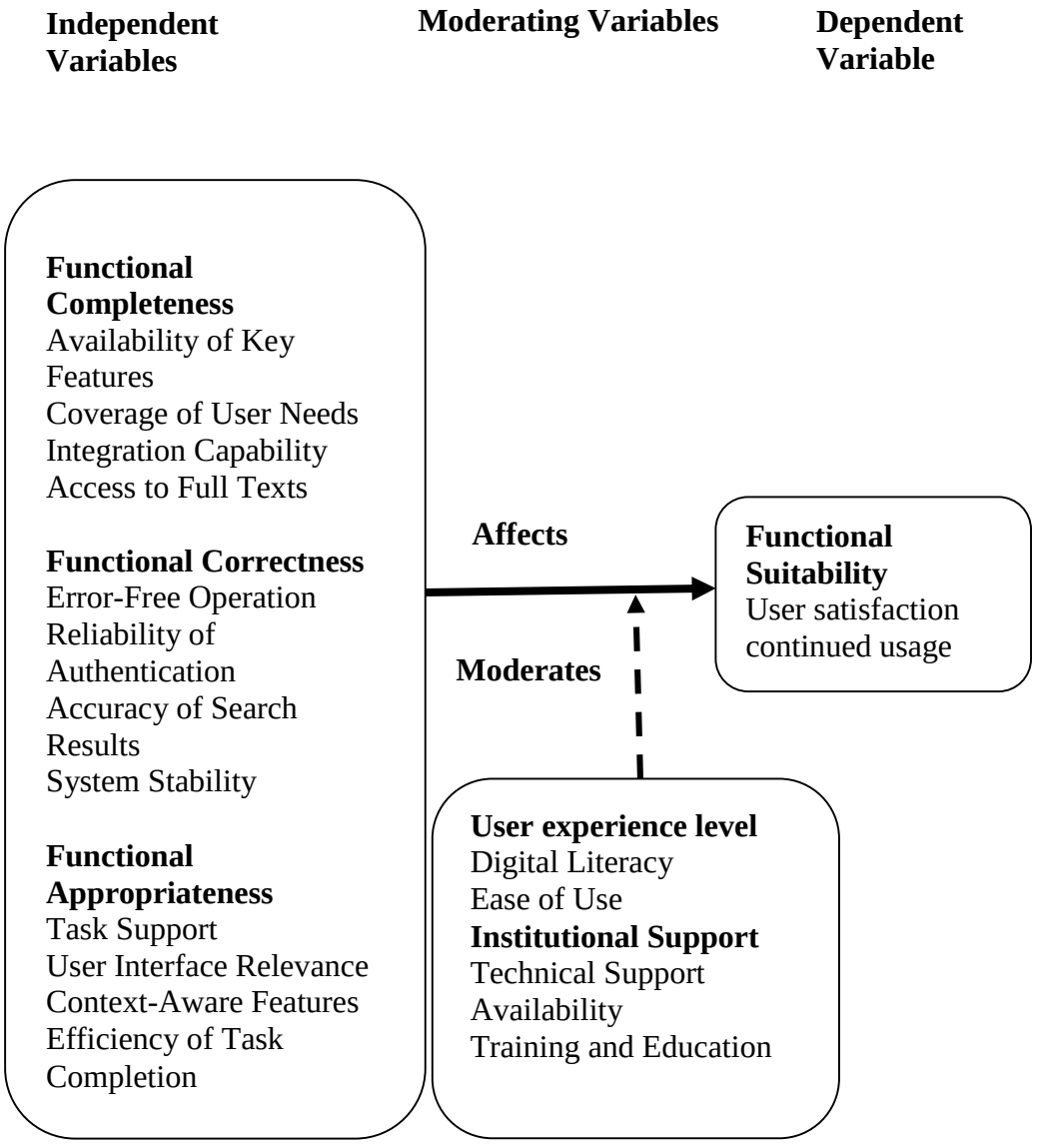


Figure 2.2: Conceptual Framework

2.8 Summary

In synthesis, the reviewed approaches differ fundamentally in evaluative focus: TAM and UTAUT explain adoption but not functionality; the DeLone and McLean model

links quality to success but at a high level of abstraction; usability frameworks diagnose interfaces but ignore back-end functions; and technical performance approaches quantify efficiency but not functional adequacy. Compared and contrasted in this way, no single existing approach evaluates whether library off-campus access systems provide complete, correct and appropriate functions, which is precisely the dimension that ISO/IEC 25010 defines but does not operationalise.

The review of literature and theoretical frameworks reveals several critical gaps in the evaluation of library off-campus access systems. First, although the ISO/IEC 25010 provides a comprehensive classification of software quality characteristics, its application in existing studies remains largely generic and not tailored to the specific operational context of off- campus access systems. Most studies adopt broad system quality perspectives without adapting the model to address requirements such as remote authentication, proxy routing, and distributed access environments.

Second, existing evaluation approaches tend to focus on isolated system attributes, such as usability, performance, efficiency, or user satisfaction, without integrating these dimensions into a unified framework. As a result, evaluations are often fragmented and do not provide a holistic account of system effectiveness, particularly regarding how different functional attributes interact to influence access to electronic resources. Third, there is limited emphasis on functional suitability as a central evaluative dimension. While characteristics such as security, compatibility, and reliability are generally addressed in off-campus access systems through established technologies, the extent to which systems provide complete, accurate, and efficient access to resources remains underexplored. Fourth, the literature lacks quantitative, empirically grounded evaluation frameworks for assessing functional suitability. Many studies rely on descriptive analysis or user perception- based measures, with limited use of structured approaches that combine multiple constructs into a single evaluative metric.

Fifth, there is insufficient attention to the practical validation of evaluation frameworks. Existing studies rarely assess whether proposed frameworks are clear, relevant, feasible, and adaptable in real-world institutional settings, which limits their usability and adoption. These gaps indicate the need for a context-specific, integrated, and empirically grounded evaluation framework that focuses on functional suitability

while incorporating both quantitative measurement and practical validation. This study addresses these issues by proposing a Functional Suitability Evaluation Framework tailored to library off-campus access systems.

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter outlines the methodology used to conduct the research. The chapter begins by discussing the research design, research location, research process, target population, sampling design, data collection, validity and reliability, piloting, data collection procedure, data analysis techniques, and ethical considerations employed in this research.

3.2 Research Design

According to Kothari [78], research design is a guide that helps with data collection and analysis. At the same time, Creswell [79] considers it the orderliness of conditions established to ensure the relevance and efficiency of research processes. This research adopted a descriptive research design to examine the functional suitability of library off-campus access systems as experienced by users in their normal operational environments. The design was selected because the research sought to document existing system functionality and user experiences without manipulating variables, in line with the research objectives.

The library's off-campus access systems under research were already deployed and in use within their respective institutions; therefore, descriptive design enabled the research to capture real-world data on functional completeness, functional correctness, functional appropriateness, user experience level, and institutional support as they naturally occur. Furthermore, the descriptive research design provided an empirical basis for identifying functional suitability attributes and for developing and validating the proposed functional suitability evaluation framework.

To achieve each specific objective, the design incorporated objective-specific methods. Objective One, identifying the attributes, was achieved through a structured survey of system users whose responses were subjected to reliability analysis, exploratory factor analysis and descriptive statistics, complemented by thematic analysis of open-ended responses. Objective Two, developing the framework, employed Pearson correlation and multiple linear regression on the survey data to derive empirical construct weights, which were normalised to construct the Functional Suitability Index. Objective Three, validating the framework, used an expert-based

evaluative survey of technical personnel, analysed through descriptive statistics and thematic content analysis against the criteria of clarity, relevance, feasibility, completeness and adaptability.

3.3 Research Process

This research followed a systematic, objective-driven process to develop and validate the proposed functional-suitability evaluation framework for library off-campus access systems. The process was structured to ensure that each stage contributed directly to identifying functional suitability attributes, developing the proposed evaluation framework, and validating its applicability in real institutional settings. The research process comprised seven sequential stages, as illustrated in Figure 3.1.

The first stage involved formulating the research problem, in which persistent functional challenges associated with library off-campus access systems were identified in academic library contexts. The second stage focused on formulating research objectives and questions, translating the identified problem into actionable research goals. The third stage entailed a review of relevant literature and theoretical foundations, drawing primarily on the ISO/IEC 25010 software product quality model. The fourth stage involved selecting an appropriate research design, adopting a descriptive approach to examine existing library off-campus access systems as they operate in their natural institutional environments. This research design enabled the collection of empirical data on system functionality and user experiences without manipulating variables [79].

The fifth stage comprised data collection and analysis, during which data were gathered from sampled participants, including off-campus system users, library and ICT staff. The analysis focused on identifying functional strengths, weaknesses, and recurring challenges related to functional completeness, correctness, appropriateness, user experience level, and institutional support. The sixth stage involved developing and validating the proposed functional suitability evaluation framework. Findings from the data analysis were used to structure the proposed framework, which was subsequently validated using established validation criteria, including clarity, relevance, feasibility, completeness, and adaptability. The final stage consisted of interpreting the results and presenting conclusions, including the validated framework, key findings, and implications for academic libraries. Recommendations were derived

from the research findings, and directions for future research were suggested based on identified limitations [79].

For each stage, the activities executed, the participants involved and the outputs generated were as follows. Stage 1, problem formulation, involved the researcher reviewing institutional service experiences and preliminary literature, yielding a defined research problem. Stage 2, formulation of objectives and questions, translated the problem into the general objective, three specific objectives and matching research questions. Stage 3, literature and theoretical review, involved the researcher synthesising prior studies and the ISO/IEC 25010 model, producing the identified research gaps, the theoretical framework and the conceptual framework. Stage 4, research design selection, produced the descriptive design and the two survey instruments.

Stage 5, data collection and analysis, involved 334 student users and 37 technical personnel across MMUST, MUT and SU, and produced the validated dataset, descriptive results and factor structure. Stage 6, framework development and validation, involved the researcher deriving regression-based weights and the technical personnel validating the framework, producing the weighted framework, its scoring rubric and the validation results. Stage 7, interpretation and conclusions, produced the conclusions, recommendations and future research directions presented in Chapter Five.

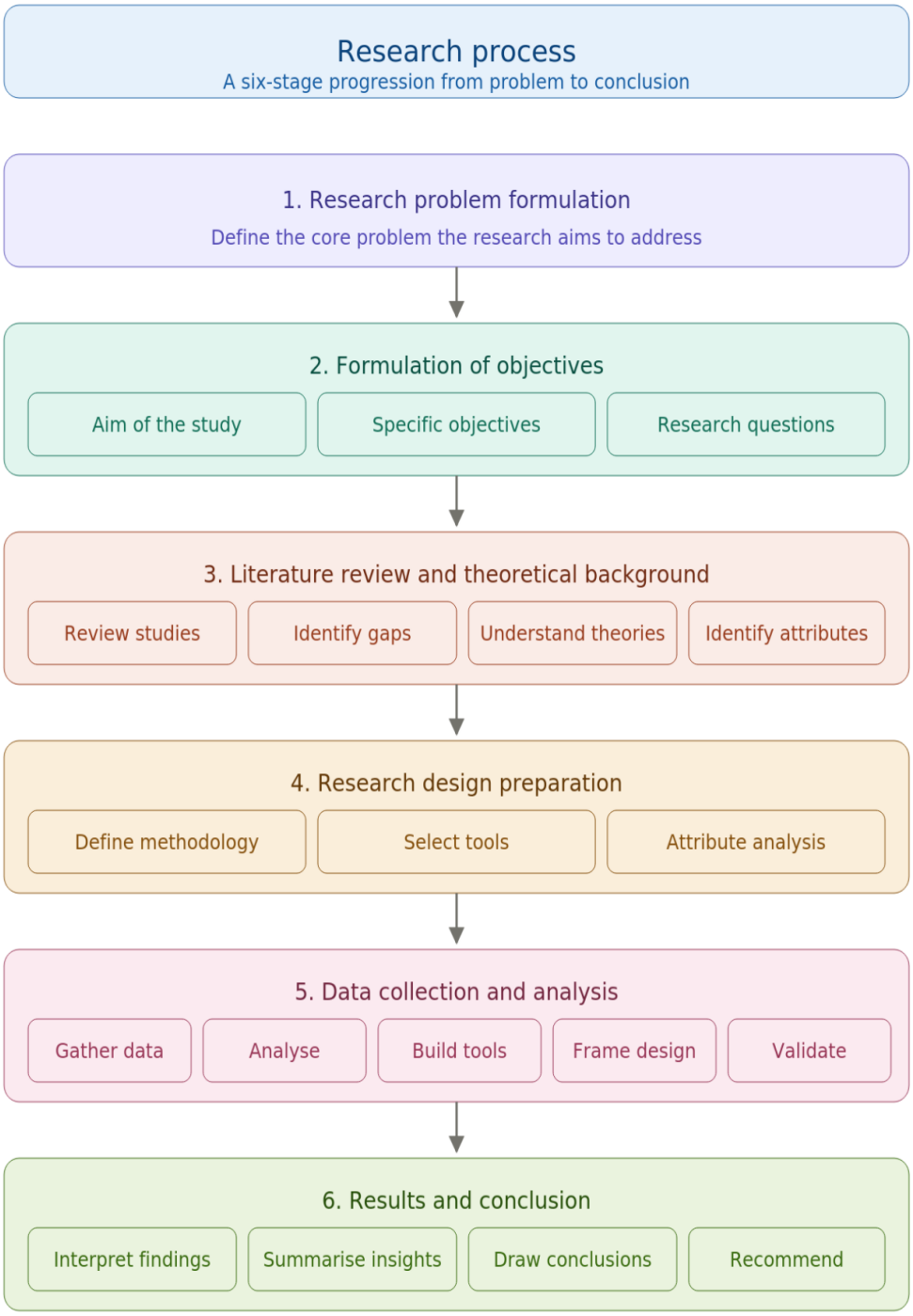


Figure 3.1: Research Process

3.4 Target Population

The target population for this study comprised 36,016 library off-campus access system users, with the student population data for the participating universities derived from the university enrolment statistics published by the Commission for University Education (CUE) [80], and 43 technical personnel drawn from three universities:

Masinde Muliro University of Science and Technology (MMUST), Murang'a University of Technology (MUT), and Strathmore University. These figures were obtained from official institutional records, namely the registered off-campus access system user lists and system access logs maintained by the library and ICT departments of the three universities, and the staffing establishment lists for library and ICT personnel, for the 2024/2025 academic year.

To ensure transparency and ethical consistency in participant selection, clearly defined inclusion and exclusion criteria were applied to both groups. For library off-campus access system users, participants were included if they were registered students at MMUST, MUT, or SU during the data collection period and had used their institution's off-campus access system, such as eMaktaba, MyLoft, or EZproxy, to access electronic resources within the previous 12 months. In addition, participants were required to be at least 18 years of age, able to read and understand the questionnaire language (English), and willing to provide informed consent through the online consent process. Conversely, participants were excluded if they were below 18 years of age, had never used the library's off- campus access system, were unable to access the online questionnaire, or declined or withdrew their consent.

For technical personnel, inclusion was limited to individuals serving as library or ICT staff, such as systems librarians, virtual librarians, ICT officers, and web administrators who were directly involved in managing, configuring, or supporting the library's off-campus access systems in the selected universities. These individuals were required to be actively employed in their respective roles during the data collection period and to provide informed consent. Technical personnel were excluded if they had no direct involvement with the off-campus access system, were on long-term leave or otherwise unavailable during the study period, or declined or withdrew their consent.

These inclusion and exclusion criteria were established to ensure that all participants had relevant experience and knowledge of library off-campus access systems, while maintaining ethical standards and minimising the risk of including respondents with insufficient exposure to the systems under investigation.

3.5 Sampling Frame and Sampling Techniques

The sampling frame comprised users of the library's off-campus access system and technical personnel across the three universities. The library's off-campus system users' lists were obtained from the library and ICT departments of MMUST, MUT, and SU, including individuals with recent access to the off-campus access systems: eMaktaba, MyLoft, and EZproxy. These lists were created using a combination of Institutional user records and System access logs indicating users who had accessed e-resources via off-campus systems within the past 12 months. To avoid systematically excluding users with relevant experience who may not appear in recent logs, recruitment messages were also shared through the institution's general communication channels. This allowed users who had previously used the systems, even if not recently, to self-identify and participate, provided they met the inclusion criteria.

For technical personnel, the sampling frame included virtual librarians, systems librarians, ICT officers, and web administrators identified through the university organisational records and staffing lists. These personnel are directly involved in managing and supporting library off- campus systems and, therefore, possess the necessary expertise to validate the proposed evaluation framework. The use of access logs is ethically justified solely for creating a sampling frame and identifying eligible users [81]. Formal institutional permission was sought from each participating university for access to the minimal data required and was used only for recruitment. The researcher did not retain raw logs.

The researcher used purposive sampling to select the three universities (MMUST, MUT, and SU). The three universities had adopted different library off-campus access systems, providing diversity in systems and exposure to both public and private university settings. The students who use the library off-campus access systems in the three universities were recruited using simple random sampling from the sampling frames of eligible users. Technical personnel were recruited using census sampling [82]. All eligible technical personnel in the three universities were invited to participate to ensure comprehensive coverage of expert views and avoid sampling bias.

The deliberate selection of universities running different systems was intended to maximise variation. Evaluating eMaktaba, MyLOFT and EZproxy within one framework demonstrates that the framework is system-agnostic, which would not have been possible had universities running identical systems been compared, and the framework evaluates functional suitability attributes common to all off-campus access systems rather than system-specific features, making cross-system comparison methodologically sound.

It is nevertheless acknowledged that comparing pairs of universities running the same system, or including universities dedicated to online programmes whose students depend wholly on remote library access, would offer complementary designs. Specifically, the 384 users were selected through simple random sampling executed in two steps: the sampling frame of eligible users from each university was assigned sequential numbers, and computer-generated random numbers were used to draw participants in proportion to each university's user population (223 from MMUST, 79 from MUT and 82 from SU). This gave every eligible user a known and equal chance of selection within their institution and eliminated selection bias.

3.6 Sample Size Selection

Census sampling was used to recruit technical personnel, including virtual library librarians, system librarians, and web administrators, across all three sampled universities. This made a total of 43 technical personnel in MMUST, MUT, and SU: 18, 11, and 14, respectively. It is justified that they were chosen based on their experience and familiarity with library off- campus access systems, and as such, can validate the proposed evaluation framework. The researcher employed the Krejcie and Morgan table to determine an appropriate sample size for the finite target population of library off-campus access system users [82]. The sample size was 384, from a target population of 36,016 active library off-campus system users. Each university's sample size was determined in proportion to the number of users of the library's off-campus access system, as shown below:

Sample Size = (Active Off-Campus Access Users ÷ Total Target Population) × Desired Sample Size

MMUST Sample Size = (20,919 ÷ 36,016) × 384 = 223

MUT Sample Size = (7,422 ÷ 36,016) × 384 = 79

SU Sample Size = (7,675 ÷ 36,016) × 384 = 82

Therefore, the sample sizes for active users of the library's off-campus access system at MMUST, MUT, and SU were 223, 79, and 82, respectively.

Table 3.1 below provides an overview of library off-campus access system users at sampled universities, highlighting the total number of users and the number of sampled users that participated in the research.

Table 3.1: Population and Sample Size

Sampled Universities	**Target Population of the library's off- campus access system users**	**Sampled library off-campus access system users**	**Sampled off-campus Technical Personnel**
Masinde Muliro University of Science and Technology	20,919	223	18
Murang'a University of Technology	7,422	79	11
Strathmore University	7,675	82	14
TOTAL	**36,016**	**384**	**43**

3.7 Data Collection

The research employed semi-structured questionnaires to collect data. There were two questionnaires for library off-campus access system users and technical personnel, with the first section capturing participants' demographic information. The remaining part of the questionnaire was divided into sections corresponding to the research objectives. The questionnaires included both closed and open-ended questions. The

open-ended questions were given at the end of the closed-ended questions to enable respondents to provide information on matters important to them that were not covered by the closed-ended questions [83]. The questionnaires were converted to an online form using KoboToolbox, an online data collection and management tool, and the link to the form was shared with the sampled respondents. The preference for online distribution stemmed from its advantages, including faster response times, reduced respondent error, and the elimination of interviewer bias. Table 3.2 summarises how the questionnaire sections and attributes support each objective:

Table 3.2: Mapping of Objectives to Questionnaire Content

Objective	Respondent	Items	Focus Areas / Attributes
Objective 1: To identify the attributes that impact the functional suitability of library off-campus access systems.	Students	A1–F43	Functional Completeness, Functional Correctness, Functional Appropriateness, User Experience, and Institutional Support
Objective 3: To validate the proposed functional suitability evaluation framework for the library's off-campus access systems.	Technical Personnel	A1–C21	Proposed framework: Relevance, Feasibility, Clarity, Completeness, and Adaptability

3.7.1 Piloting of the Research Instruments

A pilot study was conducted to assess the clarity, relevance, and reliability of the research instruments before the main data collection phase. The pilot involved two structured questionnaires: the Library Off-Campus Access System Users Questionnaire, designed for students, and the Technical Personnel Questionnaire, designed for library and ICT staff responsible for managing and supporting off-campus access systems. The pilot was carried out at Masinde Muliro University of Science and Technology (MMUST), which shares similar characteristics with the other study sites and was therefore considered appropriate for pre- testing the instruments. A subset equivalent to approximately 10% of the study sample was selected, comprising 38 library off-campus access system users and 4 technical

personnel who met the same inclusion criteria applied in the main study. To minimise bias and avoid prior exposure effects, participants involved in the pilot study were excluded from the final data collection.

The purpose of the pilot study was to evaluate the questionnaires' effectiveness in capturing the intended data and to ensure that the instruments were suitable for the target population. Specifically, the pilot assessed the clarity of questionnaire items, the appropriateness and precision of wording, the logical flow and sequencing of questions, and the adequacy and consistency of response options. It also helped identify ambiguous, redundant, or difficult-to- understand items, as well as practical challenges related to administering the questionnaires online, such as accessibility and completion times. Feedback from pilot participants was systematically reviewed and used to refine the instruments, resulting in minor revisions to improve clarity, coherence, and consistency across items. These refinements enhanced the overall validity and reliability of the research instruments and ensured they were well-aligned with the study objectives before the main data collection phase [84].

The pilot data were analysed to generate preliminary reliability estimates; all constructs returned Cronbach's alpha coefficients above the 0.70 threshold, and the full reliability results are presented in Tables 3.3 and 3.4. Based on the pilot feedback, ambiguous items were reworded, the sequencing of questions was refined, and the estimated completion time was communicated to respondents. To guarantee that pilot participants were excluded from the main data collection, the pilot responses were collected through a separate KoboToolbox link, and the institutional identifiers of pilot participants were flagged in the sampling frame so that they were removed before the random selection of the main sample was performed.

3.7.2 Validity of Research Instruments

Face, content, internal, and external validity assessments were used to evaluate the research instruments. Face validity was developed through expert assessment by the researchers, with review by university research supervisors and two experienced library science researchers. These professionals checked whether the questionnaire had adequately measured the desired constructs. Comments were documented and used to refine ambiguous wording and improve item clarity. Following the review, 12

items were reworded, 2 items were removed, and 5 items were added to improve clarity and construct coverage [84].

Content validity was established using a structured expert rating procedure in which reviewers assessed each item's relevance to its intended construct on a 4-point scale (1 = not relevant to 4 = highly relevant). The Item-level Content Validity Index (I-CVI) was calculated as the proportion of experts rating an item as 3 or 4. At the same time, the Scale-level Content Validity Index (S-CVI) was obtained by averaging I-CVI values across all items. Using a minimum acceptable I-CVI threshold of 0.78, 56 out of 64 items met the acceptance criterion without modification. In comparison, 8 items with I-CVI values ranging between 0.50 and 0.75 were revised based on expert feedback. The overall S-CVI for the instrument was 0.91, indicating adequate coverage and strong content validity of the functional-suitability constructs measured in this study [85].

Internal validity was enhanced through standardised questionnaire administration, voluntary participation, and respondent anonymity, thereby minimising bias [82]. Participants were selected based on predefined sampling criteria to ensure relevant exposure to library off- campus access systems, thereby improving response consistency and reducing measurement error. External validity was strengthened by involving multiple user groups: students and library/ICT staff from selected universities, enhancing the applicability of the findings within similar academic library contexts. However, generalisation of results remains limited to institutions with comparable operational and infrastructural characteristics.

3.7.3 Reliability of Research Instruments

The reliability of the research instruments was assessed using the Cronbach's alpha coefficient, which measures the internal consistency of questionnaire items and the extent to which they collectively measure a given construct [81]. To ensure sound measurement, multiple items were included under each construct to capture the dimensions of functional suitability and framework validation adequately. Reliability analysis was conducted using responses from the pilot study, which constituted approximately 10% of the overall sample. A Cronbach's alpha coefficient of 0.70 or higher was considered acceptable, indicating satisfactory internal consistency of the measurement scale [82]. Where any construct yielded an alpha value below the

recommended threshold, the items would be reviewed, refined, or removed to improve clarity, coherence, and consistency.

Reliability testing was performed separately for the two research instruments: the Library Off- Campus Access System Users Questionnaire and the Technical Personnel Questionnaire. As presented in Table 3.3, the students' questionnaire, which measured functional completeness, functional correctness, and functional appropriateness, demonstrated high internal consistency across all constructs, with an overall Cronbach's alpha coefficient of 0.899, indicating excellent reliability. Similarly, the results for the technical personnel questionnaire, shown in Table 3.4, indicate acceptable-to-good levels of internal consistency for the framework validation criteria, including completeness, relevance, clarity, feasibility, and adaptability, with an overall Cronbach's alpha coefficient of 0.826, indicating good reliability. These results confirm that the items within each instrument were sufficiently correlated and consistently measured the intended constructs.

These findings indicate that the research instruments were reliable and suitable for the main data collection phase. The reliability assessment ensured that the instruments produced consistent, dependable measurements, thereby enhancing the credibility of the findings regarding functional suitability and the evaluation of the proposed framework for library off- campus access systems.

Table 3.3: Reliability Results for Functional Suitability Constructs (Students' Questionnaire)

Construct	**Number of Items**	**Cronbach's Alpha**	**Interpretation**
Functional Completeness	8	0.891	Excellent reliability
Functional Correctness	10	0.943	Excellent reliability
Functional Appropriateness	9	0.864	Good reliability
Overall Scale Reliability	**27**	**0.899**	**Excellent internal consistency**

Table 3.4: Reliability Results for Framework Validation Constructs (Technical Personnel Questionnaire)

Validation Criterion	Number of Items	Cronbach's Alpha	Interpretation
Completeness	2	0.781	Acceptable reliability
Relevance	2	0.802	Good reliability
Clarity	2	0.814	Good reliability
Feasibility	2	0.789	Acceptable reliability
Adaptability	2	0.807	Good reliability
Overall Scale Reliability	**10**	**0.826**	**Good internal consistency**

3.8 Data Analysis and Presentation

The data were analysed using both quantitative and qualitative methods to investigate the relationship between the independent and dependent variables. The data analysis aligned with all research objectives, producing meaningful, focused insights. Thematic analysis was used to examine qualitative data, while descriptive and inferential statistics were used to analyse the quantitative data. In objective 1, a reliability analysis was conducted to assess internal consistency using Cronbach's Alpha. In addition, the data were subjected to Exploratory Factor Analysis (EFA) to identify the underlying constructs. Descriptive statistics, including means, standard deviations, and frequency distributions, were used to show the performance of different constructs [82].

In objective 2, the survey data were subjected to Pearson correlation to test predictive relationships. Correlation was used to identify the attributes with the greatest effect on perceptions of functional suitability, to inform the development of the evaluation framework. Moreover, multiple linear regression was conducted to obtain the empirical weights for the constructs. In objective 3, expert validation feedback was analysed using both descriptive and thematic content analysis. This approach ensured the rigour of statistics and the practicality of the research to address the research aims [81]. Thematic analysis was conducted manually following the six-phase framework proposed by Braun and Clarke [85] [86], which involves familiarisation with data, generating initial codes, searching for themes, reviewing themes, defining and naming

themes, and producing the report. Table 3.5 summarises the data analysis methods used to address each research objective.

All quantitative analyses were performed in SPSS. Specifically, descriptive statistics (means, standard deviations and frequencies) profiled construct performance; Cronbach's alpha (threshold 0.70) established reliability; the Kaiser–Meyer–Olkin measure (≥ 0.80) and Bartlett's test of sphericity ($p < 0.05$) established factorability; principal component analysis with Varimax rotation and a 0.60 loading threshold established construct validity; Pearson correlation examined inter-construct relationships; and multiple linear regression, with the ANOVA F-test and t-tests of coefficients at $\alpha = 0.05$, estimated the predictive contribution of each construct to the Functional Suitability Index, whose unstandardised coefficients were normalised into the framework weights.

Table 3.5: Analysis of objectives

Objective	**Type of Data**	**Method Used**	**Research Design**	**Data Analysis Technique**
Objective 1: To identify the attributes that impact the functional suitability of off-campus access systems.	Quantitative and Qualitative	Structured Survey and Literature Review	Descriptive and Exploratory Design	Reliability Analysis (Cronbach's Alpha), Exploratory Factor Analysis (EFA), Descriptive Statistics, Thematic Content Analysis
Objective 2: To design a weighted	Quantitative	Empirical Model	Exploratory Measurement	Pearson Correlation

functional suitability evaluation framework for library off-campus access systems.		Development using Survey Data	Framework Design	Analysis, Multiple Linear Regression, Derivation of Normalised Weights
Objective 3: To validate the proposed functional suitability evaluation framework for off-campus access systems.	Quantitative and Qualitative	Expert-Based Practical Validation	Evaluative Design	Descriptive Statistics (Mean, Std. Dev.), Thematic Content Analysis of Expert Feedback

3.9 Ethical Considerations

Ethical principles were strictly observed throughout the conduct of this research. Before data collection, the researcher obtained all necessary approvals and research authorisations, including clearance from the Board of Postgraduate Studies (BPS), approval from the Institutional Scientific and Ethics Review Committee (ISERC), and a research permit from the National Commission for Science, Technology and Innovation (NACOSTI), ensuring compliance with institutional and national ethical requirements. Informed consent was obtained from all participants before their involvement, with the introductory section of the online questionnaire providing a clear explanation of the research's purpose, the voluntary nature of participation, and the right to withdraw at any time without consequences. The researcher ensured confidentiality and anonymity by designing the questionnaire to avoid collecting personally identifiable or sensitive information, and all data collected were used strictly for academic purposes and handled securely. These measures ensured that the rights, dignity, and privacy of participants were protected throughout the research.

Regarding data security, all responses were collected through KoboToolbox over encrypted (HTTPS) connections and stored on the platform's secure servers; downloaded datasets were kept on a password-protected computer accessible only to the researcher, and backup copies were encrypted. No personally identifiable information was collected, and the institutional access-log extracts used solely to construct the sampling frame were not retained after recruitment. Concerning data destruction, the raw datasets will be securely destroyed five years after the conferment of the degree, in line with institutional research data management guidelines, through permanent deletion of the electronic files.

3.10 Summary

This chapter described the descriptive research design and the seven-stage research process adopted to achieve the study objectives. The target population comprised 36,016 off-campus access system users and 43 technical personnel from MMUST, MUT and SU, from which 384 users were selected through proportionate simple random sampling and all 43 technical personnel through a census. Data were collected using two piloted, semi-structured online questionnaires whose validity and reliability were established, and were analysed using descriptive statistics, exploratory factor analysis, Pearson correlation, multiple linear regression and reflexive thematic analysis, each aligned to a specific objective. Ethical requirements, including approvals, informed consent, confidentiality, data security and data destruction, were observed throughout. The next chapter presents the results and discussion.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results of the analysis conducted in the research. The results are organised into several sections, beginning with the response rate and the respondents' demographic characteristics. This is followed by the measurement validation of the functional suitability constructs using reliability analysis and Exploratory Factor Analysis to confirm internal consistency and construct validity. The chapter then presents the performance of the three functional suitability constructs based on descriptive statistics and supporting qualitative feedback from respondents. Subsequently, correlation and multiple linear regression analyses are used to examine the relationships among the constructs and their predictive contribution to functional suitability. The regression results are further used to derive and normalise construct weights for computing the Functional Suitability Index (FSI). Based on these empirical findings, a Functional Suitability Evaluation Framework, scoring rubric, and interpretation guide were developed. The chapter concludes with the validation of the framework by technical personnel.

4.2 Response Rate

The total response rate was 86.9%, comprising 334 student respondents and 37 technical personnel, as shown in Table 4.1. This response rate is considered high for quantitative research and was therefore deemed adequate for subsequent statistical analyses. The strong participation indicates substantial interest among both student users and technical personnel in the functional suitability of library off-campus access systems. Such a high response level suggests that respondents perceive the evaluation of digital access systems as relevant to their academic and operational activities. It also reflects strong user engagement, which is common in studies examining digital resource accessibility, where system effectiveness can influence research and learning outcomes.

Table 4.1: Questionnaire Response Rate

Respondent Category	Questionnaire Type	Issued	Returned	Response Rate (%)
Students	Library Off-Campus Access System Users Questionnaire	384	334	86.9
Technical Personnel	Technical Personnel Questionnaire	43	37	86.0
Total		427	371	86.9

4.3 Demographic Characteristics of Respondents

This section presents the demographic characteristics of respondents, comprising both students and technical personnel. Understanding the demographic profile of participants is important for contextualising the findings and assessing the sample's representativeness. The characteristics examined include gender, level and year of research for students, and departmental affiliation, education level, and years of experience for technical personnel. These variables provide background information that supports the interpretation of subsequent analyses of the functional suitability of library off-campus access systems and ensures that the research findings are grounded in the institutional and user context.

4.3.1 Students Respondents

This section presents the demographic profile of student respondents who participated in the research. Since students constitute the primary users of library off-campus access systems, their characteristics are important in understanding how functional suitability is perceived across different user segments. Variables examined include gender, research level, and year of research. These demographic attributes provide contextual background for interpreting variations in system usage patterns, digital literacy levels, and academic resource needs. The analysis ensures that the findings on functional completeness, correctness, and appropriateness are interpreted within the structure of the student population represented in the research.

4.3.1.1 Gender of Student Respondents

Male students constituted 56% (n = 187) of the respondents, while 44% (n = 147) were female, indicating a relatively balanced gender distribution, as shown in Figure 4.1.

Gender was captured as a descriptive characteristic of the sample; it was not a research variable in this study. The relatively balanced distribution indicates that neither gender group dominated the sample, which reduces the risk of composition bias in the reported perceptions of library off-campus access systems. A balanced representation helps minimise gender bias and enhances the generalizability of the findings regarding usability and access challenges. Consequently, the inclusion of both male and female respondents strengthens the credibility of the results on how users interact with library off-campus access systems.

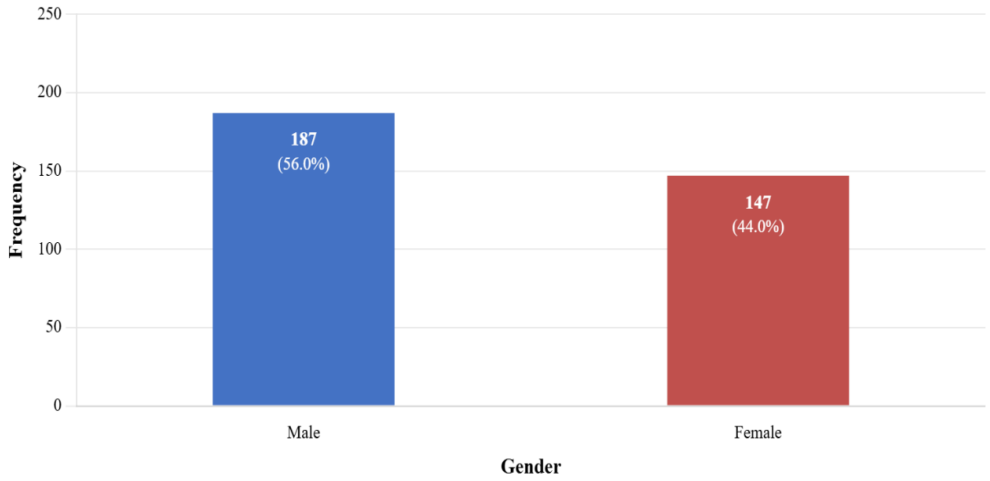


Figure 4.1: Distribution of Student Respondents by Gender

4.3.1.2 Level of Study of Student Respondents

Bachelor's degree students constituted 70% (n = 234) of the respondents, while 18% (n = 60) were diploma students and 12% (n = 40) were postgraduate students, as shown in Figure 4.2. This distribution indicates a higher participation rate among undergraduate students, which is expected, as they represent the largest proportion of the university population and are frequent users of electronic library resources. Their substantial representation suggests that undergraduate students rely heavily on remote access systems to support coursework, assignments, and research activities. Although postgraduate students formed a smaller proportion of the sample, their responses provide important insights because they typically make intensive use of scholarly databases, journal repositories, and other advanced research resources. Their inclusion therefore strengthens the comprehensiveness of the functional suitability analysis by incorporating perspectives from users with more advanced information needs.

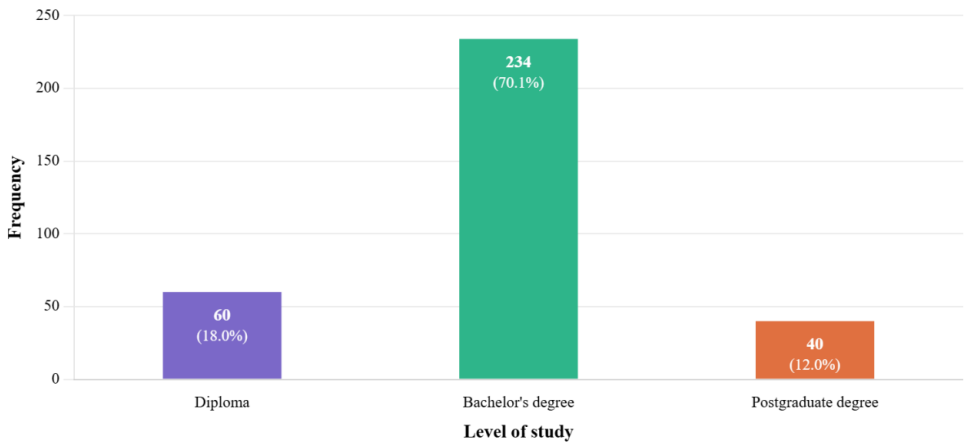


Figure 4.2: Distribution of Student Respondents by Level of Study

4.3.1.3 Year of Study of Student Respondents

The distribution of respondents across the four academic years was relatively balanced, with 26.0% (n = 87) in the first year, 28.7% (n = 96) in the second year, 25.7% (n = 86) in the third year, and 19.5% (n = 65) in the fourth year, as indicated in Figure 4.3. This balanced representation allows the research to capture perceptions from both novice users (first-year students) and more experienced users (upper-year students). First-year students often encounter challenges associated with transitioning to digital academic environments, while students in higher years tend to demonstrate greater familiarity with digital navigation and library systems. The inclusion of students from all academic levels, therefore, provides a comprehensive evaluation of the system's functional suitability across different stages of the academic experience. It also enables analysis of whether perceptions of usability and system effectiveness vary according to academic demands and user experience with library off-campus access systems.

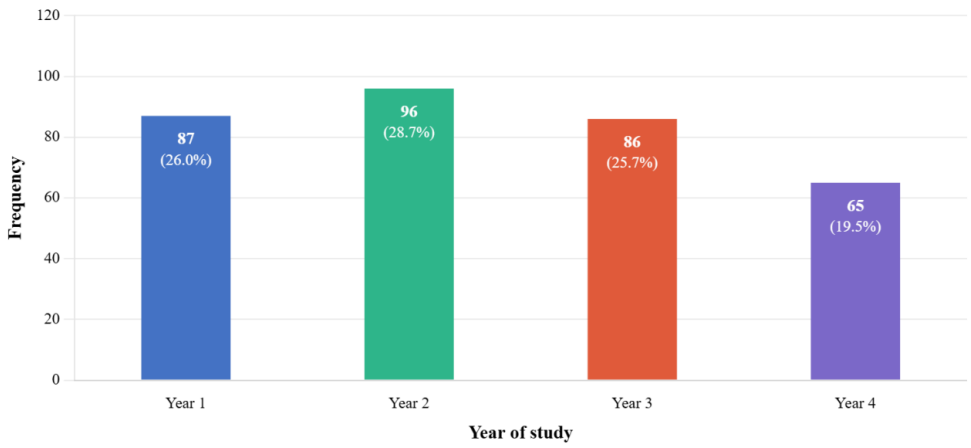


Figure 4.3: Distribution of Student Respondents by Year of Study

4.3.2 Technical Personnel Respondents

This subsection presents the demographic characteristics of technical personnel involved in the management and administration of library off-campus access systems. Technical staff play a critical role in system configuration, authentication management, troubleshooting, and infrastructure support; therefore, their professional background is relevant to the framework validation process. The analysis includes departmental affiliation, gender, education level, and years of experience. These characteristics provide insight into the institutional capacity supporting library off-campus access systems and strengthen the credibility of the practical validation findings reported in later sections.

4.3.2.1 Department of Technical Personnel

Most of the technical personnel, 59.5% (n = 22), were from the Library Department, while 40.5% (n = 15) were from the ICT Department, as depicted in Figure 4.4. This distribution reflects the collaborative nature of managing library off-campus access systems, where both departments play complementary roles. The library staff are primarily responsible for managing electronic resource licensing, metadata organisation, and user support services, while ICT personnel handle server management, authentication mechanisms, and overall technical integration. The involvement of both departments, therefore, provides a balanced technical perspective, strengthening the practical validation of the framework and ensuring that the research reflects both operational and technical considerations in the management of off-campus access systems.

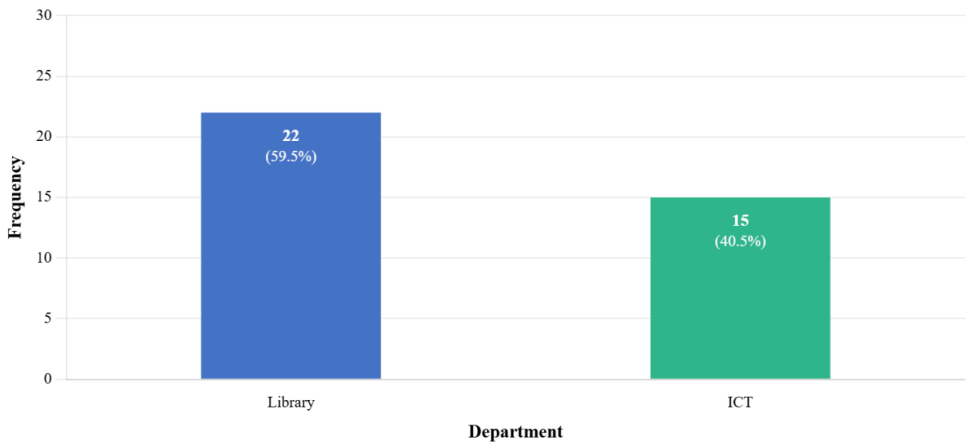


Figure 4.4: Distribution of Technical Personnel by Department

4.3.2.2 Gender of Technical Personnel

The gender distribution among the technical personnel indicated that 67.6% (n = 25) were male, while 32.4% (n = 12) were female, as shown in Figure 4.5. This pattern reflects gender representation commonly observed in ICT-intensive roles. Gender was reported solely to describe the composition of the expert panel and to assess the representativeness of the sample; it was not a research variable, and no gender-based differences in perceptions were analysed or claimed in this research. Additionally, the observed distribution highlights the importance of promoting inclusive capacity-building initiatives in digital skills development and technical training among library and ICT staff.

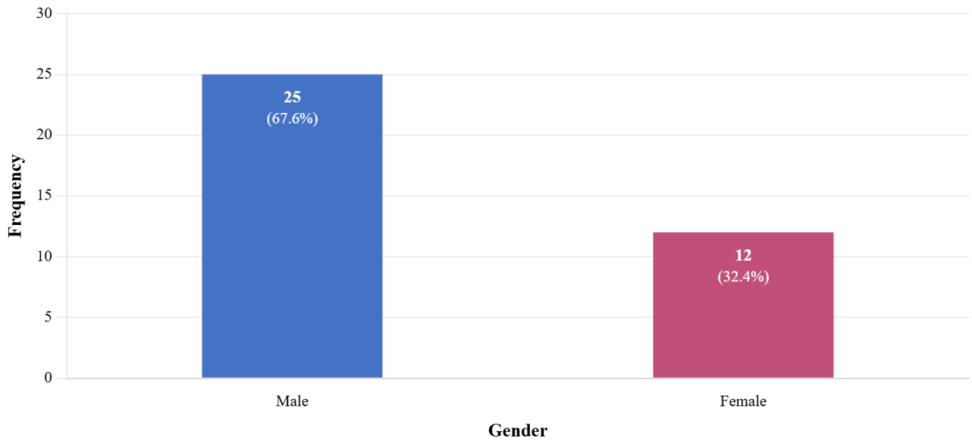


Figure 4.5: Distribution of Technical Personnel by Gender

4.3.2.3 Education Level of Technical Personnel

The educational qualifications of the technical personnel were predominantly bachelor's degree holders (40.5%, n = 15) and master's degree holders (35.1%, n = 13), with a smaller proportion holding doctoral qualifications (8.1%, n = 3), as illustrated in Figure 4.6. These advanced levels of education are consistent with the technical expertise required to manage library off-campus access systems and complex authentication infrastructures. Such qualifications align with the ICT competencies and system evaluation skills necessary for effective management and assessment of digital library services. A highly qualified workforce is therefore likely to provide informed insights into the strengths and limitations of library off- campus access systems. Additionally, the participation of personnel with doctoral-level qualifications enhances the rigour of the research's practical validation, as the evaluation framework was assessed by personnel with advanced knowledge in digital ecosystems, ICT policy, and institutional technology governance.

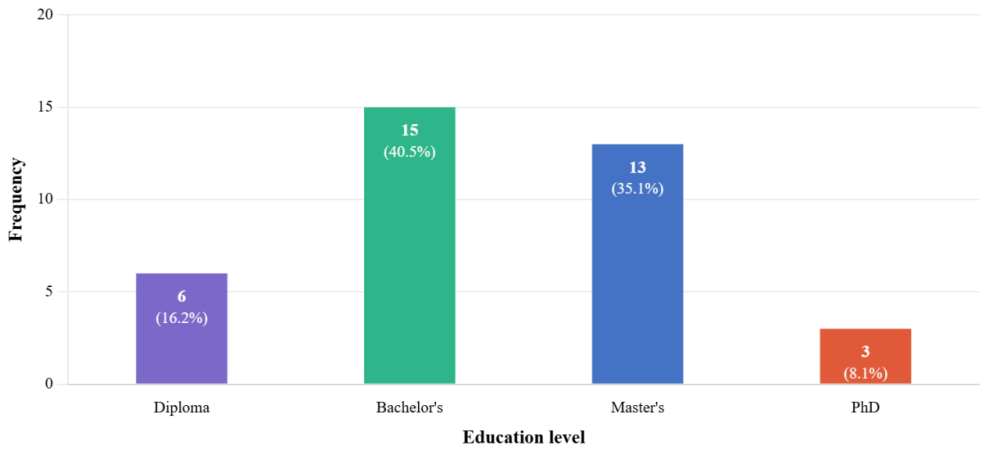


Figure 4.6: Distribution of Technical Personnel by Education Level

4.3.2.4 Years of Experience of Technical Personnel

According to Figure 4.7, most respondents (86.4%) had more than 3 years of experience operating digital library systems or ICT services. This substantial level of professional experience strengthens the credibility of the technical staff's feedback and supports the use of expert-based assessments, as commonly emphasised in digital library evaluation studies. Experienced practitioners possess practical knowledge of issues such as system stability, authentication processes, downtime management, user support challenges, and emerging digital service requirements. Their involvement,

therefore, ensures that the functional suitability evaluation framework reflects real operational conditions and can be effectively applied within institutional environments. This finding also underscores the important role of experienced professionals in guiding the evaluation and improvement of technology within digital library systems.

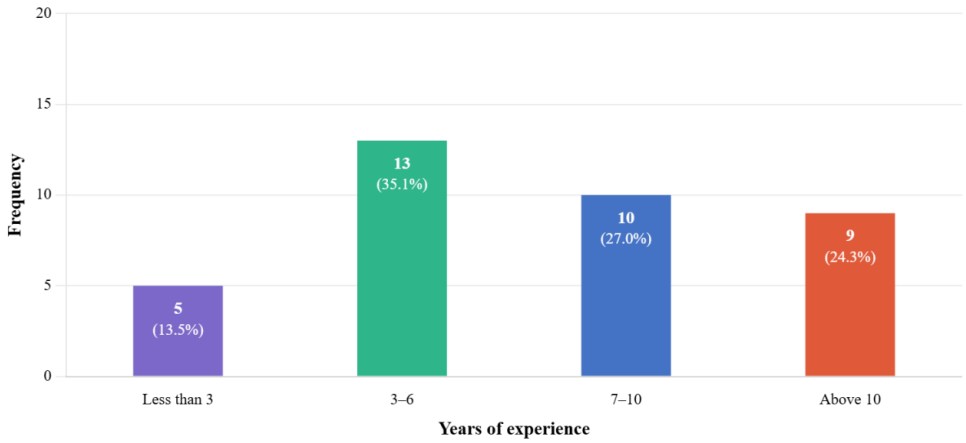


Figure 4.7: Distribution of Technical Personnel by Years of Experience

4.4 Functional Suitability Attributes of Library Off-Campus Access Systems

This section examines the functional suitability attributes of library off-campus access systems based on Functional Completeness, Functional Correctness, and Functional Appropriateness constructs, as guided by the ISO/IEC 25010 model. The section begins by confirming the measurement quality of these constructs through Exploratory Factor Analysis to ensure construct validity of the dataset. Following validation, the performance of each construct is analysed using mean scores and supporting thematic feedback. The section concludes with contextual factors which provide interpretive insight into variations in user perceptions.

4.4.1 Measurement Validation of Constructs

The measurement instruments were validated to ensure that the constructs were statistically reliable and conceptually sound. Since Functional Completeness, Functional Correctness, and Functional Appropriateness were measured using multiple questionnaire items, Exploratory Factor Analysis (EFA) was conducted to examine the underlying factor structure. Establishing construct validity at this stage

ensures that the composite scores used in subsequent descriptive and inferential analyses accurately represent the intended dimensions of functional suitability.

4.4.1.1 Kaiser-Meyer-Olkin (KMO) and Bartlett's Test

Preliminary tests were conducted to assess the dataset's suitability for factor analysis before extracting the factors. The Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy evaluates whether the variables share sufficient common variance to justify factor analysis. The obtained KMO value of 0.913 indicates excellent sampling adequacy, exceeding the recommended threshold of 0.80 for factor analysis, as shown in Table 4.2. This high value suggests that the dataset contains adequate correlations among variables and is appropriate for identifying underlying factors.

In addition, Bartlett's Test of Sphericity was performed to examine whether the correlation matrix significantly differs from an identity matrix. The results were statistically significant ($\chi^2 = 5821.476$, $df = 351$, $p < 0.001$), as illustrated in Table 4.2, indicating that the correlations among the variables were sufficiently strong for factor extraction. A significant Bartlett's test confirms that the observed relationships among variables are not random and that the dataset is suitable for factor analysis. The strong KMO value and the significant Bartlett's Test of Sphericity demonstrate that the dataset was appropriate for identifying meaningful latent constructs. These results support the theoretical assumption derived from the ISO/IEC 25010 software quality model, which conceptualises functional suitability as a multidimensional construct composed of functional completeness, functional correctness, and functional appropriateness.

Table 4.2: KMO and Bartlett's Test of Sphericity

Test	**Value**
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	0.913
Bartlett's Test of Sphericity	$\chi^2 = 5821.476$, $df = 351$, $p < 0.001$

4.4.1.2 Total Variance Explained

The factor extraction results indicate that three components were retained based on the Kaiser criterion, which recommends retaining factors with eigenvalues greater than 1.

This criterion is commonly used in exploratory factor analysis to determine the number of meaningful factors representing the underlying structure of the dataset. In this research, the three retained components collectively explain 67.60% of the total variance, as shown in Table 4.3, exceeding the commonly recommended 60% threshold for acceptable variance explanation in factor analysis. This level of explained variance indicates that the three-factor solution sufficiently represents the underlying structure of the functional suitability measurement items. The first component accounts for 43.86% of the total variance, as shown in Table 4.3, indicating that it explains a substantial proportion of the dataset's variability. The second component contributes an additional 15.84%, while the third component explains 7.90% of the variance. The cumulative variance explained by the three components, therefore, reaches 67.60%, indicating that the extracted factors collectively capture most of the variability in the functional suitability items.

Importantly, the three extracted components correspond closely to the theoretically defined constructs from the ISO/IEC 25010 model: Functional Completeness, Functional Correctness, and Functional Appropriateness. This alignment between the empirical factor structure and the theoretical model provides further evidence of construct validity for the measurement instrument. The relatively high cumulative variance explained confirms that the questionnaire items effectively represent the latent dimensions underlying functional suitability in library off- campus access systems. These results demonstrate that the factor structure is both statistically sound and theoretically consistent, thereby providing a reliable foundation for subsequent analyses. In particular, the validated factor structure supports the use of the identified constructs in further statistical analysis, including correlation analysis, multiple linear regression modelling, and the development of the Functional Suitability Evaluation Framework.

Table 4.3: Total Variance Explained (Principal Component Analysis)

Component	Initial Eigenvalue	% of Variance Explained	Cumulative %
1	11.842	43.86%	43.86%
2	4.276	15.84%	59.70%
3	2.134	7.90%	67.60%

4.4.1.3 Scree Plot Analysis

The scree plot was examined to determine further the appropriate number of components to retain in the factor analysis. The scree plot provides a graphical representation of eigenvalues in descending order and helps identify the point at which additional components contribute minimal explanatory value. In this research, the scree plot displayed a clear inflexion point after the third component, forming a distinct "elbow" in the graph. The first three components exhibited relatively high eigenvalues, as shown in Figure 4.8, indicating that they explain a substantial proportion of the total variance in the dataset. Beyond the third component, the eigenvalues showed a gradual, flattened decline, suggesting that additional components contribute only marginally to the explained variance. This pattern indicates that the first three components primarily capture the meaningful variance in the functional suitability items.

The scree plot, therefore, provides visual confirmation of the Kaiser criterion, which also suggests retaining three components with eigenvalues greater than 1. The convergence of both criteria strengthens the justification for retaining a three-factor solution. These three components correspond to the theoretically defined constructs in the ISO/IEC 25010 functional suitability model: Functional Completeness, Functional Correctness, and Functional Appropriateness. Consequently, the scree plot analysis further supports the validity of the three-factor structure used in subsequent analyses.

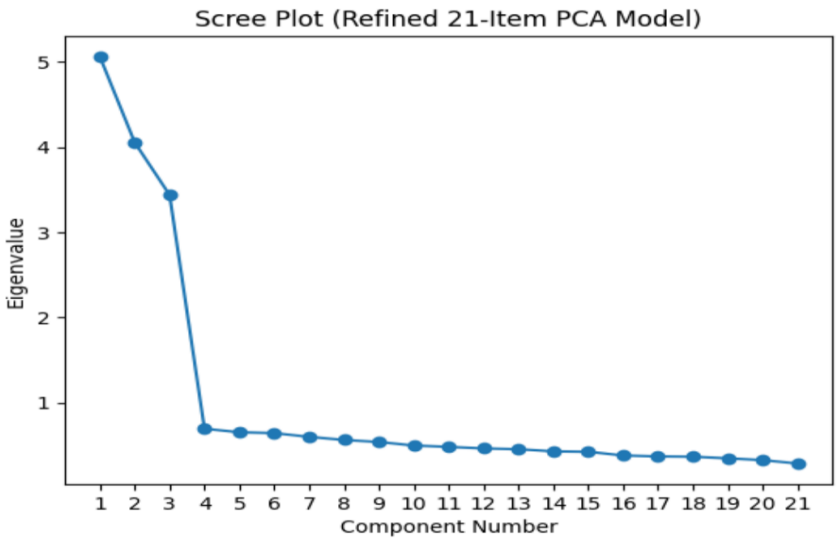


Figure 4.8: Scree Plot

4.4.1.4 Rotated Component Matrix

The rotated component matrix was examined to interpret the factor structure obtained from the Exploratory Factor Analysis. Varimax rotation was applied to enhance the interpretability of the extracted components by maximising the variance of factor loadings across variables. Varimax Rotation simplifies the factor structure by ensuring that each item loads strongly on a single factor while minimising cross-loadings on other factors. This approach is particularly useful when dealing with datasets that may contain interrelated variables, as it helps clarify the latent constructs underlying the observed items.

The minimum factor loading threshold of 0.60 was adopted to ensure strong relationships between observed variables and their underlying latent constructs. According to Hair et al. [83], factor loadings of 0.50 are considered practically significant, while values above 0.60 indicate strong correlations between indicators and their respective factors. Using a threshold of 0.60, therefore, improves construct validity by retaining only items that demonstrate substantial explanatory power within the factor structure.

a) Rotated Component Matrix for Functional Correctness The items loading on Factor 1 represent the construct of Functional Correctness, with factor loadings ranging from 0.689 to 0.812 (Table 4.4), indicating strong and consistent clustering of the items

within this factor. These results demonstrate that variables related to system accuracy, reliability, and error-free performance form a coherent latent construct. This suggests that users perceive these system behaviours as components of a single dimension reflecting functional correctness.

The factor structure aligns closely with the definition of functional correctness in the ISO/IEC 25010 software quality model, which emphasises accurate system operation, the reliability of system functions, and the minimisation of operational errors as essential aspects of software quality. The highest factor loadings were observed for items related to error-free full-text access (0.812) and correct document downloads (0.794), as shown in Table 4.4. These findings suggest that students primarily associate functional correctness with the system's ability to provide stable and accurate access to library electronic resources.

Similarly, the strong loadings for items related to authentication reliability, accurate link routing, and minimal system errors further reinforce the importance of reliability in library off- campus access systems. Previous studies on digital library system evaluation have also identified system reliability and link accuracy as key determinants of user trust and satisfaction. When authentication fails, links break, or system errors occur, the academic research process is disrupted, often forcing users to seek alternative access methods outside institutional systems. Therefore, the strong clustering of these items confirms that functional correctness represents a distinct and meaningful construct within the functional suitability evaluation framework. The results provide empirical support for the theoretical structure derived from the ISO/IEC 25010 model and reinforce the importance of system accuracy and reliability in shaping user experiences with library off-campus access systems.

Table 4.4: Rotated Component Matrix for Functional Correctness (Factor 1)

Statement	Factor Loading
Consistently opens full-text without errors	.812
Downloads open correctly (PDFs, etc.)	.794
Authentication works reliably	.781
Links direct to the correct publisher platforms	.764
Rarely encounter broken/outdated links	.732
Search results are accurate and relevant	.701
Rarely encounter system errors	.689

Note: Only loadings ≥ 0.60 shown; cross-loadings suppressed.

b) Rotated Component Matrix for Functional Completeness Factor 2 represents the construct of Functional Completeness, with factor loadings ranging from 0.701 to 0.828 (Table 4.5), indicating a strong and consistent clustering of items within this factor. These results suggest that students perceive the availability of academic resources, database coverage, and access to supplementary materials as closely related aspects of a single underlying construct. This finding demonstrates that the system's ability to provide comprehensive access to scholarly resources constitutes a distinct and measurable dimension of functional suitability.

The highest loadings were observed for access to core databases (0.828) and the system’s ability to meet academic resource needs (0.802), as shown in Table 4.5. These results highlight the central role of resource availability in shaping students’ perceptions of the usefulness and effectiveness of library off-campus access systems. Previous studies have similarly identified comprehensive access to institutional subscriptions as one of the most important determinants of the value and effectiveness of library off-campus access systems in academic libraries. The relatively high loading for consistent access to full-text resources (0.790) further reinforces the importance of full-text availability, which has been widely emphasised in digital library evaluation research as a key factor influencing user satisfaction and system effectiveness. Reliable access to full-text materials enables students to retrieve scholarly content efficiently and supports their academic and research activities.

Moderate loadings associated with access to supplementary materials and integration with scholarly tools such as Google Scholar indicate that although core database access is generally adequate, some gaps may remain in supporting tools and resource integration. Similar challenges have been identified in studies examining usability and interoperability of digital library systems, where incomplete integration with external academic tools can limit the overall effectiveness of library off-campus access systems. Therefore, the cohesive clustering of these items confirms that functional completeness represents a fundamental component of functional suitability. The results suggest that while the system provides strong access to core academic resources, institutions may further improve functional completeness by strengthening integration with supplementary resources and external scholarly tools, thereby enhancing the overall accessibility and comprehensiveness of library off-campus access services.

Table 4.5: Rotated Component Matrix for Functional Completeness (Factor 2)

Statement	**Factor Loading**
Access to core databases provided	.828
System meets academic resource needs	.802
Consistent access to full-text resources	.790
Access to supplementary materials	.758
Integration with scholarly tools (e.g., Google Scholar)	.712
The system provides the necessary features for e-resources	.701

Note: Only loadings ≥ 0.60 shown; cross-loadings suppressed.

c) Rotated Component Matrix for Functional Appropriateness Factor 3 represents the construct of Functional Appropriateness, with factor loadings ranging from 0.693 to 0.812 (Table 4.6), indicating a strong and consistent clustering of items associated with usability, efficiency, and task support. These results demonstrate that students perceive system intuitiveness, workflow efficiency, device adaptability, and ease of task completion as closely related aspects of a single latent construct. This clustering confirms that functional appropriateness captures the extent to which the system effectively supports users in accomplishing their academic tasks.

The highest loading within this factor was observed for supporting academic tasks (0.812), highlighting the importance students place on the system's alignment with their academic workflows. This finding is consistent with research that emphasises that information systems are more effective when their functionalities closely match the tasks users need to perform. When systems align well with academic processes, users can retrieve and use scholarly resources more efficiently.

Other items with relatively high loadings include intuitive interface design (0.774) and device adaptability (0.762), as shown in Table 4.6. These results reinforce findings from prior studies that emphasise the importance of user-centred design in digital learning systems and library off-campus access platforms. In particular, compatibility with multiple devices, such as smartphones, tablets, and personal computers, is increasingly important as students access academic resources across diverse technological environments. Items related to workflow efficiency, including minimising the steps required to access full-text resources (0.721) and providing shortcuts or quick-access tools (0.693), recorded slightly lower loadings than the other indicators, as shown in Table 4.6. Although these values remain above the recommended threshold of 0.60, they suggest potential areas for improving system usability. Previous studies on library off-campus access systems have similarly reported that complex navigation processes, slow system responses, and the absence of streamlined access pathways can negatively affect user satisfaction and efficiency.

Thus, the factor structure demonstrates that functional appropriateness constitutes a distinct and meaningful component of functional suitability. The strong clustering of usability-related variables confirms that students evaluate library off-campus access systems not only based on the availability or accuracy of resources but also on how efficiently and intuitively the system supports their academic activities. These findings highlight the importance of improving workflow efficiency and usability to enhance the overall effectiveness of library off-campus access systems.

Table 4.6: Rotated Component Matrix for Functional Appropriateness (Factor 3)

Statement	Factor Loading
Supports academic tasks	.812
Interface is intuitive and user-friendly	.774
Adapts well to devices (mobile/PC/tablet)	.762
Efficient task completion	.744
System minimises steps for full-text access	.721
Provides shortcuts/quick-access tools	.693

Note: Only loadings ≥ 0.60 shown; cross-loadings suppressed.

4.4.1.5 Items Dropped Based on Exploratory Factor Analysis

During the Exploratory Factor Analysis (EFA), items with factor loadings below the acceptable threshold were removed to improve the clarity and validity of the measurement model. In this research, a minimum factor loading of 0.60 was used as the retention criterion to ensure that the retained items demonstrated strong relationships with their respective constructs. Items with loadings below this threshold were excluded from the final factor structure, as shown in Table 4.7. This process helped maintain construct purity and ensured that each retained item clearly represented its underlying latent construct.

Several of the excluded items were reverse-coded statements or failure-frequency measures, which can sometimes introduce ambiguity and response bias in factor analytic procedures. Reverse-worded items may lead to inconsistent responses due to misinterpretation or respondent fatigue, thereby weakening their statistical association with the intended construct. As a result, such items may not cluster reliably with other indicators measuring the same latent variable. The removal of these items improved the clarity and stability of the three-factor structure representing Functional Completeness, Functional Correctness, and Functional Appropriateness. Through eliminating items with weak loadings, the analysis ensured that the remaining indicators more accurately capture the core dimensions of functional suitability. This refinement enhances the reliability and interpretability of the measurement instrument,

enabling more precise evaluation of the functional suitability of library off-campus access systems.

Therefore, excluding low-loading items strengthens the measurement model and supports the validity of the constructs derived from the ISO/IEC 25010 software quality framework. The resulting factor structure therefore provides a more robust basis for subsequent analyses, including correlation analysis, regression modelling, and the development of the Functional Suitability Evaluation Framework.

Table 4.7: Items Dropped Following Exploratory Factor Analysis

Original Construct	**Item Description**	**Factor Loading**
Functional Completeness	Use of alternative methods to find resources	0.47
	Citation and referencing tools	0.51
Functional Correctness	System crash frequency	0.46
	Absence of irrelevant search results	0.52
Functional Appropriateness	Excessive steps to complete tasks	0.49
	Support for real-time academic activities	0.43

4.4.2 Performance of Functional Suitability Constructs

Following confirmation of measurement reliability and construct validity, this subsection presents the performance of the validated functional-suitability constructs based on students' responses. The analysis examines Functional Completeness, Functional Correctness, and Functional Appropriateness using mean scores to determine the extent to which the library's off-campus access systems meet user expectations across these dimensions. In addition to quantitative ratings, thematic feedback from open-ended responses is incorporated to enrich interpretation and provide deeper insight into areas of strength and potential improvement. Together, these findings illustrate how the system performs in practice from the perspective of its primary users.

4.4.2.1 Evaluation of Functional Completeness of Library Off-Campus Access Systems

Functional completeness refers to the extent to which a system provides all the necessary features and resources required to support intended tasks. In the context of library off-campus access services, this includes the availability of scholarly databases, access to full-text materials, provision of supplementary academic resources, and integration with external scholarly tools. As a core component of functional suitability in the ISO/IEC 25010 model, functional completeness assesses whether users can rely on the system to access the academic resources required for their studies and research.

The results of this research indicate that students generally perceive the library's off-campus access system to perform well in terms of functional completeness, with a composite mean score of 3.78 (Table 4.8), suggesting moderate to high satisfaction with the system's ability to provide the required academic resources. The highest-rated items were access to core databases (M = 3.94) and consistent access to full-text materials (M = 3.90), as depicted in Table 4.8, indicating that the system effectively supports access to essential scholarly content required for academic work.

However, the relatively lower mean score for the statement "I often have to use alternative methods to find resources" (M = 2.88) suggests that some users still encounter limitations when accessing certain resources through the library's off-campus access system. This indicates the presence of functional gaps that may compel students to rely on alternative access mechanisms such as direct publisher platforms, search engines, or third-party tools. The composite standard deviation of 0.69, as shown in Table 4.8, indicates relatively low variability in responses, suggesting that students had fairly consistent perceptions of the system's functional completeness. These findings are consistent with [11] and [25], who reported that incomplete database coverage and restricted full-text access compel remote users to resort to alternative access channels, and they reinforce the argument in [51] that partial deployment of digital library features undermines effective utilisation. In relation to Objective One, the results confirm functional completeness as a measurable attribute impacting the functional suitability of library off-campus access systems.

Table 4.8: Evaluation of Functional Completeness of the Library Off-Campus Access Systems

Statement	Mean	Std. Dev
The system provides all the features I need to access e-resources.	3.82	0.74
The system meets most of my academic resource needs.	3.85	0.72
The system supports integration with tools like Google Scholar.	3.69	0.80
I can consistently access full-text articles and documents when needed.	3.90	0.70
I often have to use alternative methods to find resources.	2.88	0.92
The system provides access to all core databases required for my programme.	3.94	0.68
The system allows access to supplementary materials (e-books, reports, past papers).	3.79	0.75
The system provides the necessary tools for citation and referencing.	3.61	0.82

Note: Composite Mean = 3.78 Composite Std. Dev = 0.69

To further explore the quantitative findings, open-ended responses were analysed using thematic analysis following the reflexive framework proposed by Braun and Clarke [85] [86], which generated five key themes related to functional completeness: missing core databases, limited full-text access, weak system integration, inadequate citation tools, and insufficient supplementary resources.

The theme of missing core databases emerged prominently, with many respondents indicating that essential academic databases required for their programmes were either unavailable or inaccessible through the system. This limitation forced users to seek alternative access methods outside institutional platforms. A recurring phrase across these responses was that essential course databases were “not available” through the platform. The second theme, limited full-text access, reflects challenges in which users could access only abstracts despite institutional subscriptions. Respondents expressed frustration with incomplete access to scholarly materials, which directly affected their

academic work. This suggests inconsistencies in access configuration and subscription coverage.

Another recurring theme was weak system integration, particularly with institutional learning management systems such as Moodle. Respondents reported difficulties in seamlessly accessing resources through integrated platforms, indicating a lack of interoperability between systems. The theme of inadequate citation and referencing tools was also identified, with respondents noting the absence or limited functionality of tools to support academic writing and referencing. Additionally, insufficient supplementary resources, including e-books, reports, and past examination papers, were highlighted as gaps in the system's resource coverage. These findings indicate that while the system provides access to core resources, gaps remain in ensuring comprehensive, integrated access, thereby affecting the system's overall functional completeness.

4.4.2.2 Evaluation of Functional Correctness of Library Off-Campus Access Systems

Functional correctness evaluates the extent to which a system performs its intended functions accurately and reliably. In the context of library off-campus access systems, functional correctness refers to the system's ability to authenticate users securely, route links correctly to subscribed resources, provide accurate search results, maintain stable system sessions, and ensure that downloaded files are complete and error-free. Reliable and accurate system performance is essential for supporting uninterrupted academic work.

The results of the research indicate that students generally perceive the library's off-campus access system to perform reasonably well in terms of functional correctness, with a composite mean score of 3.65 (Table 4.9), suggesting moderate to high perceived system accuracy and reliability. The highest-rated item relates to the integrity of downloaded files (M = 3.89), indicating that students rarely encounter corrupted or incomplete downloads when accessing academic materials. Similarly, relatively high scores were observed for correct link routing to publisher platforms (M = 3.73) and error-free link resolution (M = 3.71), suggesting that the system generally performs well in delivering subscribed academic resources.

However, the relatively low mean score for system crashes (M = 2.74) indicates that system stability remains a concern for some users. Occasional system interruptions may disrupt academic workflows, particularly when students are engaged in time-sensitive research or coursework. Such interruptions may affect user confidence in the reliability of the off-campus access system. The composite standard deviation of 0.72, as shown in Table 4.9, indicates moderate variability in responses, suggesting that although students generally shared similar perceptions of system accuracy and reliability, some differences in user experiences were observed. These results corroborate [21] and [54], who found that broken links, authentication failures and session instability are the most disruptive technical faults in remote access environments, and they align with [32] on the centrality of reliability to software quality. With respect to Objective One, the results establish functional correctness as a core attribute of functional suitability.

Table 4.9: Evaluation of Functional Correctness of the Library Off-Campus Access Systems

Statement	Mean	Std. Dev
I rarely encounter errors while using the system.	3.55	0.86
The authentication process works reliably every time I access the system.	3.66	0.79
The system's search results are accurate and relevant.	3.62	0.82
In the past month, the off-campus access system has crashed while I was using it.	2.74	0.94
Links to e-resources open without errors (blank pages, redirect loops).	3.71	0.79
Downloaded files open correctly without corruption.	3.89	0.72
The system consistently maintains my login session until I log out.	3.68	0.85
Access links direct me to the correct publisher platforms.	3.73	0.78
I rarely encounter broken or outdated links.	3.58	0.88
Search results do not include irrelevant or misleading resources.	3.62	0.84

Note: Composite Mean = 3.65 Composite Std. Dev = 0.72

To further explore the quantitative findings, open-ended responses were analysed using thematic analysis following the reflexive framework proposed by Braun and

Clarke [85] [86], which identified four key themes related to functional correctness: broken or outdated links, authentication failures, session instability, and download errors.

The theme of broken or outdated links was frequently reported, with respondents indicating that accessing links to journal articles often resulted in errors or failed to load correctly. This disrupted the retrieval of academic resources and reduced user confidence in the system. The second theme, authentication failures, highlights issues with login processes, where users experienced repeated login errors or unsuccessful authentication attempts. These challenges hindered access to institutional resources and created barriers to system use.

A recurring phrase in the responses was that users “cannot log in” even when their credentials are correct. Another important theme was session instability, with respondents reporting unexpected timeouts or system logouts during active use. This affected workflow continuity, particularly when accessing multiple resources. Finally, download-related issues were identified, including corrupted or incomplete PDF files. These problems prevented users from effectively accessing full-text documents and compromised the system's reliability. These findings demonstrate that technical inconsistencies and system errors significantly affect the perceived functional correctness of the off-campus access system.

4.4.2.3 Evaluation of Functional Appropriateness of Library Off-Campus Access Systems

Functional appropriateness evaluates the extent to which a system supports users in completing their tasks efficiently and with minimal effort. In the context of library off-campus access systems, functional appropriateness reflects how effectively the system enables students to perform academic activities such as locating resources, accessing full-text materials, and navigating between databases. This dimension relates to the efficiency of system workflows and the ease with which users can accomplish their academic tasks.

The results indicate that functional appropriateness achieved a composite mean score of 3.58, as shown in Table 4.10, suggesting moderate levels of perceived usability and workflow efficiency. Students generally agreed that the system supports their

academic tasks (M = 3.74) and allows them to complete tasks without major delays (M = 3.66). These findings suggest that the system provides a functional interface that supports common academic activities such as accessing databases, retrieving full-text materials, and navigating scholarly resources. However, some aspects of system usability and workflow efficiency received comparatively lower ratings. For instance, the statement indicating that everyday tasks require more steps than necessary (M = 3.12) suggests that students sometimes experience inefficient navigation when accessing resources. Similarly, relatively moderate scores were recorded for shortcuts or quick- access tools (M = 3.28) and system speed for real-time academic activities (M = 3.44).

These results indicate that although the system enables access to academic resources, improvements in navigation structure, response time, and task efficiency could enhance the overall user experience. The composite standard deviation of 0.74, as depicted in Table 4.10, indicates moderate variability in student responses, suggesting that perceptions of system usability and workflow efficiency were generally consistent. However, some differences in user experiences were observed. These findings agree with [30] and [54], who reported that multi-step workflows and weak mobile optimisation depress the perceived usefulness of digital library systems, and with [51], who emphasised the alignment between system functions and user tasks. Concerning Objective One, the results confirm functional appropriateness as the third attribute impacting functional suitability.

Table 4.10: Evaluation of Functional Appropriateness of Library Off-Campus Access Systems

Statement	Mean	Std. Dev
The system supports the academic tasks I need to perform.	3.74	0.76
The user interface is intuitive and relevant for academic needs.	3.60	0.84
The system adapts well to different devices (mobile, PC, tablet).	3.55	0.85
Completing everyday tasks takes more steps than necessary.	3.12	0.98
The system allows me to accomplish tasks efficiently without delays.	3.66	0.80
The system minimises the steps needed to access full-text resources.	3.49	0.87
The system is fast enough to support real-time academic activities.	3.44	0.90
The system provides shortcuts or quick access to frequently used resources.	3.28	0.93
The system integrates well with institutional learning platforms (e.g., Moodle).	3.50	0.88

Note: Composite Mean = 3.58 Composite Std. Dev = 0.74

To further explore the quantitative findings, open-ended responses were analysed using thematic analysis following the reflexive framework proposed by Braun and Clarke [85] [86], which revealed five key themes related to functional appropriateness: complex navigation processes, interface usability issues, mobile usability limitations, lack of quick-access features, and task inefficiencies.

The theme of complex navigation processes emerged strongly, with respondents indicating that excessive steps were required to access full-text resources. This increased effort reduced system efficiency and discouraged use. The phrase “too many steps” recurred across responses describing the process of opening a single article. The second theme, interface usability issues, reflects concerns about confusing layouts and unclear labels, which made it difficult for users to navigate the system effectively.

This suggests that the system design does not fully align with user expectations. Mobile usability limitations were also frequently reported, with respondents indicating inconsistent performance across smartphones and tablets. This is particularly important in contexts where mobile access is predominant.

The theme of lack of quick-access features highlights the absence of shortcuts or tools that allow users to efficiently access frequently used resources. This limitation contributes to increased navigation time and reduced usability. Finally, task inefficiency was identified as a major concern, with respondents reporting delays in search results and slow access to resources. These issues negatively affect the ability to perform academic tasks efficiently. These findings indicate that although the system provides the necessary functions, usability and workflow inefficiencies reduce its functional appropriateness.

4.4.3 Contextual Factors Influencing Perceived Functional Suitability

In addition to the three validated functional-suitability constructs, qualitative responses were sought regarding contextual factors that shape how students perceive the performance of library off-campus access systems. The contextual factors provide interpretive insight into variations in user experiences that the core constructs may not fully capture. Specifically, User Experience Level and Institutional Support are examined as contextual influences that help explain differences in perceived system effectiveness across student groups.

4.4.3.1 User Experience Level as a Contextual Influence

Qualitative data from open-ended questionnaire items were analysed using thematic analysis following the reflexive framework proposed by Braun and Clarke [85] [86]. The analysis generated five dominant themes influencing user experience in library off-campus access systems: device compatibility challenges, limitations in digital literacy, difficulties interpreting errors, peer-dependent support, and connectivity constraints.

The theme of device compatibility challenges emerged strongly, with many respondents reporting inconsistent system performance across devices, including personal computers, tablets, and mobile phones. Students noted that certain features functioned well on desktops but were difficult to access or unreliable on mobile

devices. A common phrase in the responses was that the system “works better on a computer” than on mobile phones. This suggests that system optimisation across devices remains uneven.

The second theme, digital literacy limitations, highlights user difficulties in navigating and interacting with the system. Respondents reported challenges in searching for resources, applying filters, and troubleshooting technical issues. These findings indicate that variations in digital skills significantly affect users’ ability to utilise off-campus access systems effectively. Another recurring theme was difficulties interpreting errors, where respondents expressed frustration with unclear or unhelpful system messages. Many users indicated that system errors lacked sufficient explanation, making it difficult to resolve issues independently. Responses repeatedly described error messages that users “don’t understand” and cannot resolve without assistance. This suggests a gap in system feedback design.

The theme of peer-dependent support also emerged, with several respondents indicating reliance on classmates or colleagues for assistance rather than official technical support channels. This reflects potential weaknesses in formal support systems or accessibility of institutional help resources. Finally, connectivity constraints were identified as a significant external factor affecting user experience. Respondents noted that unstable internet connections often exacerbated usability issues, leading to session interruptions and delayed access to resources. These findings indicate that user experience level operates as a contextual factor that moderates perceived functional suitability in off-campus access systems.

4.4.3.2 Institutional Support as a Contextual Influence

Qualitative data from open-ended questionnaire items were similarly analysed using thematic analysis following the reflexive framework proposed by Braun and Clarke [85] [86]. The analysis identified five key themes relating to institutional support: delayed technical support, limited user training, insufficient documentation, poor communication, and the need for ongoing user engagement.

The theme of delayed technical support was frequently mentioned, with respondents indicating slow response times when reporting login or access issues. This delay often resulted in prolonged interruptions to access to academic resources. A recurring phrase

was that support “takes too long” when the system fails. This suggests that the responsiveness of support services is a critical determinant of system effectiveness. Another prominent theme was limited user training, with respondents indicating they had not received adequate guidance on effectively using the off-campus access system. Many users expressed the need for structured training sessions to improve their understanding and use of system features.

Closely related to this was the theme of insufficient documentation, with respondents requesting clearer user guides and instructional materials. The lack of accessible documentation limits users’ ability to resolve issues and fully utilise the system's capabilities independently. The theme of poor communication also emerged, particularly regarding system outages, updates, or maintenance activities. Respondents indicated they were often unaware of system issues or changes, leading to confusion and frustration. Respondents commonly reported that they are “not informed” when the system is down or being updated. Finally, respondents emphasised the need for continuous user engagement, including regular orientation and refresher sessions. This reflects the dynamic nature of digital systems, in which ongoing user support is necessary to maintain effective utilisation. These findings indicate that institutional support structures play a critical role in shaping sustained system use and user satisfaction.

4.5 Development of the Functional Suitability Evaluation Framework

This section addresses Objective Two, which aimed to develop a Functional Suitability Evaluation Framework for off-campus access systems. Building on the validated constructs established in Objective One, the analysis advances from descriptive assessment to examining the structural relationships among Functional Completeness, Functional Correctness, Functional Appropriateness, and the Functional Suitability Index (FSI). The Functional Suitability Index is the overall measure of the library's off-campus access system's functional suitability, derived from the composite scores of the three constructs.

The analytical process begins with Pearson correlation analysis to assess the strength and direction of the relationships among the constructs and to evaluate the potential presence of multicollinearity. Following this step, multiple linear regression analysis is conducted to determine the unique predictive contribution of each construct to the

Functional Suitability Index. The regression results provide empirical coefficients, which are subsequently normalised to derive the relative weights of the constructs. These weights form the basis for constructing the developed evaluation framework. In this way, the findings from Objective One directly informed the framework's development: the constructs validated through factor analysis (Section 4.4.1) define the framework's dimensions, the performance gaps identified in Section 4.4.2 define its evaluation criteria, and the regression coefficients estimated below define its weights, while the validation results in Section 4.6 confirm the resulting framework's practical applicability.

4.5.1 Correlation Analysis of Functional Suitability Constructs

Pearson correlation analysis was conducted to examine the relationships among the three functional suitability constructs and the overall Functional Suitability Index (FSI). Specifically, the analysis assessed the strength and direction of the relationship between each construct, Functional Completeness, Functional Correctness, and Functional Appropriateness and the FSI, which represents the overall composite measure of functional suitability derived from the three validated constructs. Pearson's correlation coefficient was selected as the appropriate statistical method because all variables are continuous and normally distributed, satisfying the assumptions required for examining linear relationships in quantitative research.

The results show strong, positive, and statistically significant correlations among all variables. Functional Correctness exhibits the strongest correlation with the Functional Suitability Index ($r = 0.861$), followed by Functional Appropriateness ($r = 0.847$) and Functional Completeness ($r = 0.812$), as depicted in Table 4.11. These findings indicate that improvements in any of the three functional attributes are associated with better overall functional suitability of library off- campus access systems.

The strong positive relationships among the constructs also suggest that the three dimensions collectively contribute to the functional suitability of library off-campus access systems. This pattern reflects the structure of the ISO/IEC 25010 software quality model, where functional completeness, functional correctness, and functional appropriateness are treated as interrelated sub-characteristics within the broader functional suitability dimension. While correlation analysis confirms strong

associations among the constructs, it does not determine each construct's relative contribution to the system's overall functional suitability. Therefore, multiple linear regression analysis was conducted to examine the predictive influence of the three constructs on the Functional Suitability Index (FSI).

Table 4.11: Pearson Correlation Matrix of Functional Suitability Constructs

Variables	**Functional Completeness**	**Functional Correctness**	**Functional Appropriateness**	**Functional Suitability Index**
Functional Completeness	1	.712**	.658**	.812**
Functional Correctness	.712**	1	.744**	.861**
Functional Appropriateness	.658**	.744**	1	.847**
Functional Suitability Index	.812**	.861**	.847**	1

Note: ** Correlation is significant at the 0.01 level (2-tailed).

4.5.2 Regression Analysis for Predictors of Functional Suitability

Multiple linear regression analysis was conducted to determine the predictive influence of Functional Completeness, Functional Correctness, and Functional Appropriateness on the Functional Suitability Index (FSI). Regression analysis is appropriate when examining the extent to which multiple independent variables predict a continuous dependent variable. In the context of this research, the technique enables the assessment of how each functional suitability construct contributes to the perceived functional suitability of library off-campus access systems. This approach is consistent with methodological practices commonly applied in software quality evaluation research.

4.5.2.1 Regression Model Summary for Functional Suitability

The regression results indicate a strong relationship between the predictor variables and the Functional Suitability Index (FSI), with a correlation coefficient of R = 0.921.

This value suggests that the combined effect of Functional Completeness, Functional Correctness, and Functional Appropriateness is strongly associated with the functional suitability of library off- campus access systems.

The coefficient of determination ($R^2 = 0.848$), as shown in Table 4.12, indicates that the three predictors collectively explain 84.8% of the total variance in the Functional Suitability Index. This high proportion of explained variance demonstrates the model's strong predictive power and confirms the relevance of the selected constructs in explaining users' perceptions of system functionality. Furthermore, the adjusted R^2 value of 0.846, as shown in Table 4.12, indicates that the model remains stable after adjusting for the number of predictors included in the regression analysis. The small difference between R^2 and adjusted R^2 suggests that the model is not overfitted and that the predictive relationship is likely to generalise well within the broader user population.

These findings provide empirical support for the research's conceptual foundation, based on the ISO/IEC 25010 software quality model. The results indicate that functional completeness, functional correctness, and functional appropriateness collectively form a robust multidimensional representation of functional suitability in library off-campus access systems. In practical terms, this implies that improvements in system functionality, operational accuracy, and task efficiency are likely to enhance the overall effectiveness of library off- campus access systems in academic libraries. The strong predictive capability of the model, therefore, justifies the inclusion of these three constructs in the Functional Suitability Evaluation Framework, reinforcing the importance of a multidimensional approach to evaluating library off-campus access systems.

Table 4.12: Regression Model Summary for Functional Suitability

Model	R	R Square	Adjusted R-Square	Std. Error of Estimate
1	.921	.848	.846	.21634

4.5.2.2 ANOVA Results for the Functional Suitability Regression Model

Analysis of Variance (ANOVA) was conducted to determine whether the regression model significantly predicts the Functional Suitability Index (FSI). The results in Table 4.13 indicate that the regression model is statistically significant, with $F(3, 330) = 699.524$, $p < 0.001$. This indicates that the three predictors, Functional Completeness, Functional Correctness, and Functional Appropriateness, jointly provide a strong explanation of the variation in the Functional Suitability Index.

The large F-value (699.524), as shown in Table 4.13, indicates that the regression model explains substantially more variance in functional suitability than would be expected by chance. This confirms that the combined effect of the three functional suitability constructs significantly improves the prediction of the Functional Suitability Index compared with a model without predictors. Similar patterns have been reported in studies of digital library system evaluation, where multiple functional attributes collectively influence perceptions of system effectiveness.

The statistically significant result, therefore, supports the suitability of the regression model and confirms that functional completeness, functional correctness, and functional appropriateness are important determinants of functional suitability in library off-campus access systems. Consequently, the model provides a reliable basis for interpreting the regression coefficients and deriving the empirical weights used to develop the Functional Suitability Evaluation Framework.

Table 4.13: ANOVA Results for the Functional Suitability Regression Model

Model	**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Regression	98.214	3	32.738	699.524	.000***
Residual	17.603	330	0.053		
Total	115.817	333			

Note: ***p < 0.001

4.5.2.3 Regression Coefficients for Functional Suitability Predictors

Regression coefficient analysis was conducted to determine the relative contribution of Functional Completeness, Functional Correctness, and Functional Appropriateness

to the Functional Suitability Index (FSI). Regression coefficients indicate the magnitude and direction of the relationship between each predictor and the dependent variable while controlling for the influence of the other variables in the model. The results in Table 4.14 show that all three predictors are statistically significant ($p < 0.001$), confirming that each construct contributes meaningfully to the prediction of functional suitability in library off-campus access systems.

Among the predictors, Functional Correctness recorded the highest unstandardized coefficient ($B = 0.411$) and standardised beta ($\beta = 0.447$), as shown in Table 4.14, indicating that it has the strongest influence on the Functional Suitability Index. This suggests that improvements in system accuracy, authentication reliability, and error-free access are likely to have the greatest impact on the overall functional suitability of library off-campus access systems.

The second strongest predictor is Functional Appropriateness ($B = 0.352$, $\beta = 0.379$), as shown in Table 4.14, indicating that usability, workflow efficiency, and system responsiveness significantly influence perceptions of functional suitability. Systems that enable users to complete academic tasks efficiently and with minimal effort are more likely to be perceived as effective in supporting academic activities. Although Functional Completeness was also statistically significant ($B = 0.286$, $\beta = 0.301$), it recorded the lowest coefficient among the predictors. This suggests that while the availability of system features and academic resources remains important, the overall suitability of the system is more strongly influenced by how accurately and efficiently the system performs its functions.

The regression results, therefore, confirm that the three functional suitability constructs significantly influence the Functional Suitability Index. These empirical coefficients form the basis for deriving the normalised weights used in the Functional Suitability Evaluation Framework, thereby supporting the development of a data-driven framework for evaluating library off-campus access systems.

Table 4.14: Regression Coefficients for Functional Suitability Predictors

Predictor	Unstandardized Coefficient (B)	Std. Error	Standardised Beta (β)	t-value	Sig.
Constant	0.214	0.062		3.451	.001
Functional Correctness	0.411	0.039	.447	10.487	.000***
Functional Completeness	0.286	0.041	.301	6.983	.000***
Functional Appropriateness	0.352	0.037	.379	9.514	.000***

Note: ***p < 0.001

4.5.3 Derivation of the Functional Suitability Index (FSI)

The Functional Suitability Index (FSI) was derived from the unstandardized regression coefficients obtained from the multiple linear regression analysis. The regression results confirmed that Functional Completeness, Functional Correctness, and Functional Appropriateness significantly predict overall functional suitability, though with varying degrees of influence. Functional Correctness emerged as the strongest predictor (B = 0.411), followed by Functional Appropriateness (B = 0.352) and Functional Completeness (B = 0.286). Because unstandardized coefficients (B) represent relative contributions rather than proportional weights, normalisation was necessary to ensure that the weights sum to 1 and preserve the original 1–5 Likert measurement scale. Each B value was divided by its total (1.049) to obtain normalised weights.

4.5.3.1 Normalisation of the Unstandardized Coefficients (B)

Normalisation Formula: $W_i = Bi / \Sigma B_i$

Where: Wi = normalised weight for construct i;

B_i = unstandardised regression coefficient for construct i;

ΣB_i = sum of all regression coefficients.

Application:

Functional Correctness B = 0.411; Functional Appropriateness B = 0.352; Functional Completeness B = 0.286

$\Sigma B_i = 0.411 + 0.352 + 0.286 = 1.049$

W(Correctness) = 0.411 ÷ 1.049 = 0.39

W(Appropriateness) = 0.352 ÷ 1.049 = 0.34

W(Completeness) = 0.286 ÷ 1.049 = 0.27

0.390 + 0.340 + 0.270 = 1.00

The weights, therefore, sum to unity, confirming proportional scaling. Functional Correctness contributes 39%, Functional Appropriateness 34%, and Functional Completeness 27% to the Functional Suitability Index. Based on these normalised weights, the Functional Suitability Index is computed as:

Eq. (1) FSI = (0.270 × FCom) + (0.390 × FCor) + (0.340 × FApp)

The use of unstandardised regression coefficients as weights is supported in multivariate statistical modelling, particularly when predictors are measured on the same scale and preservation of original measurement units is required. Unlike standardised coefficients, unstandardised coefficients retain interpretability within the original metric of the dependent variable. In composite index construction, regression-derived weights are recognised as an objective method of assigning relative importance among indicators based on empirical contribution. However, because regression coefficients do not inherently sum to unity, normalisation is required to ensure proportional representation and preserve interpretability of the final index. The sum-to-one constraint prevents inflation or distortion of the composite score and maintains consistency with the original measurement scale.

4.5.3.2 Operationalisation of the Functional Suitability Index

Operationally, each construct score is calculated as the mean of its validated construct indicators following reliability testing and exploratory factor analysis. The mean score

for each construct is multiplied by its respective normalised weight, and the weighted values are summed to obtain the final Functional Suitability Index, which ranges from 1 to 5. Higher FSI values indicate stronger functional suitability, reflecting greater system functional completeness, correctness and appropriateness. This index, therefore, provides a structured, evidence-based mechanism for evaluating library off-campus access systems in alignment with ISO/IEC 25010 and user priorities identified in the empirical analysis.

4.5.4 Functional Suitability Evaluation Framework and Operationalisation

The Functional Suitability Evaluation Framework, as illustrated in Figure 4.9, provides an evidence-based approach to assessing the completeness, correctness, and appropriateness of library off-campus access systems in academic libraries. Grounded in the ISO/IEC 25010 software quality model, the framework is structured around three empirically validated constructs: Functional Completeness, Functional Correctness, and Functional Appropriateness. These dimensions collectively capture the extent to which the system provides required resources, performs functions accurately and reliably, and supports users in accomplishing academic tasks efficiently.

Regression results demonstrated that Functional Correctness is the strongest predictor of functional suitability, highlighting the importance of stable authentication, accurate link routing, error-free access, and dependable full-text retrieval. Functional Appropriateness became second, reflecting workflow efficiency, interface usability, device compatibility, and task support, while Functional Completeness was last, representing the breadth and adequacy of accessible academic resources. Although Completeness carries a comparatively lower weight, it remains foundational to system usefulness.

The framework, as shown in Figure 4.9, integrates these constructs using empirically derived normalised weights, ensuring that the Functional Suitability Index reflects user priorities rather than subjective judgment. In addition, contextual factors such as User Experience Level and Institutional Support provide interpretive insight into variations in perceived performance. The framework offers a practical tool for diagnosing system gaps, guiding institutional improvements, and supporting continuous enhancement of library off-campus access services.

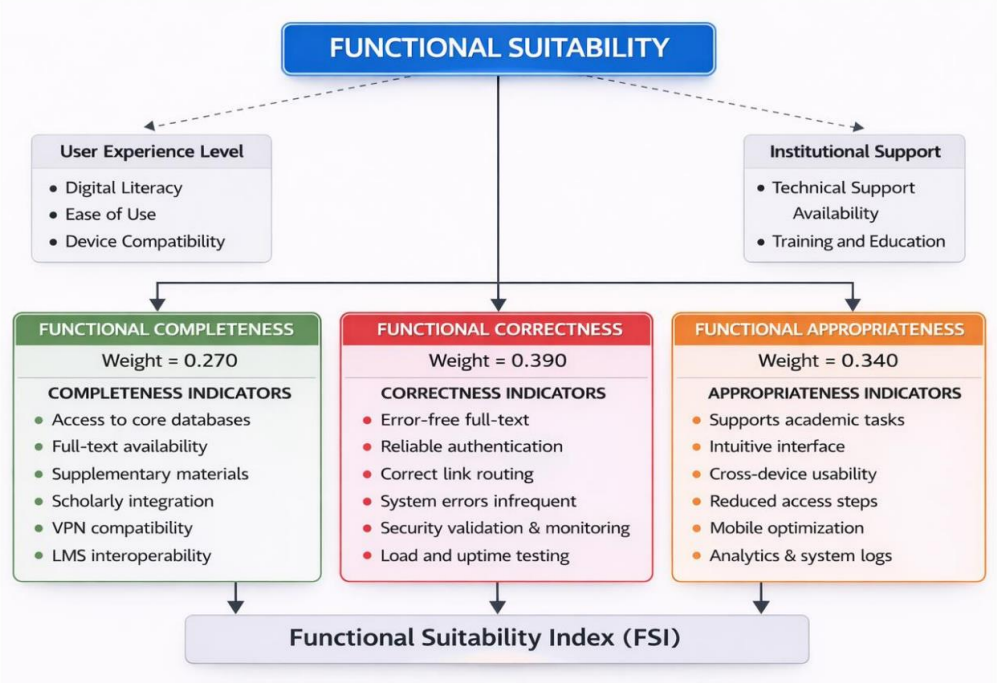


Figure 4.9: Functional Suitability Evaluation Framework

4.5.4.1 Scoring Rubric for the Functional Suitability Evaluation Framework

The scoring rubric, as shown in Table 4.15, operationalises the Functional Suitability Evaluation Framework into a practical instrument that can be applied by academic libraries and ICT departments to evaluate the functional suitability of library off-campus access systems. The rubric translates the empirically validated constructs Functional Completeness, Functional Correctness, and Functional Appropriateness into measurable evaluation criteria derived directly from the retained questionnaire items from the exploratory factor analysis results. Each criterion is rated on a five-point Likert scale ranging from very low functional suitability (1) to very high functional suitability (5), and construct scores are computed as weighted averages based on regression-derived weightings, as shown in Table 4.15. This approach ensures that the evaluation process is evidence-based, systematic, and aligned with user perceptions and ISO/IEC 25010.

Table 4.15: Scoring Rubric for the Functional Suitability Evaluation Framework

Construct	Evaluation Criteria	Rating (1–5)
Functional Completeness	Access to core databases is consistently available.	
	Full-text access is available for required materials.	
	Access to supplementary materials (reports, e- books) is adequate.	
	Integration with scholarly tools (Google Scholar, LMS) is effective.	
	The system provides all the necessary features to support academic work.	
Score for Completeness = Average × 0.270		
Functional Correctness	Full-text links open without errors.	
	Downloads (PDFs, documents) open correctly	
	The authentication process is stable and consistent.	
	System routes users to the correct publisher platforms.	
	Search results are accurate and relevant.	
	Broken or outdated links are rare.	
Score for Correctness = Average × 0.390		
Functional Appropriateness	The system supports the academic tasks users perform.	
	The interface is intuitive and user friendly.	
	The system works efficiently across devices.	
	Steps required to access the full text are minimal.	

	The system enables efficient task completion.	
	Shortcuts or quick-access tools are available.	
Score for Appropriateness = Average × 0.340		

The Final Functional Suitability Score (0–5) is computed as a weighted composite of the three empirically validated constructs:

Eq. (2) FSI = (0.270 × FCom) + (0.390 × FCor) + (0.340 × FApp)

The relative contribution of each construct to the functional suitability index is reflected in the weights given to it based on a multiple linear regression analysis. Functional Correctness is rated the highest, then Functional Appropriateness, and lastly Functional Completeness, ensuring that the attributes with the greatest impact on the system's functional suitability have a proportional effect on the final evaluation result.

4.5.4.2 Interpretation Guideline for Functional Suitability Index Scores

The interpretation of the Functional Suitability Index (FSI) scores was based on the five-point Likert scale employed in the research. Since the FSI was computed as a weighted composite mean of Functional Completeness, Functional Correctness, and Functional Appropriateness, the resulting scores remain within the same 1–5 scale continuum, as shown in Table 4.16. Consequently, interpretation is directly aligned with the original scale descriptors, preserving measurement consistency and conceptual clarity. This interpretation approach maintains alignment between measurement, analysis, and reporting, thereby strengthening the internal validity and practical applicability of the developed evaluation framework.

Table 4.16: Interpretation Guide for the Functional Suitability Index (FSI)

Mean Score	Functional Suitability Level	Interpretation
5	Very High Functional Suitability	The system demonstrates strong reliability, efficiency, and task support
4	High Functional Suitability	System supports most academic access needs with minor limitations
3	Moderate Functional Suitability	Core functionality is present, but noticeable performance gaps
2	Low Functional Suitability	Significant usability or reliability constraints
1	Very Low Functional Suitability	The system inadequately supports off-campus academic access

4.6 Validation of the Functional Suitability Evaluation Framework

The final objective of the research was to validate the Functional Suitability Evaluation Framework using the professional judgment of technical personnel responsible for administering library off-campus access systems in the three universities included in the research. This validation process involved practical validation, the evaluation of a framework by domain experts to determine its applicability, usability, and feasibility in real operational environments. Practical validation helps ensure that a framework is not only theoretically sound but also implementable and aligned with institutional practices. In this study, technical personnel assessed the framework for clarity, relevance, feasibility, completeness, and adaptability. Their feedback strengthened the framework's practical credibility and applicability before it could be recommended for institutional adoption.

4.6.1 Quantitative Validation Results of the Evaluation Framework

The total number of technical personnel involved in the validation exercise was 37, which is an 86.0% response rate from the sampled population of 43, as depicted in Table 4.1. The quantitative validation results indicate strong agreement among the technical personnel regarding the suitability of the framework. The results in Table 4.17 show a composite mean score of 4.18, demonstrating a high level of acceptance

of the Functional Suitability Evaluation Framework across the evaluated criteria. The results show that there is a high level of consensus among the 37 technical personnel that the Functional Suitability Evaluation Framework for library off-campus access systems is comprehensive, applicable, and useful in practice in the institutional settings.

The fact that the item that has the highest rating is the one that mentions that the framework addresses the most important functional suitability attributes (M = 4.41), as shown in Table 4.17, demonstrates that the technical staff see the framework as the one that incorporates the most important aspects that are necessary in the process of assessing effective library off- campus access systems. The lowest rating, however, is positive (M = 4.00) for the technical complexity factor, implying that the framework is sound but may require an intermediate level of technical expertise to use. Additionally, the composite standard deviation of 0.75 indicates relatively low to moderate variability in responses, suggesting that technical personnel generally shared consistent perceptions of the framework's clarity, relevance, feasibility, and applicability in institutional settings.

Table 4.17: Validation of the Functional Suitability Evaluation Framework

Statement	Mean	Std. Dev
The framework addresses key functional suitability attributes	4.41	.61
The evaluation criteria are relevant to existing off-campus systems	4.36	.67
The framework provides a clear structure for evaluation	4.28	.72
The framework is easy to interpret and implement in a university setting	4.10	.81
The framework integrates user feedback effectively	4.18	.76
The framework is technically feasible within the existing ICT infrastructure	4.05	.88
The framework accommodates updates and future enhancements	4.23	.69
Technical requirements for implementing the framework are clearly defined	4.08	.79
The level of technical complexity in applying the framework is reasonable	4.00	.84
The framework is compatible with existing monitoring or evaluation tools	4.15	.73

Note: Composite Mean = 4.18 Composite Std. Dev = 0.75

4.6.2 Qualitative Validation Results of the Evaluation Framework

Qualitative data from open-ended responses provided by technical personnel were analysed using thematic analysis following the reflexive framework proposed by Braun and Clarke [85] [86], which revealed six key themes related to the validation of the framework: feasibility constraints, need for automation, institutional alignment, operational completeness, adaptability for continuous improvement, and clarity of implementation guidelines. The theme of feasibility constraints emerged prominently, with many respondents highlighting institutional limitations, including inadequate ICT staffing, budgetary constraints, and reliance on manual processes for tasks such as link verification. These challenges suggest that while the framework is conceptually sound, its implementation may be affected by existing resource limitations within

institutions. Additionally, the need for automation emerged, with respondents recommending integrating automated tools, such as uptime monitoring and link validation systems. These tools were viewed as essential for enhancing the sustainability and efficiency of the framework, particularly in reducing manual workload and improving real- time system monitoring.

Another central theme was institutional alignment, with respondents emphasising the need for the framework to be integrated with existing workflows, reporting structures, and ICT governance processes. This indicates that successful implementation depends on how well the framework fits within established institutional practices and operational environments. The theme of operational completeness also emerged, with respondents suggesting the inclusion of additional technical indicators, including security validation procedures, authentication strength, VPN compatibility, analytics dashboards, and system load testing. While the core constructs were considered adequate, these suggestions indicate a need to expand the framework to capture operational realities better.

In terms of long-term applicability, the theme of adaptability for continuous improvement was identified, with respondents recommending periodic review cycles and integrating system log analytics. This reflects the need for the framework to remain responsive to evolving technologies and changing user requirements. Finally, respondents highlighted issues related to implementation clarity, noting the need for clearer operational guidelines, simplified scoring templates, and more explicit interpretation procedures. These improvements were considered necessary to ensure consistent application and ease of use across different institutional contexts. These thematic insights affirm the practical viability of the framework while highlighting areas that require refinement to support effective implementation in real-world institutional environments.

The most common phrases associated with the themes were “automate the link checking”, “monitor system uptime”, “works with the VPN”, “strengthen login security”, “a simple scoring template” and “review the indicators regularly”. These recurring phrases directly informed the operational indicators incorporated into the developed framework, which include, security validation and monitoring, and load and uptime testing were included under functional correctness; VPN compatibility and

LMS interoperability under functional completeness; and analytics and system logs, reduced access steps and mobile optimisation under functional appropriateness. In this way, the expert feedback was translated directly into the measurable attributes of the framework rather than being reported as isolated opinions.

4.6.3 Functional Suitability Evaluation Tool

To demonstrate practical implementation, the framework and its scoring rubric were operationalised into a working web-based tool, the Functional Suitability Evaluation Portal (FSI-Eval). The portal captures the evaluation details (institution, system evaluated, evaluator role and date), presents the rubric criteria of Table 4.15 for rating on the five-point scale, and automatically computes the construct means, the weighted contribution of each construct, the composite Functional Suitability Index using Eq. (2), and its interpretation against Table 4.16, together with diagnostic guidance that identifies the weakest dimension and recommends remediation priorities. Figure 4.10 presents the rubric-based rating interface of the prototype, while Figure 4.11 presents the computed results dashboard for an illustrative evaluation whose ratings approximate the construct means obtained in this research (FCom = 3.80, FCor = 3.67, FApp = 3.50), yielding an FSI of 3.65, interpreted as High Functional Suitability. The prototype confirms that the framework can be applied directly by library and ICT personnel without statistical expertise.

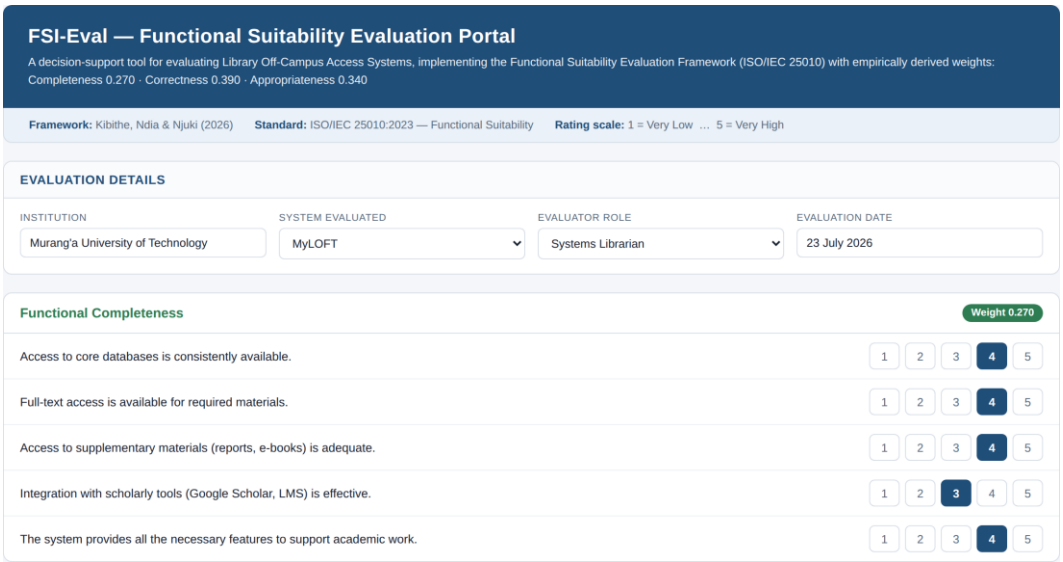


Figure 4.10: FSI-Evaluation Tool

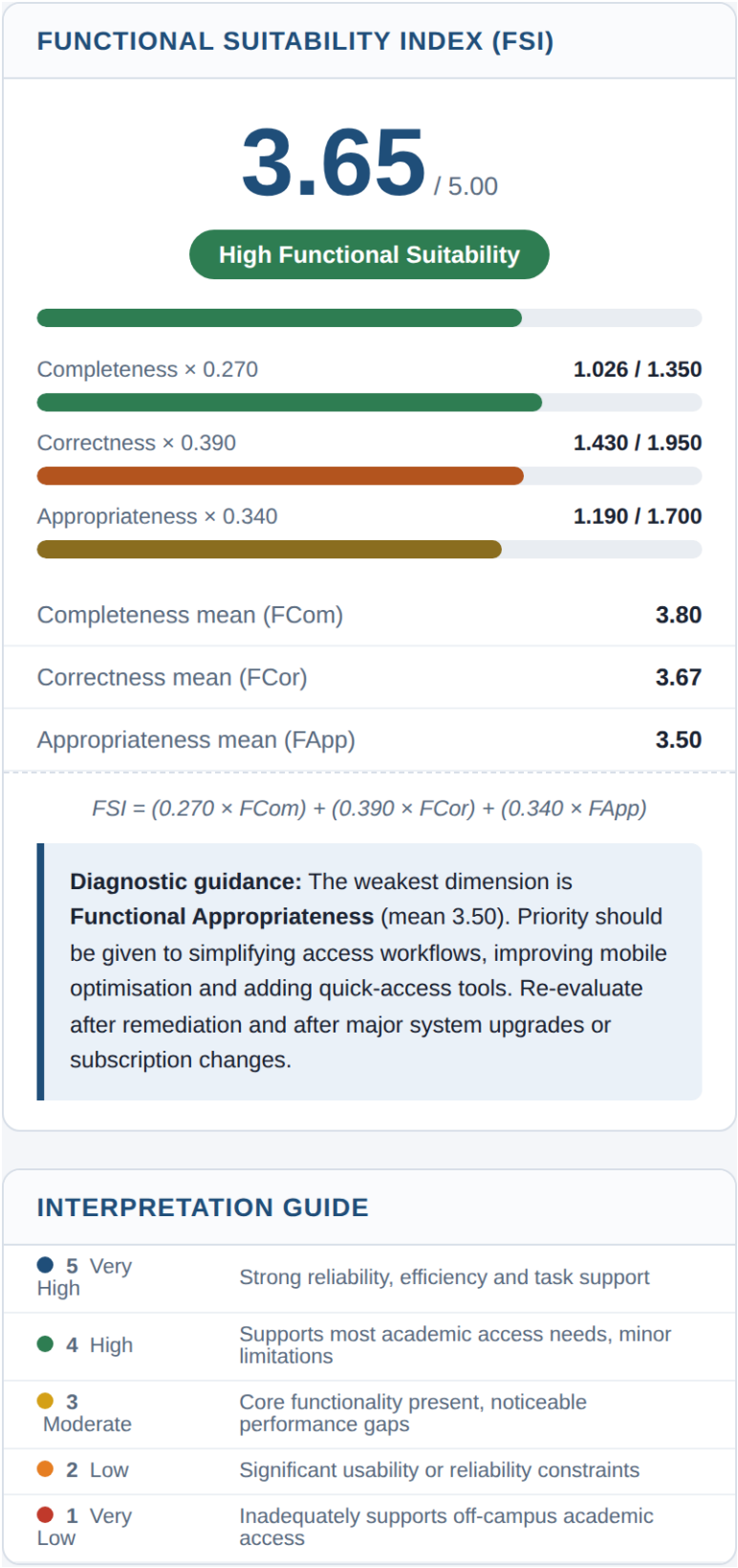


Figure 4.11: FSI-Evaluation Tool Results Dashboard

4.7 Discussion of Findings

This section discusses the study's findings in relation to the research objectives, theoretical grounding, and existing literature. The discussion focuses on interpreting the empirical results and explaining their implications for the evaluation and improvement of library off-campus access systems in academic environments.

4.7.1 Functional Suitability Attributes of Library Off-Campus Access Systems

The first objective of the study sought to evaluate the functional suitability of library off- campus access systems based on the three ISO/IEC 25010 sub-characteristics: Functional Completeness, Functional Correctness, and Functional Appropriateness. The findings indicate that while the systems demonstrate moderate to high performance across all three constructs, notable gaps remain that affect overall system effectiveness.

Functional Completeness recorded the highest mean score (M = 3.78), indicating that users generally perceive the system as capable of providing access to essential academic resources. However, qualitative findings revealed persistent gaps, including missing databases, limited access to full text, and weak integration with learning management systems. This implies that system availability alone is insufficient; institutions must ensure comprehensive resource coverage and seamless integration to avoid forcing users to seek alternative access methods, which undermines the value of institutional subscriptions.

Functional Correctness (M = 3.65) was identified as a critical determinant of system reliability, with regression results confirming it as the strongest predictor of functional suitability. However, qualitative findings highlighted issues such as broken links, authentication failures, and session instability. This suggests that even minor technical failures can significantly disrupt academic workflows, reducing trust in the system. Therefore, institutions must prioritise system stability, accurate link routing, and robust authentication mechanisms as core operational requirements rather than secondary technical concerns.

Functional Appropriateness recorded the lowest mean score (M = 3.58), indicating challenges related to usability and workflow efficiency. Themes such as complex navigation, mobile usability limitations, and task inefficiency suggest that the system

does not fully align with user expectations. This implies that system effectiveness is not only determined by what the system provides, but also by how easily users can accomplish their academic tasks. Institutions must therefore adopt user-centred design approaches that simplify workflows and optimise system performance across devices, particularly in mobile-first contexts.

The findings demonstrate that functional suitability is a multidimensional construct where availability, accuracy, and usability must be addressed simultaneously. The results support the ISO/IEC 25010 model while highlighting that, in practice, functional correctness and appropriateness have a stronger influence on perceived system effectiveness than completeness alone. The findings also align with the theoretical framework: consistent with ISO/IEC 25010, the three sub-characteristics behaved as distinct yet interrelated dimensions [10]. Practically, the results imply that library and ICT departments should treat link integrity, authentication stability and workflow simplicity as service-level priorities rather than incidental maintenance concerns.

4.7.2 Development of the Functional Suitability Evaluation Framework

The second objective aimed to develop the developed Functional Suitability Evaluation Framework based on empirical evidence. The findings from correlation and regression analyses confirmed strong relationships among the three constructs and their significant predictive influence on overall functional suitability ($R^2 = 0.848$).

Functional Correctness emerged as the most influential predictor, followed by Functional Appropriateness and Functional Completeness. This finding challenges the common assumption that access to resources is the primary determinant of system effectiveness. Instead, it demonstrates that system reliability and usability are more critical in shaping user perceptions of functionality. This has important implications for system design and evaluation, as it shifts focus from resource provision to performance quality and user experience.

The derivation of normalised weights from regression coefficients provides an objective, data- driven basis for constructing the Functional Suitability Index. This ensures that the developed framework reflects actual user priorities rather than subjective assumptions, making it more reliable and applicable in real-world

institutional settings. The framework, therefore, moves beyond descriptive evaluation by offering a quantifiable method for assessing system performance.

Additionally, the integration of contextual factors such as user experience level and institutional support enhances the explanatory power of the framework. This indicates that system performance cannot be fully understood without considering user capabilities and institutional conditions. As a result, the framework provides a more holistic approach to evaluation by combining technical, user, and organisational dimensions.

4.7.3 Validation of the Developed Framework

The third objective focused on validating the Functional Suitability Evaluation Framework using technical personnel. The findings indicate a high level of agreement among respondents (Composite Mean = 4.18), confirming that the framework is relevant, clear, feasible, and applicable within institutional environments. However, qualitative feedback revealed concerns about technical complexity, resource constraints, and the need for additional operational features, such as automation and analytics integration. This suggests that while the framework is conceptually sound, its successful implementation depends on institutional capacity, including the availability of technical expertise, infrastructure, and financial resources. Without these, even well-designed frameworks may face practical limitations.

The recommendation to integrate automation tools, such as link validation and uptime monitoring, underscores the need for continuous system evaluation rather than periodic assessment. This implies that functional suitability should be treated as an ongoing process rather than a one-time evaluation, requiring institutions to adopt dynamic monitoring strategies. Furthermore, the emphasis on aligning the framework with existing workflow structures emphasises the importance of organisational compatibility. This means that evaluation frameworks must be adaptable to institutional contexts to ensure effective adoption and sustainability.

4.8 Summary

This chapter presented the research findings beginning with the response rate (86.9%) and the demographic profile of student respondents (n = 334) and technical personnel (n = 37). Measurement quality was confirmed using the full research dataset, with high

internal consistency across the functional suitability constructs (α = 0.874–0.903; overall α = 0.927) and excellent factorability (KMO = 0.913; Bartlett's test significant). Exploratory Factor Analysis supported a three-factor structure aligned to Functional Completeness, Functional Correctness, and Functional Appropriateness, explaining 67.60% of total variance and guiding the removal of low-loading items. Descriptive results showed moderate-to-high performance across the constructs (Completeness M = 3.78; Correctness M = 3.65; Appropriateness M = 3.58), while qualitative feedback highlighted key gaps in database coverage, link reliability, authentication stability, navigation efficiency, and mobile usability.

Correlation analysis demonstrated strong positive relationships among the constructs and the Functional Suitability Index, with Correctness showing the strongest association with overall suitability. Multiple regression analysis confirmed that the three constructs significantly predict overall functional suitability ($R = 0.921$; $R^2 = 0.848$; $F(3,330) = 699.524$, $p < 0.001$), with Functional Correctness contributing most (B = 0.411), followed by Functional Appropriateness (B = 0.352) and Functional Completeness (B = 0.286). These coefficients were normalised (sum = 1.049) to generate proportional weights (0.390, 0.340, 0.270), which were used to derive the Functional Suitability Index formula: FSI = (0.270×FCom) + (0.390×FCor) + (0.340×FApp).

The chapter concluded by presenting the evaluation framework, scoring rubric, and interpretation guide and validating the framework with technical personnel, whose quantitative ratings were high (M = 4.00 – 4.41) and whose qualitative feedback supported feasibility while recommending refinements such as automation, stronger authentication/security indicators, and analytics integration. Chapter four closes with the FSI- evaluation tool that automates the functional suitability evaluation of off-campus systems.

CHAPTER FIVE
CONCLUSION, RECOMMENDATIONS AND FUTURE WORK

5.1 Conclusion

The conclusions below are organised by research objective and are drawn directly from the empirical findings presented in Chapter Four: the attribute results for Objective One, the correlation, regression and index-derivation results for Objective Two, and the expert validation results for Objective Three.

5.1.1 Functional Suitability Attributes of Library Off-Campus Access Systems

The findings indicate that the functional suitability of library off-campus access systems is determined by three interrelated dimensions: Functional Completeness, Functional Correctness, and Functional Appropriateness. The objective of evaluating these constructs was successfully achieved through empirical analysis, which provided a comprehensive understanding of how the systems enable remote access to academic resources. The findings demonstrated that while the systems generally provide access to required resources, their effectiveness is uneven across the three dimensions, with functional completeness performing relatively better than correctness and appropriateness.

The importance of this achievement lies in its contribution to a more structured, evidence-based understanding of system functionality in academic libraries. The study provides a standardised lens for assessing functional suitability by grounding the evaluation in the ISO/IEC 25010 framework. More importantly, it demonstrates that system effectiveness extends beyond mere access provision to include the accuracy of system operations and the efficiency with which users can accomplish their tasks. This represents a shift from traditional evaluation approaches that emphasise the availability of resources to a more holistic perspective that incorporates reliability and usability as equally critical components of functionality.

The implications of these findings are far-reaching. In the absence of this evaluation, institutions would likely continue to equate system effectiveness with resource availability, overlooking critical issues such as broken links, authentication failures, and inefficient user workflows. Such an approach would perpetuate existing challenges, including underutilisation of subscribed resources, increased reliance on alternative information sources, and reduced user satisfaction. Ultimately, failure to

address these dimensions would limit the ability of off- campus access systems to support teaching, learning, and research effectively, thereby weakening the role of academic libraries in digital environments.

5.1.2 Development of the Functional Suitability Evaluation Framework

The results demonstrate that the research developed a Functional Suitability Evaluation Framework based on empirical relationships among Functional Completeness, Functional Correctness, and Functional Appropriateness. This objective was achieved through the application of statistical modelling techniques, which enabled the determination of each construct's relative contribution to overall functional suitability. The resulting framework integrates these constructs into a coherent and structured model, supported by empirically derived weights that reflect their actual influence on system performance.

The importance of this achievement lies in providing a practical, systematic tool for evaluating off-campus access systems. Unlike conventional approaches that rely on isolated metrics or subjective user perceptions, the developed framework provides a comprehensive, data-driven method for assessing system functionality. It bridges the gap between theoretical quality models and practical system evaluation by operationalising the concept of functional suitability in a measurable, practical form. Furthermore, the inclusion of contextual factors such as user experience level and institutional support enhances the framework’s relevance by acknowledging that system performance is influenced not only by technical features but also by user capabilities and institutional support.

The implications of this contribution are significant for both research and practice. Without such a framework, institutions would lack a consistent basis for evaluating and comparing system performance, leading to fragmented assessment practices and limited capacity for evidence-based decision-making. This would hinder the identification of system weaknesses and the prioritisation of improvement efforts. Thus, providing a structured evaluation approach, the framework enables institutions to make informed decisions regarding system design, implementation, and enhancement, thereby improving the effectiveness and sustainability of off-campus access services.

5.1.3 Validation of the Developed Functional Suitability Evaluation Framework

The findings indicate that the developed Functional Suitability Evaluation Framework is valid, relevant, and applicable within institutional contexts, as confirmed through validation by technical personnel. The objective of validating the framework was achieved, with respondents expressing strong agreement on its clarity, feasibility, and usefulness for evaluating off-campus access systems. The validation process provided practical insights into the framework's applicability within real-world library and ICT environments.

The importance of this achievement lies in demonstrating that the framework is not only theoretically grounded but also operationally viable. Validation ensures that the framework aligns with institutional realities, including existing infrastructure, technical capacity, and organisational workflows. It also confirms that the framework addresses the key evaluation needs of stakeholders responsible for managing and supporting off-campus access systems. This strengthens the credibility and applicability of the framework as a tool for guiding system evaluation and improvement.

The implications of this finding are critical for the practical adoption of the framework. Without validation, the framework would remain largely theoretical, limiting its usefulness in addressing real-world challenges. Institutions may be reluctant to adopt untested models, particularly where implementation requires technical and organisational investment. The research enhances the likelihood of adoption and integration into institutional practices by confirming its feasibility and relevance. Furthermore, the findings highlight the need for continuous evaluation mechanisms, suggesting that functional suitability should be monitored and improved over time rather than assessed as a one-time activity. This ensures that off- campus access systems remain responsive to evolving user needs and technological developments.

5.2 Recommendations

Based on the findings and conclusions of this study, the following recommendations are proposed to enhance the functional suitability of library off-campus access systems. These recommendations are categorised into policy-level and practice-level interventions to support both strategic and operational improvements. Each recommendation derives directly from an empirical finding of the research: the

dominance of functional correctness in the regression model (B = 0.411), the usability gaps reflected in the lowest construct mean (functional appropriateness, M = 3.58), the completeness gaps identified in the thematic analysis, and the institutional support deficiencies reported by users.

5.2.1 Recommendation to Policy

At the policy level, universities, regulatory bodies, and library consortia should establish structured guidelines and standards to ensure effective implementation and evaluation of off- campus access systems. First, universities, national regulatory bodies such as the Commission for University Education (CUE), and library consortia should develop standardised evaluation frameworks for off-campus access systems based on recognised models, such as ISO/IEC 25010. This will ensure that institutions adopt a consistent and comprehensive approach to assessing system functionality beyond basic access provision.

Second, institutions should formulate policies that mandate regular system evaluation and performance audits, focusing on functional completeness, correctness, and appropriateness. Such policies will promote continuous monitoring of system performance and enable early identification of technical and usability issues. Third, there is a need to develop policies that support integration of library systems with institutional digital platforms, particularly Learning Management Systems (LMS) such as Moodle. This will enhance seamless access to academic resources and improve the overall user experience.

Fourth, universities should establish policies that prioritise capacity building and user training, ensuring that both students and staff are equipped with the necessary digital skills to utilise off- campus access systems effectively. This includes incorporating digital literacy training into institutional programmes and providing ongoing user support. Finally, institutions should adopt policies that encourage investment in robust ICT infrastructure, including reliable internet connectivity, secure authentication systems, and scalable system architectures. Such investments are essential to support the stability and performance of off-campus access systems in diverse usage environments.

5.2.2 Recommendation to Practice

At the operational level, libraries and ICT departments should implement practical measures to address the functional and technical challenges identified in this study. First, institutions should prioritise improving system reliability and functional correctness by implementing automated tools for link validation, authentication monitoring, and tracking system uptime. This will reduce issues related to broken links, failed logins, and session instability, which were identified as major barriers to effective system use.

Second, there is a need to enhance system usability and functional appropriateness by adopting user-centred design principles. This includes simplifying navigation, improving interface clarity, and optimising system performance on mobile devices. Given the prevalence of mobile access, systems should be designed to ensure consistent performance across different devices. Third, libraries should work towards improving functional completeness by ensuring comprehensive coverage of core academic resources. This includes addressing gaps in database subscriptions, ensuring consistent full-text access, and expanding access to supplementary materials such as e-books, reports, and past examination papers.

Fourth, institutions should strengthen technical support services by establishing responsive help desk systems, providing clear user documentation, and ensuring timely communication about system updates and outages. This will reduce reliance on peer support and improve overall user confidence in the system. Fifth, institutions should implement continuous user training and engagement programmes, including orientation sessions, workshops, and online tutorials. These initiatives will enhance user competence and enable more effective utilisation of system features.

Finally, the developed Functional Suitability Evaluation Framework should be adopted and integrated into institutional practices to guide ongoing system evaluation and improvement. Institutions should use the framework as a basis for regular performance assessment and strategic planning, ensuring that off-campus access systems remain responsive to user needs and technological advancements. Specifically, academic libraries should periodically evaluate their off-campus access systems using the developed Functional Suitability Evaluation Framework and its scoring rubric to identify deficiencies in functional completeness, correctness and

appropriateness, and should set a minimum acceptable FSI threshold, for example 4.00, as a service-level target for their systems.

5.3 Future Work

Building on the limitations acknowledged, future research should pursue the following focused extensions. First, the framework should be validated in a broader range of public and private universities, including institutions dedicated to online and distance programmes whose students rely wholly on remote library access, to strengthen generalisability. Second, the framework should be compared empirically with other software quality models and evaluation approaches to benchmark its diagnostic power.

Thirdly, the framework should be extended to additional ISO/IEC 25010 quality characteristics, such as security, compatibility, reliability and performance efficiency, and to other library information systems, including institutional repositories, discovery services and integrated library systems. Fourth, longitudinal and pilot implementation studies should assess changes in functional suitability following system upgrades or policy interventions and evaluate the organisational impact of adopting the framework, while advanced modelling approaches such as Structural Equation Modelling may be employed to examine causal relationships and refine the weighting structure. Finally, future versions of the framework should investigate the integration of usability, accessibility and cybersecurity indicators, and the use of Artificial Intelligence and machine learning to automate functional suitability assessment.

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APPENDICES

Appendix 1: Questionnaire (Students)

Dear Respondent,

RE: Research Questionnaire

I am pursuing a Master of Science in Information Technology at Murang'a University of Technology. My research topic is *"***A Functional Suitability Evaluation Framework for Library Off-Campus Access Systems"**. To help me complete this academic endeavour, please fill out the attached questionnaire to the best of your knowledge. The information you provide will be treated with the utmost confidentiality and used for academic purposes only.

Yours sincerely,

Kenneth Kariuki Kibithe -SC401/5213/2018

Department of Information Technology

Murang'a University of Technology

Section A: Demographic Information

Please tick where appropriate.

A1. Gender: Male [ ] Female [ ]

A2. Level of study: Postgraduate Degree [ ] Bachelor's Degree [ ] Diploma [ ]

A3. Year of Study: Year1 [ ] Year2 [ ] Year3 [ ] Year4 [ ]

A4. University: MMUST [ ] SU [ ] MUT [ ]

Instructions: For questions B5–26, please indicate your level of agreement with the statements using the scale below:

Scale	**Description**
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

Section B: Functional Completeness

No.	Statement	Scale (1–5)
B5	The system provides all the features I need to access e-resources.	
B6	The off-campus access system meets most of my academic resource needs.	
B7	The system supports integration with tools like Google Scholar.	
B8	I can consistently access full-text articles and documents when needed.	
B9	I often have to use alternative methods to find resources. (Reverse)	
B10	The system provides access to all core databases required for my course/programme.	
B11	The system allows me to access supplementary materials (e-books, reports, past exam papers) beyond journal articles.	
B12	The system provides all the tools and features needed for citation and referencing.	

B13. What important features do you think are missing from the current off-campus access system?

B14. How could these missing features improve your access experience?

Section C: Functional Correctness

No.	Statement	Scale (1–5)
C15	I rarely encounter errors while using the off-campus access system during my academic tasks.	
C16	The authentication process works reliably every time I access the system.	
C17	The system's search results are accurate and relevant.	
C18	In the past month, the off-campus access system has crashed while I was using it.	

C19	Links to e-resources usually open without errors, such as blank pages or redirect loops.	
C20	Downloaded files (e.g., PDFs) open correctly without corruption.	
C21	The system consistently maintains my login session until I choose to log out.	
C22	Access links provided by the system direct me to the correct publisher platforms.	
C23	I rarely encounter broken or outdated links when accessing resources.	
C24	Search results do not include irrelevant or misleading resources.	

C25. Please describe any technical errors or bugs you frequently encounter when using the system.

C26. How do these issues affect your ability to complete academic tasks?

Section D: Functional Appropriateness

No.	**Statement**	**Scale (1–5)**
D27	The system supports the academic tasks I need to perform.	
D28	The user interface is intuitive and relevant for my academic needs.	
D29	The system adapts well to different access environments (e.g., mobile).	
D30	Completing common tasks (such as logging in, searching, or opening full text) in the system requires more steps than necessary.	
D31	The system allows me to accomplish academic tasks efficiently without unnecessary delays.	
D32	The system minimises the number of steps needed to access full-text resources.	
D33	The system is fast enough to support real-time academic activities such as live research discussions.	
D34	The system provides shortcuts or quick access to frequently used resources.	

D35	The system integrates well with institutional learning platforms (e.g., Moodle, LMS).	

D36. How well does the system support the academic tasks you perform most frequently?

D37. What specific improvements would make the system more useful for your tasks?

Section E: User Experience Level

E38. What challenges do you face when using the off-campus access system across different devices (PC, mobile, tablet)?

E39. How do these challenges affect your ability to access academic resources?

E40. In your opinion, what would make the system easier to use for students with different levels of digital literacy?

Section F: Institutional Support

F41. What kind of technical support would make the off-campus access system more reliable for you?

F42. Have you received adequate training or guidance on how to use the system? If not, what training would be most useful?

F43. What additional support services should the university provide to improve your experience with off-campus access?

Appendix 2: Questionnaire (Technical Personnel)

Dear Respondent,

RE: Research Questionnaire

I am pursuing a Master of Science in Information Technology at Murang'a University of Technology. My research topic is *"***A Functional Suitability Evaluation Framework for Library Off-Campus Access Systems"**. To help me complete this academic endeavour, please fill out the attached questionnaire to the best of your knowledge. The information you provide will be treated with the utmost confidentiality and used for academic purposes only.

Yours sincerely,

Kenneth Kariuki Kibithe -SC401/5213/2018

Department of Information Technology

Murang'a University of Technology

Section A: Demographic Information

Please tick where appropriate

- **A1. Department:** Library [ ] ICT [ ]
- **A2. Gender:** Male [ ] Female [ ]
- **A3. Level of Education:** Diploma [ ] Bachelor's [ ] Master's [ ] PhD [ ]
- **A4. Position/ Title:** ……
- **A5. Years of Experience in Virtual Library or ICT:** Less than 3 [ ] 3–6 [ ] 7–10 [ ] Above 10 [ ]
- **A6. University:** MMUST [ ] SU [ ] MUT [ ]

Section B: Framework Evaluation

Instructions: For questions B7–16, please indicate your level of agreement with the following statements regarding the proposed **functional suitability evaluation framework** for off-campus access systems using the scale below:

Scale	**Description**
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

Validation Criterion	Item No.	Statement	Scale 1–5)
Completeness	B7	The framework comprehensively addresses the key attributes necessary for assessing functional suitability.	
	B8	The framework incorporates practical mechanisms for integrating user feedback.	
Relevance	B9	The evaluation criteria are relevant and applicable to existing off-campus access systems.	
	B10	The framework is compatible with existing evaluation or performance monitoring tools.	
Clarity	B11	The framework provides a clear structure for evaluating system functionality.	
	B12	The technical requirements to implement the framework are clearly defined.	
Feasibility	B13	The framework is easy to interpret and implement in a university setting.	
	B14	The framework is technically feasible to implement within an existing library or ICT infrastructure.	
Adaptability	B15	The framework accommodates updates and future system enhancements (i.e., it is extensible.	
	B16	The level of technical complexity in applying the framework is reasonable.	

Section C: Framework Validation and Improvement

C17. Are there any additional attributes or dimensions you think should be included in the framework?

C18. In your opinion, how could this framework be improved to better fit institutional needs?

C19. What technical or operational challenges do you foresee in implementing this framework?

C20. How do you suggest incorporating feedback from both technical personnel and users into the framework for ongoing improvement?

C21. Are there any aspects of the framework that you find unclear or difficult to understand, and how could they be improved?

Appendix 3: Krejcie and Morgan Table for Determining Sample Size for a Finite Population

N	*S*	*N*	*S*	*N*	*S*
10	10	220	140	1200	291
15	14	230	144	1300	297
20	19	240	148	1400	302
25	24	250	152	1500	306
30	28	260	155	1600	310
35	32	270	159	1700	313
40	36	280	162	1800	317
45	40	290	165	1900	320
50	44	300	169	2000	322
55	48	320	175	2200	327
60	52	340	181	2400	331
65	56	360	186	2600	335
70	59	380	191	2800	338
75	63	400	196	3000	341
80	66	420	201	3500	346
85	70	440	205	4000	351
90	73	460	210	4500	354
95	76	480	214	5000	357
100	80	500	217	6000	361
110	86	550	226	7000	364
120	92	600	234	8000	367
130	97	650	242	9000	368
140	103	700	248	10000	370
150	108	750	254	15000	375
160	113	800	260	20000	377
170	118	850	265	30000	379
180	123	900	269	40000	380
190	127	950	274	50000	381
200	132	1000	278	75000	382
210	136	1100	285	1000000	384

Note.—*N* is population size. *S* is sample size.

Source: Krejcie & Morgan, 1970

Appendix 4: Approval of Research Proposal and Supervisors Letter

MURANG'A UNIVERSITY OF TECHNOLOGY
Office of the Director, Postgraduate Studies
E-mail: bps@mut.ac.ke
Website: www.mut.ac.ke
P.O. Box 75-10200
Murang'a, Kenya

Ref: MUT/ARP/PGS/19/2020 /VOL.1 **Date:** 5th November, 2025

Mr. Kenneth Kariuki Kibithe,
School of Computing and Information Technology,
Murang'a University of Technology,
P.O. Box 75-10,200
Murang'a.

Dear Mr. Kibithe,

RE: APPROVAL OF RESEARCH PROPOSAL AND SUPERVISORS

I am pleased to inform you that the Directorate of Postgraduate Studies on 4th November, 2025 considered and approved your Master research proposal entitled ***"A Functional Suitability Evaluation Framework for Library Off-Campus Access System."*** and appointed the following as supervisors:

1.Dr. John Gichuki Ndia - Murang'a University of Technology

2.Dr. Jane Wanjiru Njuki - Murang'a University of Technology

You may now proceed with your data collection subject to obtaining research permit from NACOSTI, if required. You should also begin consulting your supervisors and submit through them quarterly progress reports to the Director Postgraduate Studies through your CoD and School Dean. Progress Reports forms can be accessed in the Student Portal.

It is the policy and regulations of the University that you observe deadlines. The guidelines on Postgraduate supervision can be accessed in the post graduate Handbook.

Your responsibilities as a student will include, among others;

i. Maintain regular consultation with your supervisor(s), at least once a month
ii. Submit quarterly reports on time, through your supervisors, CoD, Dean and to the Director of Postgraduate Studies;
iii. Ensure quality work all through;

iv. Present your research findings at 2-3 seminars/conferences prior to thesis examination.

v. Publish one article from your research findings in a refereed journal prior to thesis examination.

For any further clarification please contact the undersigned.

Yours Sincerely,

Prof. Geoffrey Muchiri, PhD
Director, Postgraduate Studies
GM/MMK

DIRECTORATE OF POSTGRADUATE STUDIES
MURANG'A UNIVERSITY OF TECHNOLOGY
12 NOV 2025
P. O. Box 75 - 10200, MURANG'A
Tel: 0771463515, Email: info@mut.ac.ke

Copy to:

1. Registrar, Academics, Research and Students Affairs
2. Dean, School of Computing and Information Technology

Appendix 5: ISERC Approval Letter

OFFICE OF INSTITUTIONAL SCIENTIFIC ETHICS REVIEW COMMITTEE MURANG'A UNIVERSITY OF TECHNOLOGY

Website: www.mut.ac.ke ; Email: iserc@mut.ac.ke

Ref: **MUT-ISERC/A/014** 17TH NOVEMBER 2025

KENNETH KARIUKI KIBITHE

Reg. No: SC401/5213/2019

Dear Kenneth,

RE: A functional suitability evaluation framework for Library off-campus access systems (P017/11/2025)

This is to inform you that the Murang'a University of Technology Institutional Scientific Ethics Review Committee (MUT-ISERC) has reviewed and **approved** your above research proposal. The approval period is **17th November 2025 to 16th November 2026.**

This approval is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc) are submitted for review and approval by MUT-ISERC before implementation.
c) Any adverse events (death, life-threatening problems) whether related or unrelated to the study, must be reported to the MUT-ISERC within 72 hours of occurrence.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to MUT-ISERC within 72 hours.
e) Clearance of export of biological specimens must be obtained from relevant institutions.
f) Submission of Progress reports at a regular interval, at least every 6 months.
g) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal).*
h) Submission of an *executive summary* report within 90 days upon completion of the study to MUT-ISERC.

Prior to commencing your study, you will be expected to obtain a research license from NACOSTI, and other clearances as applicable.

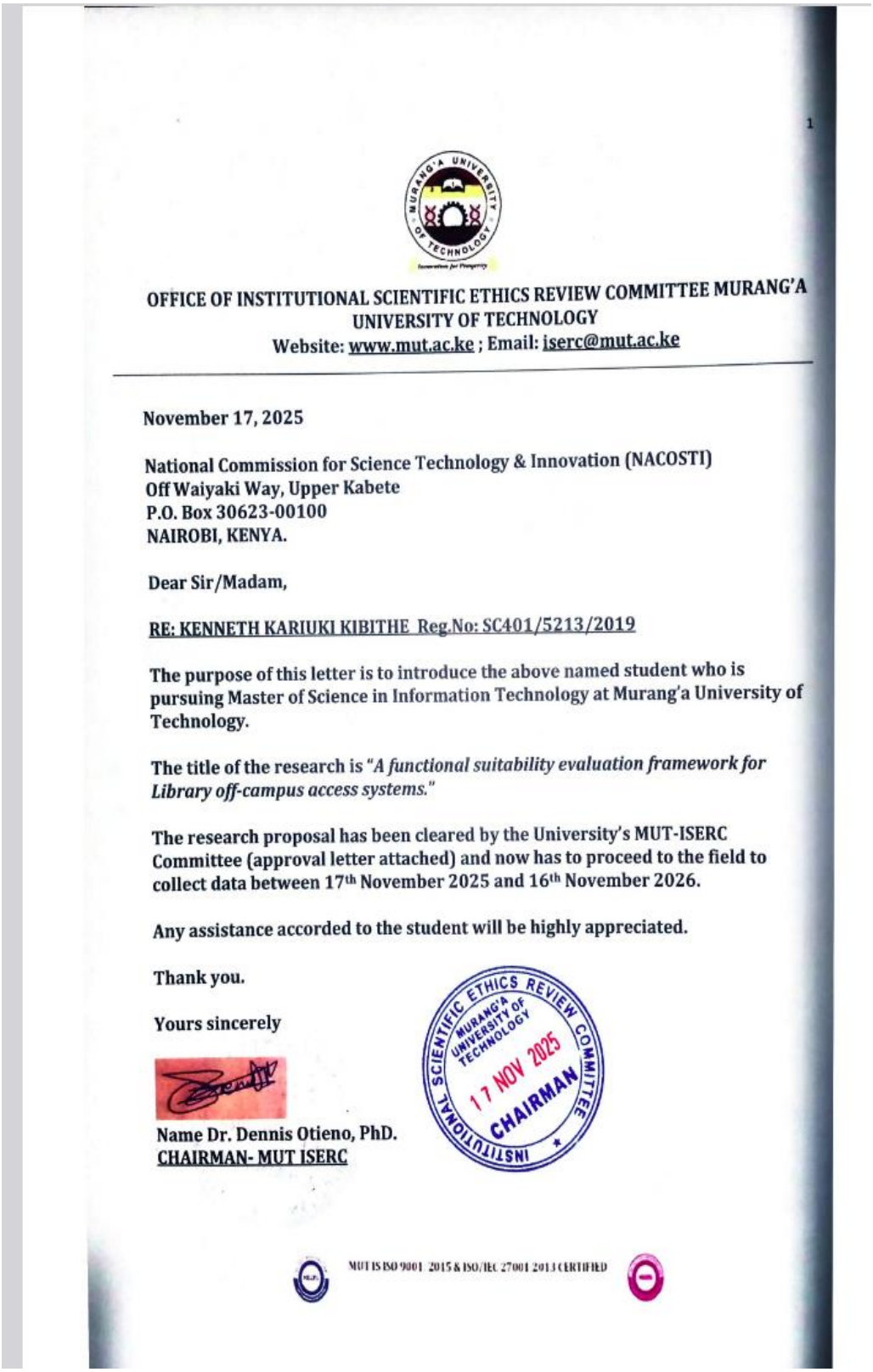
Yours sincerely

Dr. D. Otieno, PhD

Chairman, Murang'a University of Technology ISERC

INSTITUTIONAL SCIENTIFIC ETHICS REVIEW COMMITTEE MURANG'A UNIVERSITY OF TECHNOLOGY 17 NOV 2025 CHAIRMAN

Appendix 6: Research Approval Introduction Letter



1

OFFICE OF INSTITUTIONAL SCIENTIFIC ETHICS REVIEW COMMITTEE MURANG'A UNIVERSITY OF TECHNOLOGY
Website: www.mut.ac.ke ; Email: iserc@mut.ac.ke

November 17, 2025

National Commission for Science Technology & Innovation (NACOSTI)
Off Waiyaki Way, Upper Kabete
P.O. Box 30623-00100
NAIROBI, KENYA.

Dear Sir/Madam,

RE: KENNETH KARIUKI KIBITHE Reg.No: SC401/5213/2019

The purpose of this letter is to introduce the above named student who is pursuing Master of Science in Information Technology at Murang'a University of Technology.

The title of the research is "*A functional suitability evaluation framework for Library off-campus access systems.*"

The research proposal has been cleared by the University's MUT-ISERC Committee (approval letter attached) and now has to proceed to the field to collect data between 17th November 2025 and 16th November 2026.

Any assistance accorded to the student will be highly appreciated.

Thank you.

Yours sincerely

Name Dr. Dennis Otieno, PhD.
CHAIRMAN- MUT ISERC

INSTITUTIONAL SCIENTIFIC ETHICS REVIEW COMMITTEE
MURANG'A UNIVERSITY OF TECHNOLOGY
17 NOV 2025
CHAIRMAN

MUT IS ISO 9001: 2015 & ISO/IEC 27001:2013 CERTIFIED

Appendix 7: NACOSTI Research Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **359426**

Date of Issue: **01/December/2025**

RESEARCH LICENSE



This is to Certify that Mr.. Kenneth Kibithe Kariuki of Murang'a University of Technology, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kakamega, Muranga, Nairobi on the topic: A FUNCTIONAL SUITABILITY EVALUATION FRAMEWORK FOR LIBRARY OFF-CAMPUS ACCESS SYSTEMS for the period ending : 01/December/2026.

License No: **NACOSTI/P/25/4182518**

359426

Applicant Identification Number

Ag. Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

Appendix 8: Publications

[1] K. K. Kibithe, J. G. Ndia, and J. W. Njuki, “Functional Suitability Evaluation Framework for the Off-Campus Access Systems in Academic Libraries,” International Journal of Computer Applications, vol. 187, no. 98, pp. 17–29, Apr. 2026, doi: 10.5120/ijca0ef11bfd02e2.’

[2] K. K. Kibithe, J. G. Ndia, and J. W. Njuki, “Validation of a Functional Suitability Evaluation Framework for Library Off-Campus Access Systems,” The African Journal of Information Systems, (Submitted).