



## Assessment of ICT services using the Information Technology Infrastructure Library Framework at Muhimbili University of Health and Allied Sciences, Tanzania

<sup>1</sup>SUKUMS F, <sup>2</sup>WAMALA-LARSSON C W, <sup>1</sup>KISENGE R

<sup>1</sup>Directorate of Information and Communication Technology (ICT), Muhimbili University of Health and Allied Sciences (MUHAS), P. O. Box 65001, Dar es Salaam, Tanzania

<sup>2</sup>Institute of Computer and Systems Sciences -SPIDER, DSV, Stockholm University, P. O Box 7003, 164 07, Kista, Sweden

\* Corresponding author: [fsukums@muhas.ac.tz](mailto:fsukums@muhas.ac.tz)

### Abstract

An increasing enrolment of students and demand for flexible delivery modalities in higher education calls for an urgent digital transformation in this sector. In addition, emerging global wicked challenges demand the appropriate use of information and communication technologies (ICT) to address them; for instance, the COVID-19 pandemic has accelerated the adoption of digital teaching, learning and transformation of educational services in higher learning institutions (HLIs). This study assessed ICT infrastructure, systems and services at the Muhimbili University of Health and Allied Sciences (MUHAS) in Tanzania using the Information Technology Infrastructure Library (ITIL) framework. This qualitative study used desk reviews of data obtained from interviews, system walkthroughs, document reviews and consultative meetings. The study used data from an assessment conducted between February 2017 and August 2021. The assessment found that MUHAS provides various ICT infrastructures and services, with a rapidly increasing demand for ICT services. A total of 84 ICT services at MUHAS were mapped and grouped as "Customer-facing" or "Supporting". The services were also categorised as "Core", "Enabling", or "Enhancing". The ICT services were at different maturity levels depending on the duration of their demands, requirements, capacity, usage, and availability of the required resources. Various educational technologies such as an eLearning platform, video conferencing systems, student management and assessment systems were used to enhance teaching, learning and progress tracking. This paper presents the experience of using the ITIL framework in assessing ICT infrastructure, systems and services at a university in Tanzania. It provides information on the services catalogue and its organisation as well as strengths, weaknesses, challenges and opportunities for using ICT in transforming university functions. In addition, this study informs other HLIs on similar assessments and strategic organisation of their ICT services in resource-constrained settings.

**Keywords:** *Digital transformation, educational technologies, eLearning, higher education, ITIL, MUHAS, Tanzania*

**Cite as:** Sukums *et al.*, (2023) Assessment of ICT services using the Information Technology Infrastructure Library Framework at Muhimbili University of Health and Allied Sciences, Tanzania, *East African Journal of Science, Technology and Innovation* 4(3).

Received: 21/03/2023

Accepted: 28/06/2023

Published: 30/06/2023

### Introduction

The Fourth Industrial Revolution (4IR) delivers or promises digital transformations in different domains, including education and health. However, African countries lag in different 4IR aspects: infrastructure, technology access and education

(Kayembe & Nel, 2019). In the education sector, universities need to be equipped with reliable and sustainable funding mechanisms, adequate and robust infrastructure, and the right skills to train and produce graduates who can confidently and competently engage in the 4IR. Consequently, HLIs

must upgrade their digital learning infrastructure, systems and services to cope with the changing teaching and learning landscape. Therefore, there is a need for a user-centric digital learning ecosystem that ensures that teachers, students, administrators and policymakers have access to appropriate digital tools for facilitating effective and efficient teaching, learning, assessment and research, as well as overall management effectiveness of the institutions (Dintoe, 2018; Olawale & Mutongoza, n.d.). Furthermore, increasing enrolment of students and demand for flexible content delivery modalities for higher education call for an urgent digital transformation in the sector, which could be an essential catalyst for improved learning outcomes, faculty productivity and a conducive working environment. In addition, emerging global wicked challenges demand an appropriate use of digital technologies to address these challenges; for instance, the coronavirus disease 2019 (COVID-19) pandemic has accelerated the adoption of digital learning and the transformation of educational services in HLIs (Matete *et al.*, 2023; Okafor *et al.*, 2022).

HLIs are harnessing and mainstreaming ICT into all its operational and management functions to ensure that new ICT developments are embraced to promote the university's vision, mission and core functions (Alenezi *et al.*, 2023; Kommers *et al.*, 2021). Thus, it is imperative to understand the present situation of ICT infrastructure, systems and services at MUHAS in order to develop strategic priorities for upgrading and managing the ICT services to meet the increasing demand for digital transformation and online participation in teaching, learning and research, in addition to the provision of public services. This increased demand for ICT services is primarily driven by an increased enrolment of students and the need to ensure the continuity of university activities during pandemics like COVID-19 (Paschal & Mkulu, 2020).

MUHAS, formerly Muhimbili University College of Health Sciences (MUCHS), was among the first institutions in Tanzania to start using e-mail services in the 1990s. MUHAS, a premier medical university in Tanzania, offers undergraduate and postgraduate

training in biomedical, clinical and allied health sciences. There are over 90 programmes, including 17 diploma programmes, 15 undergraduate degrees, 67 master's degrees, various PhD programmes and postdoctoral studies (Muhimbili University of Health and Allied Sciences, 2019). The academic courses include health information systems, health information management, monitoring and evaluation, bioethics and biomedical engineering.

MUHAS has progressively harnessed and mainstreamed ICT into all its operational and core functions. The Directorate of ICT (DICT), which started as a Unit in 2000, is mandated to spearhead the development, management and maintenance of various ICT infrastructure, systems and services; capacity building to the MUHAS community as well as innovation and development in digital technologies in health and education sectors. In order to facilitate the delivery of ICT services, the DICT is organised into three major sections: ICT Infrastructure, Educational Technologies and Research, and Management and Information Systems. The Directorate also offers technical support to ICT services management and users, including faculty, researchers, administrative staff, and postgraduate and undergraduate students.

Moreover, MUHAS has developed various ICT-related policies, including ICT policy, ICT security policy and eLearning policy. The policies address several ICT services and aspects such as ICT Governance and Management; ICT Infrastructure and Internet Services; Access to ICT services and resources; ICT Security and Business Continuity Management; Adoption and Institutionalization of ICT in academic and administrative functions; ICT Training and Capacity Building; ICT Research, Development and Innovation; Special needs and Gender; Third Party Management; End User Support; Acquisition of ICT Systems and Products; Bring Your Own Device (BYOD); Systems and Applications Migration; ICT Equipment Disposal; Strategic Partnerships and collaborations; Compliance to the Best Practices in ICT Industry; Enterprise Architecture (EA); and Systems and Infrastructure Maintenance.

Universities are progressively embracing educational technologies and promoting the use of ICT among staff and students (Dintoe, 2018; Kalolo, 2019; Kayembe & Nel, 2019; Paschal & Mkulu, 2020). However, limited studies have focused on a

comprehensive assessment of ICT infrastructure, systems and services in universities to improve its IT service management (ITSM).

IT Service Management (ITSM) is a strategic approach to designing, delivering, managing, and improving how IT is used within an organisation (Ruiz *et al.*, 2018). ITSM offers a framework to provide IT-related services and the interaction of IT staff with users and is often related to the British Government's Information Technology Infrastructure Library (ITIL). ITIL is one of the most popular frameworks for ITSM, including evaluation (Tang & Todo, 2013). ITIL was ranked first (47% of 261 IT leaders) among the top five most used ITSM frameworks (Ruiz *et al.*, 2018). Other frameworks include CMMI (Capability Maturity Model Integration) as a product-oriented framework focusing on software development, maintenance, and product integration; COBIT (Control Objectives for Information and Related Technologies) focusing on IT management and governance emphasising regulatory compliance, risk management, aligning IT with business goals and performance measurement (Kaiser, 2018; Limanto, Khwarizma, Imelda, *et al.*, 2017; Serrano & Pereira, 2020). These frameworks provide guidance for overall IT governance and IT-related service management. ITIL is a service-oriented framework designed to facilitate a systematic approach to the management of IT service provision.

The ITIL framework provides a set of concepts and policies for managing IT infrastructure, development and operations to align business requirements with ICT services to enhance the delivery of core functions (teaching, learning, research, administration, and public services) of the University. Therefore, this study aimed to explore and document a comprehensive review of ICT infrastructure, systems and services at MUHAS in Tanzania using the ITIL framework. The article also presents knowledge of the ICT services catalogue and organisation and strengths, weaknesses and opportunities to improve ICT infrastructure, systems and services at MUHAS. The study findings will inform other HLIs in similar assessment and strategic organisation of their ICT services in resource-constrained settings.

## Materials and Methods

### *Design*

This qualitative study was conducted using desk reviews of data obtained from interviews, system walkthroughs, document reviews and consultative meetings. This case study aimed at collecting and analysing information from available documents, including reports, plans and other materials from MUHAS. The ITIL framework was used to conduct a comprehensive assessment and establish the ICT services management and maintenance strategies. This facilitated a broader perspective on the existing ecosystems, challenges, the needs and demands of different stakeholders for the appropriate digital transformation of core functions of higher learning institutions (Bowen, 2009; Rashid *et al.*, 2019).

The desk review used an assessment report on the use of ICT infrastructure, systems and services at MUHAS between February 2017 and August 2018 and subsequent updates of the ICT service catalogue. The assessment report and its implementation plan were later presented to the University management for implementation, which is continuously being monitored. It should be noted that before commencing the assessment, terms of reference were developed to guide the scope and process of the assessment and key stakeholders' engagement.

### *Settings*

The study presents a desk review of the ICT services and its assessment conducted at MUHAS main campus and the then MUHAS Academic Medical Centre (MAMC), now under Muhimbili National Hospital at Mloganzila in Dar es Salaam, Tanzania. The assessment was led and conducted by MUHAS ICT personnel in collaboration with experts from the Swedish Program for ICT in Developing Regions (SPIDER). The technical assessment covered ICT infrastructure, systems and services at MUHAS. The review shows that the assessment team visited different ICT facilities and locations at both campuses.

### *Study participants*

The review shows that the assessment covered different perspectives of all the MUHAS key stakeholders, including the top university management, ICT officers, faculty, researchers, students and administrative staff as customers, users or beneficiaries of ICT services. The stakeholders were drawn from the Directorate of ICT, the directorate of library services, deans and directors,

administrators at various university units, the university management and the MUHAS Senate ICT Committee members (Table 1). Key informants were

purposely selected in the assessment, and data were collected until data saturation (Graneheim & Lundman, 2004).

**Table 1**

*Summary of stakeholders interviewed/consulted during the ICT assessment in 2018 and the development of the University ICT service catalogue*

Category of stakeholders	Number of respondents (%)
Top university management	4 (4.4)
Deans and Directors	11 (12.1)
Faculty	6 (6.6)
ICT officers	12 (13.2)
Student representatives	3 (3.3)
Others, e.g., administrative officers, accountants	4 (4.4)
<b>TOTAL</b>	<b>91 (100)</b>

**Data collection**

Sixteen key informants were interviewed, and three consultative meetings were convened to get in-depth insights into the status of ICT services and the required improvements.

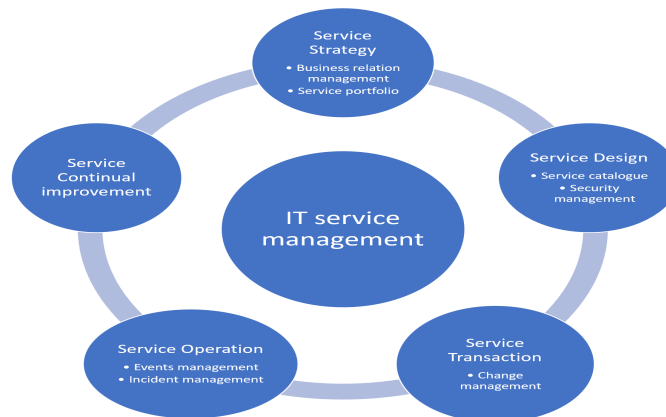
**Adoption of the ITIL framework**

The review shows that the terms of reference guided the technical assessment of ICT infrastructure, systems and services. The assessment employed the ITIL framework as it is commonly used to improve the management of IT services, including ensuring alignment of the core business and the ICT services in

the university. The ITIL service lifecycle 2011 edition (Kaiser, 2018; Limanto, Khwarizma, Rumagit, *et al.*, 2017) provided an all-encompassing assessment of MUHAS' IT services. The assessment processes covered all five core stages of the lifecycle of an IT service: Service Strategy, Service Design, Service Transition, Service Operation, and Continual Service Improvement (see Figure 1). The framework allowed the review of different processes and activities during the design, development, delivery, and support of MUHAS ICT services.

**Figure 1**

*The ITIL service lifecycle (adapted from [8]) used to inform the assessment*



*IT Service Strategy*

The assessment explored the existing IT service strategy at MUHAS, including the existence and coverage of ICT strategic plans. Interviews with the university management and ICT staff were conducted to understand their strategic approach to IT services. Using the ITIL framework, we assessed how well the current strategy aligns with ITIL's best practices, such as defining the user requirements, developing the specifications, and preparing implementation plans.

#### *IT Service Design*

We examined the existence of an ICT services catalogue, architectures, policies, and security measures to understand how well they align with the customer's needs

#### *IT Service Transition*

**Table 2**

*ICT service review guide used during the assessment in 2018*

SN	Item	Description/Findings
	<b>Section A: General</b>	
1.	Service name	
2.	Short description	
3.	Customer	
4.	Owner	
5.	Manager	
6.	Stakeholders	
7.	Users	
8.	Criticality	
	<b>Section 2: Requirements</b>	
1.	Capacity	
2.	Availability	
3.	Security	
4.	Data integrity	
5.	Confidentiality	
6.	Non-repudiation needed	
7.	Service level	
8.	Continuity plan	
	<b>Section 3: Documentation</b>	
1.	Configuration documentation	
2.	System description	
3.	Diagrams/drawings	
4.	Dependencies	
5.	Backup Strategy	
6.	<b>Section 4: Security</b>	
7.	Security perimeter	
8.	Authentication/authorisation/accounting	
9.	Updates	
10.	Threats to the system	
11.	Backup plan availability	

We then examined how new or changed services were implemented. We analysed documents related to change management and conducted interviews with ICT staff or others to understand the service transition process.

#### *IT Service Operation*

This aimed to understand the day-to-day operations of IT services, including incident and issues management, client relationship management practices and help desk systems.

#### *IT Continual Service Improvement*

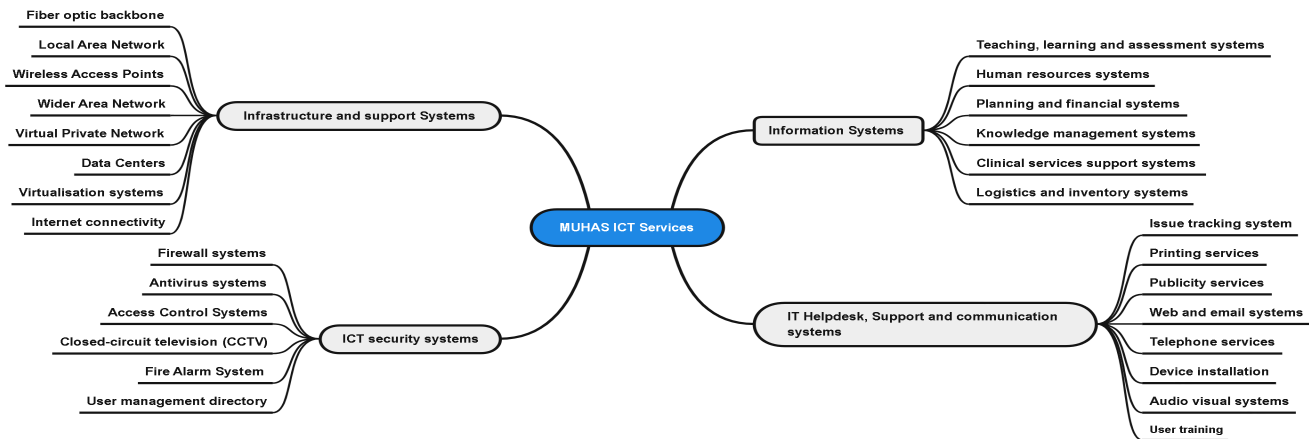
We explored potential areas for improvement based on the identified challenges and gaps and recommendations to MUHAS on how they can progressively refine their IT services to meet their stakeholders' needs more effectively.

As indicated in Table 2, different characteristics of existing ICT services were reviewed. A walkthrough of each service was conducted through a predefined guide (Table 2). The review informed the development of an ICT services catalogue (see Figure 2). The assessment focused on the systems that support the university’s core business, including the Moodle-based eLearning platform, dental clinic patient management information system (Dentrix

practice management software and DEXIS imaging software), Epicor-based integrated financial management information system (IFMIS), integrated library information system (Koha), students’ academic records information system (SARIS) and Zimbra based electronic mail system. Other key areas assessed were MUHAS main website, network infrastructure including MUHAS campus network and local area networks (LANs), wireless network and MAMC network.

Figure 2

MUHAS ICT infrastructure, systems and services mapped during the assessment



The review report was validated through consultative meetings, including the MUHAS vice chancellor, deputy vice chancellors, and the senate ICT committee, to gather their feedback and needs on ICT organisation and services. During the consultative meetings, stakeholders also reviewed and verified information in the developed ICT services catalogue. The final assessment report was submitted and presented to the university management. An action plan and resource requirements for implementing the assessment recommendations were developed and incorporated into the university plans.

**Data Analysis**

During the assessment, qualitative analysis was conducted whereby notes from the interviews,

consultative meetings and system reviews were typewritten at the end of each session. The notes were collated and summarised to ease the data analysis process. We analysed the qualitative using thematic analysis (Dahlgren, 2007; Dahlgren *et al.*, 2007; Graneheim & Lundman, 2004). The thematic analysis involved carefully reading and re-reading the transcripts to examine and categorise the respondents’ opinions. The study was carried out in three stages: first, the line-by-line coding of field notes and transcripts (that is, unpacking of text into discrete elements to expose underlying thoughts and meanings); second, the in-depth examination and interpretation of the resultant codes into descriptive themes and; third, interpretation of the descriptive themes into more abstract analytical themes (Table 2). The Microsoft Excel software was used to organise different themes and sub-themes and summarise them as presented in tables according to the ITIL framework.

Table 3

*A summary of the ICT service catalogue at MUHAS*

<b>Classification</b>	<b>Group</b>	<b>Number of services (%)</b>
Type	Customer-facing services, e.g., eLearning platform, SARIS	67 (80%)
	Supporting services, e.g., firewall, web content management system	17 (20%)
Category	Core services, e.g., website, video conferencing, financial information system, research information system	74 (88%)
	Enabling services, e.g., domain name system, firewall	7 (8%)
	Enhancing services, e.g., proxy, traffic shaping or spam filtering services	3 (4%)
Implementation Status	Operational services	54 (64%)
	Under development services	28 (33%)
	Retiring services	2 (2%)
Sourcing Location	Insourced services	70 (83%)
	Outsourced services	14 (17%)
<b>Total number of services</b>		<b>84 (100%)</b>

As indicated in the assessment report, different stakeholders were involved in data collection, validation and dissemination of the assessment findings (Table 1). The iterative data collection and validation resulted in cross-fertilisation and enrichment of the assessment findings. Review and mapping of the existing ICT infrastructure, systems and services were conducted using a predefined tool (Table 2), and the findings are presented in Table 3. The services were categorised into “core service”, “enabling service”, and “enhancing service”. A core service is defined as a service that delivers the primary outcomes – utility and warranty – desired by one or more customers. An enabling service is a service needed to provide a core service, while an enhancing service is a service added to a core service to encourage customers to use the core service. This information was used to produce the MUHAS ICT services catalogue, which has been adopted and updated regularly after assessing existing services and needs for additional services and the integration of various systems and services.

**Results**

A comprehensive assessment of MUHAS's ICT infrastructure, systems, and services was conducted to identify strengths, weaknesses, and opportunities, thereby facilitating the improvement of IT service management in alignment with the ITIL Service Lifecycle 2011 edition. Our findings are organised according to the ITIL components: Service Strategy, Service Design, Service Transition, Service Operation, and Continual Service Improvement, as described in the subsequent sections.

*IT Service Strategy*

The University’s strategic plan, ICT strategic plan, and ICT policy documents bolstered an ICT service strategic framework. The University Strategic Plan had specific objectives for applying ICT. The MUHAS ICT policy and operational procedures describe the overall governance of ICT and provide strategic direction on planning, development or acquisition, implementation, management, maintenance, usage and security of IC services. ICT security policy and disaster recovery plans also focus on specific ICT security and business continuity aspects. However, the ICT Policy was recognised as outdated and insufficient in capturing emerging digital trends. This policy, nevertheless, lays the groundwork for managing IT services within the institution. Furthermore, a concern arose from the observed inconsistency in the practical application of these

strategic guides, captured by a stakeholder who revealed, "While we have formal documents, their application in our everyday operations seems sporadic and inconsistent".

The strategic documents need more formal processes and guidelines, with requests typically initiated by a MUHAS stakeholder or directly mandated by the Vice-Chancellor's office. Furthermore, the current approach to request prioritisation appears unstructured, as one of the directors explained, "The 'first-come, the first-served policy seems to be the de facto approach despite the principle of prioritising services based on relevance and urgency." This is made evident by the absence of a MUHAS ICT master plan focusing on key services and infrastructure, detailed documenting plan and cost estimates for implementing and maintaining strategic infrastructure and services.

#### **Service Design**

IT Service Design at MUHAS primarily emphasises the functionality and capacity of IT services. While a rudimentary IT service design process is in place, it lacks comprehensive documentation, a gap illuminated by a DICT member, "We communicate the system design and configurations to the stakeholders, but there is usually no formal record." Additionally, it was observed that explicit considerations for security and availability are noticeably insufficient in the service design process. Despite this, a milestone in the form of an ICT services catalogue was a crucial step in the right direction. An interviewee explained its significance, "It was our first attempt at inventorying all of MUHAS ICT systems and services, an important step towards better IT service design management."

#### **IT Service Transition**

While existent, service transition processes at MUHAS were found to be minimalistic, direct, and lacking formality. One ICT officer described this: "We have some practices to coordinate changes, but without formal guidelines, it can lead to issues in more complex services."

#### **IT Service Operation**

Within MUHAS, the DICT is accountable for Service Operation processes. However, these processes are primarily rudimentary and informal. An exception to this pattern is the partially formalised incident and request management process and help desk system. An ICT officer drew attention to its limitations, stating, "Even though we try to solve all reports, we lack

a consistent mechanism to ensure complete analysis and proper feedback to the requestor."

#### **IT Continual Service Improvement**

The study revealed a notable gap within the DICT, as there were no formal IT service improvement processes. Lack of IT services review, feedback analysis, and improvement plans was a recurring complaint by stakeholders of all IT services during assessment interviews. This assessment project was part of an attempt to develop an IT service review and improvement process. MUHAS has defined review and improvement processes that are not specific to IT services. MUHAS has a Directorate of Quality Assurance (DQA) to address the need for continuous improvement for the whole organisation. The assessment connected with DQA to align the assessment with general MUHAS policies and promote knowledge transfer on the assessment of ICT services. The repercussions of this gap were illustrated by a student representative who said, "We experience a lack of IT services review, feedback analysis, and improvement plans." Nevertheless, this assessment study signifies a step towards establishing a systematic approach to IT service review and improvement in the future.

#### **Development of the MUHAS ICT Service Catalogue**

Initially, MUHAS lacked a comprehensive ICT service catalogue, and the interdependencies between services were limited. The existing systems predominantly offered functionalities and options as singular solutions to the users. The assessment informed the development of a comprehensive ICT Services catalogue. This revealed that MUHAS provides various ICT infrastructures and services (Figure 2), with a gradually increasing demand for ICT services. A total of 84 ICT services were mapped and grouped as "Customer-facing" or "Supporting". The services were also categorised as "Core", "Enabling", or "Enhancing". Core service delivers the primary outcomes desired by customers, an enabling service is needed to provide a core service, and an enhancing service encourages customers to use the core service. Furthermore, different ICT services were at varied maturity levels and implementation depending on the duration of their demands, requirements, capacity, usage, and availability of the required resources.

The respondents indicated that most ICT services and their functionalities were available for key stakeholders, especially students and staff. The ITIL



framework was used to map and organise ICT services; hence Table 3 summarises the number of available ICT service and their respective proportions in each ICT service class. As shown in Table 3, more than 33% of the services in the catalogue were under development (new or re-designed services), while only 2% were retiring, and 83% of the services are hosted and managed to insource at MUHAS. The assessment revealed that the DICT was overly overwhelmed to adequately design, acquire and implement new ICT services while managing, maintaining and supporting existing ICT infrastructure, systems and services. Furthermore, during the assessment, many new services were being acquired and required by the strategically essential and new MAMC at the Mloganzila campus.

It was further pointed out that numerous challenges affecting the provision and access to ICT services at MUHAS are related to three major components: customers, requirements, and resources. These challenges include limited integration between ICT services, inadequate technical support, insufficient funding to implement and sustain ICT services, shortage of ICT officers, users' resistance to utilise ICT services, and low digital literacy among customers. Some of the major issues identified within the various services are elaborated below.

#### *Network services*

The university operates a variety of network services, encompassing internet connectivity provided through fibre optic networks, local area networks (LAN), wireless local area networks (WLANs), and virtual local area networks (VLANs). The network services are expected to cater for about 5000 students and 800 staff. The network architecture needs to be revised to ensure it meets users' and service needs and provides options to avoid a single point of failure.

#### *ICT Service Continuity and Security*

Network security was found to be adequate. However, it needs regular assessment and improvement to prevent potential attacks, including denial of services or eavesdropping, as many functions of the university rely on digital platforms. The review shows that there is also a need to improve service continuity through different approaches, including establishing redundancy for critical services. The university has implemented the ICT disaster preparedness and recovery plan. The assessment emphasised the need for dedicated

system backup and testing environments to ensure thorough testing of the systems before installation and regular testing of system and data backups.

The existence of a firewall, network segmentation using VLANs, a virtual private network (VPN), and onsite and offsite backup services assure ICT security. The assessment identified several areas for enhancing physical and logical security, including data integrity, confidentiality and non-repudiation of the infrastructure and systems. Different security mechanisms such as access controls, encryption and intrusion protection and detection need to be enhanced. There should be regular upgrading and updating of network devices, software and applications and their dependencies. In addition, a central logging server should be installed to gather and store logs from all ICT devices or equipment.

#### *Integration and Interoperability*

Based on assessment recommendations, six management information systems were integrated to streamline data sharing across university systems. Further improvements on enhancing integration and interoperability were planned after reviewing additional use cases and the development of the university enterprise architecture as a blueprint to guide planning, development or acquisition, customisation and maintenance of various ICT services at MUHAS.

#### *ICT Governance*

The assessment found that the university has different organs and guidelines for ICT services management. However, it also observed a need for improving the implementation of guidelines and the development of service-specific standard operating procedures and service level agreements in line with the Tanzanian eGovernment regulations.

#### *Educational technologies*

The respondents indicated that MUHAS had strengthened the use of innovative technologies, including eLearning platforms, video conferencing and simulation or digital tools for teaching, learning and assessment. For instance, the Moodle-based eLearning platform was reported to have improved sharing of teaching and learning contents, sharing of electronic resources, learner-teacher interactions and feedback, and conduct of continuous assessments such as quizzes, tests and assignments. Furthermore, using students' academic records information has automated application, selection, registration,

payment of student fees, tracking of academic progress and generation of certifications and reports. The digital tools have been integrated with other systems within the University, regulatory bodies, and related government information systems.

### **Documentation**

The assessment found limited documentation of some critical services. It is paramount that the documentation of the service continuity plan, including disaster recovery plan, service installations, configurations, network diagrams, manuals, and testing reports, are well-kept and regularly updated for effective and efficient management and corrective and preventive maintenance of ICT services. The assessment further found that there needed to be more detailed documentation of systems and user requirements as well as system change management. There needed to be more documentation of service level agreements for each ICT service. At the same time, there were explicitly limited defined customers and stakeholders for each ICT service who could provide all required resources for acquiring and maintaining the services.

### **Discussion**

This paper presents the assessment of ICT infrastructure, systems and services at MUHAS using the ITIL, a globally established framework that can be contextualised in different settings. The assessment emphasised the importance of developing an inclusive University ICT master plan, allocating adequate resources (skilled human resources, financial and computing) for managing robust ICT services, engaging service users during the service design and transition, including formalising and documenting change management processing, strengthening events and problem management systems and implementing continual service improvements.

HLLs utilise ICTs for a myriad of operations, including teaching, learning, research, administration and public services (Jolly, 2019; Kayembe & Nel, 2019). The digital tools for numerous functions, including preparing, delivering and sharing teaching and learning content to learners; research conducts; administrative support; student and staff management, financial management, enhance communication among different stakeholders, including learners, facilitators, members of the faculty, administrators, regulators, government authorities, researchers as well as the

outside world. In the digital age, the ITIL's comprehensive lifecycle stages – Service Strategy, Service Design, Service Transition, Service Operation, and Continual Service Improvement (Axelos, 2023) – provide a robust approach for assessing the maturity of ICT services within higher learning institutions (HLLs) like MUHAS.

The findings of this assessment have been instrumental in planning and successful implementation of establishment and upgrading ICT services, including improved use of education technologies and wider dissemination of research findings to all stakeholders through training on the use of e-learning systems, instructional design, access and use of e-resources and publishing in peer-reviewed journals. Enhanced use of ICT services is expected to be an enabler to MUHAS as it strives to increase student enrolments and improve research capacity to enable quality training of more students and contribute towards attaining adequate qualified healthcare workers who can effectively provide appropriate healthcare to Tanzanians.

Tanzanian Commission for Universities (TCU) released Handbook for Standards and Guidelines for University Education in Tanzania in December 2019, which requires universities to create and maintain enabling technology and learning environment by establishing training programmes on pedagogical skills and the use of ICT in teaching and learning for staff but also equip students with necessary digital skills to become competent in their respective professional fields (Tanzania Commission for Universities, 2019). A study conducted in 2019 on the State of Higher Education by TCU reported that 100% of public university institutions have an ICT policy in place, compared to 82% of privately-owned institutions. Furthermore, the TCU report indicated that most students (around 175,000) followed full-time physical university education. The report showed that over 60% of employers in Tanzania reported an overall skills gap, including IT skills. It was indicated that there is increasing enrolment. At the same time, the student-teacher ratio remains relatively low, and low proportion of highly skilled workforce entering the labour market and limited usage of ICT in higher education (Tanzania Commission for Universities, 2019; United Republic of Tanzania, 2018). The TCU report also recommended initiatives towards improving ICT infrastructure and increasing lecturers' capabilities on the use of ICT services in line with other efforts to

strengthen the use of ICT in teaching, learning, research and management in HLLs (United Republic of Tanzania, 2018). This emphasised the need to accelerate efforts to improve ICT services in HLLs, including increasing digital literacy among graduates.

Some challenges reported in the present assessment include unreliable ICT infrastructure, including unreliability and slowness of network or internet, limited financial resources to acquire and maintain ICT infrastructure, limited skills to use the ICT services, inadequate technical support due to shortage of ICT officers, regulatory framework, e.g., intellectual protection policy hindering sharing, modification of e-resources on the digital learning platforms. All these challenges hinder the use of e-resources and e-services in teaching, learning and research. Similar challenges, such as unreliable electricity, resistance to change amongst instructors, Insufficient Internet bandwidth and inadequate funds, were reported in other studies. The ICT infrastructure strengthening is expected to continuously enhance the use of digital technologies in the management of higher education and to enhance teaching, learning, research and public services. Similar challenges have been reported in other studies (Kommers *et al.*, 2021; Langthaler & Bazafkan, 2020; Manyengo, 2021).

A previous study conducted at MUHAS indicated that the availability of a fast and reliable network and internet connectivity facilitated the use of online resources, including information search and web 2.0 technologies for online surveys, presentation, content sharing and storage (Lwoga & Sukums, 2018). Major challenges hindering the efficient utilisation of ICT services include limited access to appropriate computing devices, low student digital literacy, and lack of competent and timely technical support (Langthaler & Bazafkan, 2020). This implies that HLLs should produce not only skilled digital professionals but also a digitally enabled workforce to cope with dynamic job market demands. To achieve this goal, HLLs must invest and implement reliable and user-centric ICT services to facilitate core functions of teaching, learning, research and public services.

There is a need for an enterprise architecture approach in managing ICT services and digital transformation in line with the increasing demands for universities to engage in innovation, knowledge management, commercialisation or industrial

linkages and marketing in the digital economy era (Gayatri & Nagalakshmi, 2019; Indrawan & Sumitra, 2019; Meutia *et al.*, 2022).

The efficient and effective use of ICTs is a cornerstone in digitally transforming the core functions of most HLLs in teaching, learning, research and public services. The use of ICT tools transforms an environment for teaching and learning to be more learner-centred. Therefore, institutions should heavily invest in fostering research, innovations and development as well as producing graduates who are competent with digital literacy and knowledge management capabilities. The graduates should couple with recent advancements in digital technologies such as artificial intelligence, digital twins, augmented and virtual realities, robotics, big data and blockchain. Furthermore, the digitalisation of education in HLLs should also incorporate the adoption of advanced digital technologies such as virtual reality, augmented reality and gamification (digital educational games) as the education sector strives to develop skills required for digital transformation in the 4IR era (Kommers *et al.*, 2021).

#### ***Implications of the findings***

Our application of the ITIL framework yielded crucial insights into the state of ICT services at MUHAS. The framework guided our categorisation of services and helped us identify gaps in IT service provision. Regular comprehensive assessment and stakeholder engagement are imperative in understanding the quality of IT service management and devising strategies for improving the services. The experience from this study can be tailored for use in other higher learning institutions to provide a broader perspective on the current digital/ICT ecosystems, challenges, needs, and demands of different stakeholders to drive an appropriate digital transformation of the core university functions. As indicated by Wang and colleagues, the practical implications of robust ITIL implementation extend beyond individual institutions as it could help IT service providers regularly assess their IT service quality in line with changing users' needs and expectations (Wang *et al.*, 2022).

#### **Conclusion**

The findings present the experience of using the ITIL framework for assessing ICT infrastructure, systems and services at a university level in Tanzania. The article outlines the achievements in using ICT to deliver university functions. It also presents several

challenges hindering the efficient utilisation of digital technologies and recommendations for addressing the challenges and improving ICT services. In this article, the university management and other stakeholders were involved in the assessment of ICT services as well as the development of strategies for improving the effective and efficient utilisation of digital technologies to enhance the conduct of the core functions of the University. The management, as a key arm in allocating financial, human and technical resources for upgrading ICT services, should clearly understand the institutions' ICT service portfolio. The developed ICT service catalogue or service portfolio needs to be regularly maintained and updated to improve coordination, resource mobilisation and utilisation and management of the services.

### **Recommendation**

Using the ITIL framework, this study assessed the ICT infrastructure, systems, and services at MUHAS, showing varying maturity levels and improvement opportunities. The study recommends a regular review of the ICT governance framework and ensuring its usage in IT service management processes such as service portfolio management, business relationship management and supplier management, as well as harmonisation of service requests, service prioritisation and service approvals.

It is paramount to develop the university enterprise architecture as a blueprint to guide the planning, development or acquisition, customisation and maintenance of various ICT services at MUHAS. The architecture should be aligned with the higher education sector and the government's broader enterprise or services architecture to ensure coordination, harmonisation, integration and interoperability of ICT systems and services to ensure efficient delivery of core functions of higher learning institutions: teaching, learning, research and public services but now more so innovation, knowledge management, commercialisation and marketing in the digital economy era. Moreover, mapping and organising ICT infrastructure, systems and services using globally established frameworks that can be contextualised in different settings is an important milestone in understanding the status of the installed services, user needs and expectations. The assessment also defined priorities for sustained management, maintenance and upgrading of ICT services to cater for increasing demands from different stakeholders. It is crucial to conduct regular

readiness assessments of ICT infrastructure, systems and services to ensure HLIs' business continuity during emerging and re-emerging pandemics like COVID-19.

### **Acknowledgements**

We thank Enrico Pelletta from the Royal Institute of Technology and Ulf Noring from Stockholm University for their technical support in conducting the assessment and the MUHAS management, academic and supporting staff for their active participation in the assessment. This work was conducted through a review of secondary data from the assessment. No direct funding was involved. The Swedish International Agency (Sida) funded the assessment within the Library and ICT sub-program. Sida did not have any role in the study design, data collection and analysis, decision to publish, or preparation of the manuscript. Manuscript writing was not supported financially.

### **Ethical consideration**

The assessment was conducted as operational research in which all administrative permissions are under the Sida sub-programme and as per university procedures. Verbal consent was obtained from all participants.

### **Availability of data and materials**

Data used in the current study are available from the corresponding author upon reasonable request.

### **Abbreviations**

ITIL: Information Technology Infrastructure Library framework; MUHAS: Muhimbili University of Health and Allied Sciences; MAMC: MUHAS Academic Medical Centre; ICT: Information and Communication Technology; IT: Information Technology; SARIS: Students' Academic Records Information System; TCU: Tanzania Commission for Universities; HLIs: Higher learning institutions.

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