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Technological literacy in using Learning Management System among students in higher education institutions Tanzania: the case of two selected universities

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Abstract. This paper aims to test the predictive power of facilitative conditions and technological literacy skills in using the Learning Management System (LMS) for learning in a Tanzanian university setting. The paper adopts a quantitative approach in which data were analysed using the linear regression model after securitising for multicollinearity, linearity, normality of data, homoscedasticity, and measurement reliability. The study's findings indicate that the environmental context had more predictive power for technological literacy among students than the technological and organisational context. The paper provides insights to educational practitioners in HLIs to strengthen their systems so that the technological learning environment aligns with the student's technological literacy development needs. The findings also highlight the need for university authorities to adopt new technological innovations that could be used to enhance students' digital literacy skills development and be able to cope with 21st-century skills. By examining the level of technological literacy, the research can shed light on the potential barriers students face in using LMS and point out some areas where interventions are needed. This, in turn, can enhance educational outcomes by improving students' digital skills and their ability to engage with online learning resources.

Keywords: digital divide, digital safety, e-learning, digital literacy, online learning

1. Introduction

Technological advancements have transformed teaching by offering new opportunities and options, such as smart education, which could improve future teachers' professional growth [56]. One prominent technological tool in higher education is the Learning Management System (LMS), which provides a digital platform for course management, content delivery, tracking, and interaction between students and instructors [22]. The LMS provides a platform for instructors to deliver course materials, assessments, and other learning resources to students. It also allows students to access and interact with their instructors and peers [20]. Despite its increasing

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use, implementing LMS faces many challenges from the individual to the organisation. For example, Antwi-Boampong [8] found that infrastructure, faculty concerns, and institutional and technical support barriers hinder the implementation of LMS. Even though there are perceived benefits of (LMS) in facilitating distance learning for students, there are several challenges, such as poor internet accessibility and limited understanding due to the absence of direct face-to-face support from instructors who can provide detailed explanations about the topics [15]. Learning inequalities result from improper pedagogical practices when utilising the LMS since students may struggle to understand complicated concepts without prompt assistance and clarification.

Effective implementation of LMS depends on facilitative conditions such as digital infrastructure, internet, digital skills among LMS users and institutional support. However, evidence indicates that the use of LMS to support online learning has been constrained by limited instructors' capacity, knowledge on how to conduct online courses, technological factors, environmental factors, staff attitudes towards delivering online courses, lack of digital skills among instructors and lack of experience in e-learning [7, 51]. Instructors' pedagogical knowledge is crucial in ensuring the effective use of an LMS to facilitate learning through LMS. However, evidence indicates that pedagogical knowledge among university instructors is not exhaustive, affecting students' ability to acquire digital literacy skills. Further evidence by Alhazmi et al. [3], Bahar, Wahab and Ahmad [10] indicates that instructors in universities are technologically incompetent, have a low rate of interactivity and lack of understanding of learner characteristics and attitude and thus, limited engagement of learners in learning through LMS. Likewise, Papadakis [55] reports that when students are exposed to LMS that provide Massive Open Online Courses (MOOCs), they face high dropout rates, and their engagement tends to be low due to lack of motivation, limited support and irrelevance of the content to students' needs.

Also, Baluyos and Clarin [13] found that instructors experienced inadequate pedagogical training for online teaching due to limited time for the preparation of modules, exams, and other related instructions, which led to limited realisation of the learning outcomes among students. Moreover, Kamisli and Akinlar [29], Lowell and Yang [37] found that instructors encounter barriers to high-quality online teaching, including a lack of pedagogical knowledge, skills, and low self-efficacy. Instructors' inability to engage students in online learning and low technological solutions adoption leads to inadequate digital skills among students [28]. Furthermore, Anas, Basri and Musdariah [6] found gaps between what instructors know, think, and believe and what they do in their digital practices. This indicates they are inadequately supported, which may warrant continuing professional development and critical pedagogy in digital literacy development to enhance learners' learning.

Perhaps the mismatch in the knowledge gap in pedagogical practices among instructors and curriculum implementation would impact students' learning and digital literacy development. Learners in the 21st century are expected to be exposed to several technological solutions to enhance their learning. However, this has not been the case in most HEIs in low- and middle-income countries, as technology is inadequately adopted in pedagogical practices. Several researchers have reported that during the COVID-19 pandemic, for example, most instructors lacked the technological skills to run online distance learning programs. Thus, students could not access any learning [46]. The study conducted by Subashini et al. [65] reveals that the shift to online distance learning during the COVID-19 pandemic met resistance among students due to ineffective pedagogical techniques employed by their instructors which they felt that were

preoccupied with limited hands-on activities. In other countries such as Ghana, students had limited participation in the Moodle LMS during COVID-19 due to a lack of prompt feedback from instructors and the complexity of the system, which mostly appeared not to be user-friendly to them [59].

While universities have been entrusted to be the primary drivers of technological innovations and solutions in the 21st century [31], there is limited evidence indicating such roles in low-income countries. Similar emphasis has been put in the Africa Agenda that there is a need for sustained ICT investments in HEIs to ensure learning and scientific reforms that aim to transform Africa's economy [1]. Despite this emphasis, one could note limited efforts that have been made among African universities to achieve the same as the investment in technological solutions for learning such as LMS is still at the infancy stage [5, 50]. The study in Zimbabwe, for example, indicates that students lack computer skills. As a result, they continue to rely on the printed module and face-to-face tutorials [67]. Similarly, in Ethiopia, more than 85% of university students from rural areas learn without laptops or desktop computers, except very few of them from rich urban families [40]. Limited access to digital devices indicates that students in HEIs, particularly in developing countries, have limited opportunities to develop digital literacy skills.

Most low- and middle-income countries have already established the ICT frameworks and policies that guide the virtual delivery of education in a blended mode. Consider an example of the TCU guideline in Tanzania, emphasising the investment in ICT infrastructure that should support online delivery. Nevertheless, this has not been the case [68]. HEIs in Tanzania have been reported to face a number of challenges, such as limited internet access, unavailability of relevant digital content, and outdated ICT infrastructures, just to mention a few. Several studies in Tanzania in HEIs report that there is shallow adoption of technological solutions, something that limits the development of digital literacy skills among students [43, 49, 50]. For instance, in the survey that involved 126 countries, including Tanzania, around 17% were reported to have been using LMS regularly while only 11% were using it very often, and the remaining 72% were not using distance learning [27].

Further evidence indicates that the adoption of e-learning systems in Tanzania's Universities is still very low, at about 46% of the universities have adopted e-learning systems for both Public and Private Universities with 75% of e-learning application software being Moodle based [32]. Other factors which limit students' adoption of LMS include trust, university readiness, environmental factors and instructor quality [33]. Further evidence from Rwanda indicates that students had minimal participation in online learning due to limited accessibility of ICT resources, slow network, and lecturers' teaching overload [48]. These studies give the impression that there is an increased trend of low adoption of technological systems supporting e-learning.

Previous studies indicate several barriers to the successful integration of technology for developing digital literacy skills among learners in HLIs in developing countries, notably Tanzania [7, 33, 46, 49, 51]. Other studies have found that the main obstacles to the use of LMS in HEIs in Tanzania include a lack of access to computers and the Internet, limited Internet speed, a lack of policies, and expertise in creating digital resources [44, 45, 47]. The available empirical evidence supports the view that adopting LMS depends on several factors, such as technological, individual and institutional factors. However, most of the literature discusses barriers associated with low adoption and implementation of LMS without adequate categorisation of facilitative

conditions and their influence or predictive power on digital literacy skills among students in HEIs. More existing literature emphasises the infrastructure and institutional factors facing university instructors with limited attention to students' perspectives. The current study, therefore, aimed to bridge this gap by assessing how students perceive and interact with the LMS, their competencies and the limitations they face in utilising the LMS. Thus, the current study is essential in establishing predictive conditions for adopting and implementing LMS in HLIs. It also adds to a growing body of literature on the debate surrounding the adoption of e-learning strategies in HLIs in developing countries. It is possible to note that this research provides evidence to scholars and researchers interested in understanding and developing expertise in developing digital literacy skills among students. Universities may be able to update their curricula to incorporate the skills required for digital literacy and guarantee that graduates are ready for the needs of the digital workforce by analysing the gaps in students' technology literacy.

2. Research questions

The study employed quantitative methodological procedures to address the following research questions:

1. What are the students' technological literacy in utilising the LMS for learning?
2. Is there a relationship between facilitative conditions and technological literacy?

2.1. Theoretical considerations

This study employed the Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Venkatesh et al. [75]. UTAUT was chosen because it is a strong theory that has been extensively utilised to evaluate technological adoption and use in many disciplines, including education [2, 4, 9, 60, 61]. The assumption behind UTAUT is that the actual technology usage is determined by behavioural intention [75]. UTAUT consists of four constructs, i.e., effort expectancy, performance expectancy, social influence and facilitating conditions and four moderating variables (i.e., age, gender, experience and voluntariness to use). The constructs, combined with the moderating variables, directly impact behavioural intention to use technology [14].

According to this study, an individual's attitude toward using technology is primarily influenced by their performance expectancy, which refers to how much they believe that using the system will help them achieve increases in job performance, and effort expectancy, which refers to how easily they can use the system [62, 75]. It would be simple for students to develop technological literacy skills when their attitudes are positively influenced and when they accept and utilise technology, as a good attitude will drive them to develop additional skills to be competent and at ease when using LMS. Additionally, Social influence, which refers to the extent to which people think it is important for others to use the new technology, persuades students to become technologically literate because the people around them think it is crucial for their future development and acquisition of 21st-century skills. Furthermore, facilitating conditions, which are also referred to as the degree of assurance that an organisational and

technological infrastructure exists to facilitate the use of the system, directly influence how people intend to use LMS [21, 75]. The availability of necessary resources in the institution was thought to favour students' desire to use the LMS for learning and to predict their views on it.

3. Methodological procedures

3.1. Research approach and design

This study employed a quantitative research approach. Descriptive quantitative research design and Correlational Research design were applied in this study. Descriptive quantitative research described a sample population to provide insight into the sample characteristics and digital literacy skills possessed by students. Correlational Research design explored the relationship between digital literacy skills and facilitative conditions [69]. The study was conducted in two selected universities in Tanzania. The selection was based on the fact that the current adoption of digitisation of operations in teaching is not exhaustive; a number of pieces of evidence indicate that they have not fully harnessed the use of LMS for supporting blended learning since both students and instructors lack adequate preparations to shift to e-learning [43, 45, 46, 73, 74].

3.2. Research tools and sampling procedures

The study employed simple random sampling techniques to sample students engaged in a SurveyMonkey questionnaire using five-point Likert scales (i.e., ranging from strongly disagree to strongly agree). Data were collected using a self-designed questionnaire which adapted some key constructs and aspects from UNESCO ICT Competency Framework for Teachers [72] and Technology Organization Environment Framework [12], measuring domains of digital literacy and facilitating conditions for the adoption of LMS. UNESCO ICT Competency Framework highlights and emphasises the necessary technological skills for student-teachers, while the Technology Organization Environment Framework highlights necessary conditions to be considered when implementing digital technology such as LMS in institutions.

In total, 36 (thirty-six) items were used to measure all the domains/dimensions of the study variable of interest. The questionnaire was shared with students who had an equal chance of being included in the study.

3.3. Data analysis procedures

Ordinal data were aggregated and converted to continuous data based on a five-point scale used in the Likert scale. Before doing that, the authors ensured that all items were in the same wording. After that, Kolmogorov-Smirnov was used to test the normality of data before the analysis to opt for parametric or non-parametric analysis. The internal consistency reliability was computed using Cronbach's alpha of coefficient [17]. The overall alpha value ranged from (α=.72 to α=.914), suggesting that the scale used was highly reliable (appendix A). The value for each item reached the minimum reliability ($\alpha \geq .70$) value, suggesting that they all measured

related constructs. The data were collected from 383 students (i.e., 242 from university D and 141 from university A), out of whom 230 were males and 153 were females.

Data were analysed using the linear regression model after securitising for multicollinearity, linearity, normality of data, homoscedasticity, and the reliability of the measurement. The data met the required psychometric features, suggesting that multiple regression analysis was a robust technique to assess the relationships between the variables of the study interest. The University Research Ethical Committee provided the ethical clearance (i.e., MA.84/261/63/84) on behalf of the Tanzania Commission for Science and Technology (COSTECH).

4. Results

The results in table 1 indicate that the study involved 383 participants. Of them, 230 (60.1%) were males, and the rest were females. Likewise, most respondents had the age group below 25 (74.7%), and the least age group were between 36-45 (2.6%). Most respondents were from University D, 242 (63.2), and the rest were from University A.

Table 1
Demographic information of the study participants.

Variables	Categories	Male		Female		Total	
		N	**Percent**	***N***	**Percent**	***N***	**Percent**
Age	Below 25	161	42.0	125	32.6	286	74.7
	Between 25-35	63	16.4	24	6.3	87	22.7
	Between 36-45	6	1.6	4	1.0	10	2.6
	Subtotal	230	60.1	153	39.9	383	100.0
Institutions	University A	78	20.4	63	16.4	141	36.8
	University D	152	39.7	90	23.5	242	63.2
	Subtotal	230	60.1	153	39.9	383	100.0

4.1. Students' technological literacy skills

The study's first objective aimed to explore student-teachers' technological literacy in using LMS to enhance e-learning. The purpose was to explore if university student teachers had the technological literacy skills necessary for utilising the LMS. Also, it aimed to explore whether university student-teachers had the knowledge necessary to use LMS. The findings are as shown in table 2.

The findings in table 2 indicate that technological literacy among respondents varied slightly, whereby the highest mean score of 4.24 in the item related to the ability to produce a word text using word processing programs and the lowest mean score value, i.e., 2.27 in the item related to the awareness of various LMS (i.e., Edmodo, Moodle, Blackboard, Canvas etc. This indicates that most student-teachers in universities have the basic knowledge related to the use of LMS, which starts from being able to write a text that can be used in online learning. Also, it indicates that student-teachers at this institution lack knowledge of using LMS. The

Table 2
Students' technological literacy skills.

Questionnaire items	Total	
	Mean	SD
I can produce a text using a word-processing program	4.24	0.81
I am aware of various LMS (i.e., Edmodo, Moodle, Blackboard, Canvas, etc.)	2.27	0.90
I use LMS to communicate with my fellow students and instructors	2.36	1.02
I can customise multimedia content (i.e. video, image, audio) to be uploaded in LMS	2.6	1.23
I can create and edit topics for discussion and reflection in the LMS	2.29	1.08
I can participate in different discussions and reflections through LMS	2.54	1.10
I am aware of various educational policies that advocate the use of LMS	2.58	1.06
I am able to identify various sections of the educational policies that enforce the use of LMS for learning	2.71	1.07
I am able to use LMS to facilitate my learning	2.41	1.10
I am able to upload and submit the assignments in the LMS	2.61	1.12
I am able to select, use and incorporate appropriate digital content in LMS	2.67	1.08
I am able to attempt the online quizzes/tests assigned to me by the instructors through LMS	2.66	1.17
I am able to select, describe and use communication and collaboration tools (features) embedded in the LMS	2.55	1.13
I am able to troubleshoot common problems in LMS	2.69	1.10
I am able to navigate to different features and tools within the LMS	2.61	1.03

general impression from the results in table 2 is that students rarely interact with technological solutions that may enhance their digital literacy practices.

4.2. The relationship between the facilitative conditions and technological literacy

The study intended to assess which of the three facilitating conditions had the most predictive/determining power of technological literacy among the students. To assess this useful relationship, multiple regression analysis was conducted using standard multiple regression analysis. Thereafter, age and gender were controlled using hierarchical multiple regression analysis. In this case, age and gender were entered in block 1, whereas the three independent variables (technological context, organisational context, and environmental context) were entered in block 2 to assess if age and gender impacted the relationship between facilitating conditions and students' technological literacy. The second analysis was also repeated against institutions and examined if the type of institutions the respondents belonged to played a moderation effect in this relationship. The outcomes of the analysis are summarised next.

Given the output in table 3, the data did not display any highly correlated variables. The highest correlation was between the technological and environmental contexts (r=.43), suggesting that there were no highly correlated independent variables as evidence of the absence of multiple collinearities. Likewise, the variables had some significant correlations with the dependent variables, and the highest was between the environmental context and technological literacy

Table 3
Multiple correlations of independent variables against technological literacy.

	Technological literacy	Technological context	Organization context	Environmental context
Technological literacy	1.000	.330	.322	.498
Technological context	.330	1.000	.373	.431
Organisation context	.322	.373	1.000	.321
Environmental context	.498	.431	.321	1.000

Table 4
Predictive power of each independent variable over students' technological literacy.

	Standardized coefficients	t	Sig.	Correlations			Collinearity statistics	
	β			Zero-order	Partial	Part	Tolerance	VIF
(Constant)		12.75	.000					
Technological context	.097	1.941	.053	.330	.099	.084	.753	1.328
Organisation context	.156	3.262	.001	.322	.165	.142	.829	1.206
Environmental context	.406	8.287	.000	.498	.392	.360	.785	1.274

(r=.50). In that case, it is reasonable to argue that the data were suitable to conduct multiple regression analysis. Besides, based on the variance inflation factor (VIF) and the Tolerance values, it was evident that the data met the requirement for conducting a regression analysis model [66]. The details of the multiple regression analysis are presented in table 4 underneath.

Based on table 4 above, out of the three independent variables, environmental context emerged as the variable with the most predictive power of technological literacy of students (β=.406, p<.001). The second and third determining variables were organizational (β=.156, p=.001) and technological context (β=.097, p=.053). The overall model was significant $F(3, 379)=50.277$, p<.001. The model explained 28.5% of the variance in technological literacy (R squared: r^2=.285). These findings suggest that a high score of environmental contexts was associated with a high score of technological literacy. In other words, increasing one standard deviation unit of environmental context would likely increase to .406 standard deviation units of technological literacy. Further, the findings could be interpreted to mean that for obtaining high impacts of technological literacy among students, improving environmental context would play the most significant role, followed by organisational and technological contexts, respectively.

The regression model was controlled for possible confounding factors, such as age, gender, and institutions, via the hierarchical regression analysis noted in the previous section. The results indicated that model 1 was more significant than model 2 in explaining technological literacy. Institutional factors affected the model by indicating a significant explanatory power over the technological literacy of students (β=.205, p<.001), $F_{change}(3, 379)=28.817$, p<.001. The overall model 1 explained 18.6% of the variance in technological literacy.

On the other hand, model 2, which included facilitating conditions, revealed that only two variables out of three significantly predicted technological literacy after controlling for possible

confounding factors. In particular, the environmental context was still a unique variable (β=.328, p<.001) followed by organisational factors (β=.126, p=.009). The general model explained 12.9% of the total variance in technological literacy after controlling (F_{change}(3, 376)=23.686, p<.001), confounders compared to 28.5% of the total variance in technological literacy when confounders were not statistically controlled for the model. In that regard, the predictive power of technological context disappeared after controlling for confounding factors (β=.077, p=.123).

These findings provide novel contributions to understanding the moderation effect of demographic factors in the relationship between the facilitating conditions and the student's technological literacy. Therefore, these results speak of the importance of assessing the effect of demographic factors when measuring technological literacy determinants.

As indicated in table 5, no highly correlated variables existed. The results indicated that the data did not violate the assumption of multicollinearity as there were no highly correlated variables, nor did the tolerance and VIF values.

Table 5
The relationship between facilitating conditions and technological literacy after controlling for possible confounders.

Model		Standardized coefficients	t	Sig.	Correlations			Collinearity statistics	
		β			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)		10.51	.000					
	Gender	-.002	-.041	.967	-.037	-.002	-.002	.985	1.015
	Age	.035	.728	.467	.137	.037	.034	.933	1.072
	Institution	.421	8.807	.000	.430	.412	.408	.940	1.064
2	(Constant)		7.168	.000					
	Gender	.028	.646	.518	-.037	.033	.028	.974	1.026
	Age	-.006	-.135	.893	.137	-.007	-.006	.903	1.107
	Institution	.205	4.018	.000	.430	.203	.171	.701	1.427
	Technological context	.077	1.547	.123	.330	.080	.066	.735	1.361
	Organisation context	.126	2.643	.009	.322	.135	.113	.807	1.238
	Environmental context	.328	6.171	.000	.498	.303	.263	.646	1.547

5. Discussion

The results indicate that students had limited technological literacy skills which is against the 21st-century skills requirements where they need to be competent enough to cope with the dynamic technological environment. The findings highlight the need for specific interventions to improve students' technological literacy skills. Also, the study by Lokmic-Tomkins et al. [36] discovered that despite students' positive opinions toward technology and its pervasiveness in their lives, they still lack the confidence to use it and other software necessary for learning. This indicates that digital literacy for learning purposes is still a problem for many students. Furthermore, this study's findings align with the study findings of Smith [64], which emphasise the need to handle complex issues, which include the digital gap, socioeconomic disparity, and

poor infrastructure. Also, Nikou and Aavakare [52] found that the use of digital technologies within higher education environments is still a problem related to the lack of technological literacy skills among university staff and students.

The evidence indicates that digital literacy is vital in enhancing students' academic achievement. Still, most students report several constraints, such as electricity failure, low internet bandwidth, ICT facilities, and lack of development of digital literacy programmes and standards, which limit the effectiveness of the skills [71]. Technological literacy skills are essential for enabling students to access and evaluate information online. Students with low technological literacy may struggle to access online resources, limiting their ability to gather relevant and credible information for their studies. This, in turn, can hinder their academic potential and research capabilities. Likewise, low technological literacy among university students can result in limited employment opportunities.

It was also tested whether the three facilitating conditions had the most predictive/determining power of technological literacy among the students. It was concluded that the environmental context was the more predictive power for technological literacy among students than technological and organisational context. The findings highlight the significance of the environmental context in shaping students' technological literacy. Given the influence of the environmental context on technological literacy, HEIs need to create an enabling environment that supports the acquisition of literacy skills among students. Strong emphasis could be placed on investing in digital infrastructure and fostering a digital culture in their institutions. Although the environmental context was found to be a strong predictor in this study, another study in Tanzania indicates the technological factors to be the most significant predictor of using LMS [42]. Similarly, Coman et al. [18] highlight that technical issues are the most important determinants followed by organisational barriers such as instructors' limited skills in the adoption and use of digital learning platforms, and usually, their teaching styles improperly adapted to the online environment.

Along with these results, the study by Gama, Chipeta and Chawinga [25] states that e-learning in HEIs in Malawi is not fully practised due to underdeveloped ICTs and power infrastructure are the most common impediments (i.e., technological barriers) followed by the lack of an e-learning policy and lack of knowledge to use ICTs among students which fall and organisational factors. Although technological factors have been identified as key determinants of the use of technology (i.e., LMS), human capital resources such as staff, students, faculties and experts are a key influential factor [76]. It is possible to agree with Wang et al. [76] that technology alone cannot guarantee integration in teaching, teaching and learning. This was evident during the outbreak of the COVID-19 pandemic when most HEIs had already adopted many technologies, including the use of LMS. However, the transition to online learning was challenging due to low instructors' and students' digital competencies [19, 50, 58].

While the findings of the current study highlighted environmental factors as the most predictive facilitating conditions determining the power of technological literacy among the students, other studies highlight the organisational and technological determinants being perceived to be relevant in determining instructors' ICT use [24]. Other researchers consider all factors (i.e., technological, organisational and environmental) to influence the technological literacy and adoption of e-learning in HEIs [34]. In their studies, Ergado, Desta and Mehta [23], Lufungulo et al. [38], Permadi and Fathussyaadah [57] have revealed barriers such as

inadequate ICT infrastructure, inaccessibility of ICT resources, lack of confidence to use ICT, and underutilisation of ICT resources as technological factors; the lack of top management support and shortage of skilled human resource as organisational factors; and lack of ICT policy for education culture of ICT use, exposure to ICT resources, and suitable environment for ICT resources establishment as environmental factors. It is also noted that the adoption of online learning by educational institutions depends on the ability of the organisation to accept or reject information technology [57]. Similarly, Baig, Shuib and Yadegaridehkordi [11] note that top management support, financial resources, human expertise and skills, competitive pressure, security and privacy, and government policies are some of the determinants for the effective adoption of technology, particularly big data.

While the global agenda emphasises harnessing ICT to strengthen knowledge dissemination, information access, quality and effective learning [26], one could note difficulties in achieving the same in a situation with several limitations. It has been reported that e-learning is inhibited by the cost of internet services, internet inaccessibility, lack of institutional support and lack of training [63]. Several papers indicate the prevalence of the digital divide, lack of stable Internet services and connectivity, digital devices, limited training on ICT opportunities, electricity, lack of readiness to adapt to new technologies, support systems, no focused interventions in LMS for teaching [30, 39].

The prevalence of the digital divide among students and institutions hindered students' ability to adopt e-learning strategies during COVID-19, and most of them were uncertain about learning in a new digital learning environment through LMS [16, 41]. The study by Oscar and Marcella [54] revealed that students lacked basic skills in using e-learning systems, and thus, it was difficult for them to balance home responsibilities and online learning tasks during the COVID-19 pandemic. During the COVID-19, the majority of instructors were working from home; they had to use their Internet bundles to facilitate students' learning, but many students did not have access to reliable Internet access and/or technology outside the main campus [46]. Other researchers posit that adopting e-learning during COVID-19 was perceived negatively by some students who felt that the systems could be vulnerable to online attacks on the websites that may compromise the quality of learning [39]. The sudden shift to online teaching created a range of contradictions among instructors and students. Most instructors were novices to online teaching and had inadequate ICT and pedagogical training to engage fully learners in online learning [35, 70]. Another critical challenge was maintaining students' engagement in online learning due to limited knowledge, anxiety and stress, inadequate teaching environment, increased workload and unstable Internet [53]. It makes sense to note that many HEIs in developing countries lacked ICT policies, frameworks and models guiding the implementation of ICT in teaching and learning, weak digital culture and lack exposure to ICT resources in the higher learning institutions [23, 50].

While the global agenda emphasises harnessing ICT to strengthen knowledge dissemination, information access, quality and effective learning [26], one could note difficulties in achieving the same in a situation where instructors continue to rely on traditional face-to-face teaching, which has been criticised for being less effective. It has been noted that adopting e-learning systems creates greater opportunities for universities to offer education that meets national, regional and international labour market requirements of which technology is considered the heart of productivity [68]. However, it remains unclear how this could be achieved as there is

limited evidence regarding using LMS in HEIs in the Tanzanian context and other developing countries.

6. Conclusion and recommendations

This study gives insights into how HEIs must prioritise technological innovations that may enhance students' digital literacy skills. The findings indicate that students had low technological literacy skills. Given such a situation, their ability to communicate with peers and instructors and participate in collaborative group projects through digital tools may be compromised. On this basis, one may conclude that students are inadequately prepared to successfully learn through a digital learning environment, which may hinder their ability to develop 21st-century skills (i.e., collaboration, communication, creativity and critical thinking). Our study findings show that apart from the environmental context, which was identified as the most predictive power for technological literacy among students, technological and organisational factors are also vital enablers that need to be addressed by the university authorities to ensure effective learning through LMS. Limited pedagogical skills in running online programs among instructors and a preference for face-to-face instructions create a critical dilemma in transforming learning through technology. This calls for institutional and individual changes in attitudes towards technology to harness learning opportunities offered by technological learning environments. It has been noted that universities lacked adequate technological readiness and preparations during the outbreak of the COVID-19 pandemic, which now calls for university authorities to adopt new technological innovations that could be used in future emergencies. Technological adoption also depends on instructors' and students' digital competencies, which the current study found to be low due to several reasons, such as lack of training, unreliable Internet, high costs of bandwidth, and limited access to technological devices, to mention a few. Total digital transformations in universities, particularly in developing countries, would require universities to provide support in training and substantial investments in technological solutions.

6.1. Study limitations

Since this study gives a broad overview of the predictive factors (i.e., facilitative conditions) on adopting and implementing the LMS, some occurrences and debates around cultural, social, and expectations still need to be investigated for future research, therefore, it is desirable to investigate how these factors may influence the adoption while considering similar statistical measures. Likewise, students' self-regulation and motivation towards adopting and implementing the LMS were not tested in this study; thus, future studies may also focus on this to see how they can predict the adoption of LMS. In addition, the current study concentrated solely on establishing the conditions that may influence the effective adoption and implementation of LMS among students, ignoring instructors and administrators. Further studies may include the assessment of instructors' and administrators' digital competencies towards adopting LMS. The findings of this study are specific to two public Universities in Tanzania where the research was conducted. On this basis, caution should be exercised when generalising the results to other contexts or student populations in HLIs. Several other universities are running under private ownership, which may have variations in context from the public ones. Again, the study

involved participants from diverse cultural backgrounds, and cultural variations may influence the findings in digital literacy skills and institutional culture. These variations may limit the generalizability of the findings across different cultural settings.

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A. Internal consistency reliability

Table 6
Overall internal consistency for items measuring students' technological literacy for using LMS (α=.81).

Questionnaire items	Corrected item-total correlation	Cronbach's alpha if item deleted
I can produce a text using a word-processing program	-.03	.82
I am aware of various LMS (i.e., Edmodo, Moodle, Blackboard, Canvas, etc.)	.21	.81
I use LMS to communicate with my fellow students and instructors	.31	.80
I can customise multimedia content (i.e. video, image, audio) to be uploaded in LMS	.38	.80
I can create and edit topics for discussion and reflection in the LMS	.33	.80
I can participate in different discussions and reflections through LMS	.54	.79
I am aware of various educational policies that advocate the use of LMS	.48	.79
I am able to identify various sections of the educational policies that enforce the use of LMS for learning	.45	.79
I am able to use LMS to facilitate my learning	.39	.80
I am able to upload and submit the assignments in the LMS	.55	.78
I am able to select, use and incorporate appropriate digital content in LMS	.52	.79
I am able to attempt the online quizzes/tests assigned to me by the instructors through LMS	.52	.79
I am able to select, describe and use communication and collaboration tools (features) embedded in the LMS	.51	.79
I am able to troubleshoot common problems in LMS	.49	.79
I am able to navigate to different features and tools within the LMS	.49	.79

Table 7
Overall internal consistency for items measuring facilitating conditions towards using LMS (α=.744).

	Corrected item-total correlation	**Cronbach's alpha if item deleted**
The university adopts and implements new technologies such as LMS	.29	.74
The university upgrades the features and functionalities of the LMS	.40	.73
The university addresses the security and privacy concerns associated with the use of LMS	.47	.72
The LMS we use integrates other systems or technological tools used by the university (i.e., students' information system or library systems)	.35	.73
The technological infrastructure supports the effective use of LMS at my university	.15	.75
My university ICT policy intends to promote my ability to use LMS platforms effectively	.20	.74
We are involved in any decision made at my university about any changes or adoption/implementation of LMS	.38	.73
My university is ready to update changes or innovations we suggest for the improvement of LMS	.11	.75
My university collaborates with other departments across the university on the implementation of LMS	.42	.72
My university ICT policy supports the use of LMS within the learning process	.07	.75
My university gives priority to LMS Training to improve the ICT skills of students	.36	.73
My university introduces ways to improve LMS-related skills	.21	.74
The university offers adequate ICT expertise to facilitate the use of LMS	.18	.74
The university offers adequate computers to facilitate the use of LMS	.19	.74
The university offers consistent internet access with sufficient speed and free WIFI to simplify the use of LMS	.38	.73
The university offers studios for developing multimedia content for supporting teaching and learning through LMS	.35	.73
The university provides the accessibility of free digital resources through LMS	.48	.72
The university enforces data privacy regulations for LMS users	.49	.72
The university offers the LMS, which is user-friendly and meets students' learning expectations	.42	.72