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Assessing Telecommuting Readiness: An Ecosystem for Higher Education Institutions

Emily Bagarukayo[1] | Irene Arinaitwe[1] | Benedict Oyo[2] | Gilbert Maiga[1] | Kenneth Watiti[1]

[1]Makerere University, Kampala, Uganda | [2]Gulu University, Gulu, Uganda

Correspondence: Emily Bagarukayo (ebagarukayo@gmail.com)

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ABSTRACT

The onset of the Covid-19 pandemic triggered a global political, economic, and social re-calibration, with several companies worldwide opting to retain employees through online work for critical activities. Uganda, just like the rest of the world, implemented restrictions on human movement, necessitating the decongestion of workspaces and the adoption of social distancing measures in various organizations. Telecommuting enables employees to work remotely through online systems. Makerere University, in collaboration with Gulu University, was chosen as the case study. The aim of the study was to assess readiness for telecommuting and develop an Ecosystem for telecommuting (ECOSYSTEL) to enable business continuity at Higher Education Institutions (HEIs). Assessing the readiness of telecommuting involved evaluating multiple factors to determine if the institution is prepared to implement and sustain telecommuting effectively. A mixed methods study design was adopted, and both qualitative and quantitative data were collected from staff and students. The findings highlighted the flexibility in work schedules as one of the prominent advantages of telecommuting. Various tools, such as learning management systems, communication platforms, human resource systems, and attendance and scheduling systems, were identified as supportive aids for telecommuting. The results also indicated a notable increase in productivity during telecommuting while revealing a lack of awareness of telecommuting and its policies. These findings served as the requirements for developing the ECOSYSTEL platform that integrates systems and tracks telecommuting. The platform was tested at the two participating universities. The study recommends continuous sensitization of the ECOSYSTEL platform to increase its usage, thereby reducing interruptions in higher education workflows, since the platform is customizable according to the respective work processes.

1 | Introduction

The global onset of the COVID-19 pandemic in January 2020 prompted a widespread recalibration in political, economic, social, and educational spheres. In Uganda, the introduction of telecommuting in the education sector during the pandemic was a new experience for academic and managerial staff alike, catching schools and universities off guard. Initially viewed as a temporary adjustment, it became evident over time that a significant and lasting transformation toward digitalization and hybrid communication methods had occurred, presenting challenges in adapting to this new paradigm. The shift underscored the need for education institutions to swiftly integrate technology into their operations and teaching methods to effectively navigate future disruptions. Telecommuting has since then become prevalent in Uganda, prompting higher educational institutions (HEI) to adopt telecommuting solutions for business continuity and employee safety. Telecommuting in higher education involves working outside a traditional on-campus office setting, with communication primarily conducted through computer-based

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technologies with colleagues and students (Nilles 1975). According to the International Labour Organisation (Eurofound and the International Labour Office 2017) telecommuting offers flexibility in work arrangements, allowing employees to balance professional and personal responsibilities. Telecommuting leverages information and communication technologies (ICTs) such as video conferencing, project management software, and communication platforms to facilitate communication, collaboration, and task completion without the necessity of physical presence in a centralized workspace. The importance of telecommuting in HEI cannot be underrated because conventional universities grapple with limitations in physical space and need to promote a better work-life balance for both faculty and students (Percival and Muirhead 2011). In addition, the pandemic fueled the need for telecommuting in HEI. Thus, a number of studies have been conducted on telecommuting in HEI. Despite the benefits of telecommuting, such as offering flexibility and continuity during unprecedented events such as the COVID-19 pandemic, its adoption in many organizations has been accompanied by several challenges. Simut et al. 2021 analyzed the challenges and opportunities of telecommuting in the school system. In their study, they found that fatigue, anxiety, lack of adequate tools, lack of niche digital skills, poor familiarity with e-learning platforms, and lack of adequate devices for online education do not automatically cancel the prospect of sustainability and efficiency for online education. Thus, their study points to a need for innovative tools to support e-learning and telecommuting by faculty. In response, these institutions had to swiftly seek IT solutions to facilitate the continuation of education in the absence of prior digitalization efforts (López Peláez et al. 2021). Furthermore, the lack of clear telecommuting policies and guidelines further complicates the adoption process, as organizations grapple with ensuring accountability, productivity, and work-life balance for remote employees (Harris and Jones 2020). Therefore, the study aimed at *assessing the readiness for telecommuting in higher education institutions in Uganda and providing a platform to enhance telecommuting adoption in HEIs*. Assessing the readiness of telecommuting involved evaluating multiple factors to determine if the institution is prepared to implement and sustain telecommuting effectively. Assessing readiness required comprehensive evaluation across technological, human, and organizational domains. Ensuring these factors are aligned enhances the likelihood of successful telecommuting implementation. The following research questions were investigated in line with this aim: *(i) what are the indicators of telecommuting readiness among HEIs in Uganda? (ii) what system can be used for telecommuting in HEIs?* This research therefore makes a contribution to the body of knowledge in telecommuting by examining the readiness of HEIs to adopt telecommuting. In addition, the research contributes to practice through a platform called ECOSYSTEL that integrates systems and tracks productivity within the higher education sector. The research used a mixed methods approach to realize the objectives.

2 | Literature Review

This section presents a review of literature on telecommuting in HEIs, telecommuting policies, guidelines, and procedures, and platforms for supporting telecommuting in HEIs.

2.1 | Telecommuting in HEIs

Telecommuting, teleworking, or telecommuting is a work arrangement where employees perform their job tasks from a location outside of the traditional office environment, typically from home or another remote location (Illegems and Verbeke 2004). This setup relies heavily on technology such as computers, internet connectivity, and communication tools to facilitate seamless collaboration and productivity (Allen et al. 2015). Telecommuting offers employees greater flexibility in managing their work-life balance while allowing employers to potentially reduce overhead costs associated with maintaining physical office spaces (Bloom et al. 2021).

In the realm of HEI, telecommuting has become increasingly prevalent, especially with the advancements in digital learning platforms and virtual collaboration tools. In the Ugandan context, telecommuting has been welcomed by staff and students since 2020. Professors and academic staff can conduct lectures, seminars, and meetings remotely, enabling access to education for students regardless of their geographical location (Houlden and Veletsianos 2019). The graduate students at the University prefer having classes online due to the convenience of studying while they drive home or while in their offices. Moreover, administrative tasks such as admissions, student counseling, and research collaboration can also be efficiently carried out through telecommuting, enhancing the operational efficiency of HEIs. Today, anyone can access information on the website relating to their studies.

2.2 | Benefits of Telecommuting in HEIs

The benefits of telecommuting for HEIs are multifaceted. For example, Ng analyzed the benefits and challenges of telecommuting by staff and their families. The study found that monitoring and evaluating performance should be based on results rather than physical presence or visibility. There is a need to ensure adequate and appropriate ICTs are equipped in home offices, and effective training and support are provided, ensuring that academics telecommuting have an adequate, safe, and healthy work environment at home.

Secondly, it provides greater flexibility for both faculty and staff, allowing them to tailor their work schedules to accommodate personal commitments, leading to increased job satisfaction and retention (Lupu 2017). The staffs at the university prefer having classes from home, especially in the evenings. Additionally, telecommuting can result in cost savings for HEIs by reducing expenses related to office space, utilities, and commuting allowances (Bloom et al. 2021). In 2022, when there was a fuel crisis, telecommuting came in handy for us. Furthermore, telecommuting promotes inclusivity by breaking down geographical barriers, enabling HEIs to recruit talent from diverse backgrounds and geographical locations, thereby enriching the intellectual capital of the institution (Houlden and Veletsianos 2019). People from different walks of life can access any content from anywhere, which promotes digital inclusion.

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2.3 | Challenges of Telecommuting in HEIs

The adoption of telecommuting by HEIs during the pandemic posed several challenges. One notable challenge is the digital divide, as not all employees have equal access to the necessary technology and internet connectivity for telecommuting (Alipour et al. 2021). Also, instructors experience heightened stress during telecommuting, as they are required to enhance the quality of education by integrating both traditional and interactive teaching methods, while also exploring new tools to engage students (Pressley and Ha 2021). In addition, vocational schools encountered significant challenges in delivering education due to their focus on practical, hands-on professions such as electricians and cosmetologists. Many institutions faced difficulties in ensuring equitable access to necessary technology and resources for all staff and students, exacerbating existing disparities in digital literacy and access to education. It was not easy to access technology due to the affordability of infrastructure and electricity in some parts of the country. Moreover, maintaining the quality of education and student engagement in a remote setting proved challenging for educators accustomed to traditional classroom environments. It can be challenging to monitor the students, especially the younger ones. Concentration may be difficult, and hence the need for blended learning sometimes. Additionally, concerns regarding data security and privacy arose with the increased reliance on online platforms for communication and collaboration. We need to use software and systems that are secure. Despite these challenges, the rapid adoption of telecommuting by HEIs during the pandemic underscored the importance of flexible work arrangements and the need for continuous innovation in the delivery of education.

2.4 | Telecommuting Policies, Guidelines and Procedures in HEIs

Implementing robust policies, guidelines, and procedures for telecommuting is essential for any organization considering telecommuting arrangements. General policies typically cover areas such as work hours, communication expectations, and data security protocols (Allen et al. 2015). These policies ensure clarity for employees regarding their responsibilities and availability while working remotely. Additionally, organizations establish procedures for accessing company systems and data securely, often requiring the use of Virtual Private Networks (VPNs) and multifactor authentication. Guidelines for setting up a home office environment conducive to productivity, including ergonomic considerations and internet connectivity standards, are also common components of telecommuting policies. In Uganda, such guidelines are not available; all one needs is to have an internet connection and electricity, and they can telecommute. Moreover, organizations may outline procedures for equipment provision, reimbursement for expenses related to telecommuting, and reporting technical issues to support employees in their telecommuting endeavors (Allen et al. 2015). In Uganda, we are not compensated to telecommute; one can use the money saved on transport to buy internet bundles; otherwise, they are free to commute to the office now that the pandemic is over.

In the context of HEIs, specific telecommuting policies, guidelines, and procedures are developed to address the unique needs of academic environments. HEIs establish policies regarding faculty engagement in online teaching, including expectations for course design, delivery methods, and student interaction. Guidelines for the use of learning management systems (LMS) and educational technology tools are also outlined to ensure consistency and quality in online course delivery (Houlden and Veletsianos 2019). Furthermore, procedures for supporting students in accessing online resources, submitting assignments, and participating in virtual discussions may be established to promote student success in remote learning environments. HEIs may also implement policies addressing the mental health and well-being of faculty and staff engaged in telecommuting, providing resources for stress management, work-life balance, and social support (Houlden and Veletsianos 2019). At Makerere University, we have a general policy; we need to develop some of these.

HEIs in Uganda, for example, have developed telecommuting policies specific to their context. These policies address issues such as access to technology and internet connectivity, which may be limited in certain regions. Additionally, guidelines for supporting faculty and students in navigating online learning platforms and addressing technical challenges are established to ensure equitable access to education. Furthermore, procedures for monitoring and evaluating the effectiveness of telecommuting arrangements are implemented to continuously improve telecommuting practices in HEIs. This is vital because productivity needs to be monitored and checked. By developing tailored telecommuting policies, guidelines, and procedures, HEIs in Uganda can effectively navigate the challenges of remote learning and promote academic continuity in times of disruption.

2.5 | Platforms for Supporting Telecommuting in HEIs

Telecommuting relies heavily on digital platforms that facilitate communication, collaboration, and task management. Worldwide, some of the most commonly used platforms for telecommuting include communication tools such as Slack, Microsoft Teams, and Zoom, which enable real-time messaging, video conferencing, and file sharing. Project management platforms like Trello and Asana are also popular choices for organizing tasks and tracking progress remotely. These platforms include features that streamline telecommuting processes and enhance productivity for teams operating across different locations and time zones.

During the COVID-19 pandemic, several platforms saw a surge in popularity as organizations quickly adapted to telecommuting requirements. For instance, video conferencing platforms like Zoom experienced unprecedented growth, becoming ubiquitous tools for virtual meetings, webinars, and online classes (Bloom et al. 2021). Similarly, collaborative document editing platforms such as Google Workspace (formerly G Suite) and Microsoft Office 365 became essential for remote teams to collaborate on documents, spreadsheets, and

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presentations in real time. These platforms facilitated seamless communication and collaboration, enabling businesses and educational institutions to maintain continuity amid the pandemic-induced disruptions.

In HEIs in Uganda, telecommuting platforms have played a crucial role in ensuring academic continuity and administrative efficiency. While platforms like Zoom and Microsoft Teams are commonly used for virtual lectures, meetings, and student consultations, locally developed solutions such as E-LMS tailored to the specific needs of Ugandan HEIs have also gained traction. Additionally, mobile-based communication platforms like WhatsApp have been instrumental in facilitating informal communication and peer collaboration among students and faculty members. Despite challenges such as limited internet connectivity and infrastructure, the adoption of telecommuting platforms in HEIs in Uganda has enabled educators and students to overcome geographical barriers and continue academic activities remotely.

2.6 | Assessing Readiness

Assessing the readiness of telecommuting at HEIs involves evaluating multiple factors to determine if the institution is prepared to implement and sustain telecommuting effectively. It requires comprehensive evaluation across technological, human, and organizational domains. Ensuring these factors are aligned enhances the likelihood of successful telecommuting implementation.

Assessing readiness helps identify gaps in infrastructure, skills, or cultural attitudes that hinder telecommuting adoption (Weiner 2009). For example, an institution with ample technological infrastructure but low staff motivation may encounter resistance, reducing the likelihood of successful implementation. Conversely, high motivation without proper infrastructure can lead to frustration and failure.

2.6.1 | Frameworks and Assessment Tools

Several frameworks assist in the systematic assessment of readiness for telecommuting. These include the Technology-Organization-Environment (TOE) framework, which evaluates technological, organizational, and environmental factors (Tornatzky and Fleischer 1990). HEIs can adapt such models to identify strengths and gaps. Yang et al. (2022) highlighted that universities with robust digital infrastructure and proactive policies exhibited higher telecommuting readiness during the COVID-19 pandemic. Ojo and Oladipo (2020) suggest that readiness is contingent on leadership commitment and institutional culture.

2.6.2 | Readiness Theory and Telecommuting

Readiness theory provides a useful framework for understanding whether an organization, workforce, or community is prepared to effectively implement telecommuting. It emphasizes that successful telecommuting adoption depends on both structural and psychological factors, such as infrastructure, technology, organizational culture, and individual attitudes (Weiner 2009).

In the context of telecommuting, readiness refers to the extent to which an organization or HEI possesses the necessary components to support telecommuting. The key factors for assessing readiness include the technological infrastructure, digital skills and training, organizational policies and support, cultural and attitudinal readiness at the HEI.

Technological Infrastructure is needed for effecting telecommuting. Wang and Li (2021) highlighted that technological infrastructure and organizational culture are critical determinants of telecommuting readiness in universities, which include the availability of reliable internet, secure networks, and appropriate hardware and software platforms for remote teaching, research, and administrative tasks. There is a need for reliable internet, hardware, and secure software systems (Chung et al. 2021). Telecommuting cannot function effectively without adequate technological readiness. HEIs must evaluate whether their current IT systems can support large-scale remote access securely.

Clear organizational policies concerning telecommuting expectations, data security, privacy, and performance evaluation are crucial (Ojo and Oladipo 2020). The institution's readiness depends on having these policies and support in place. Clear organizational policies, managerial support, and a culture that encourages and trusts telecommuting are required (Wang and Li 2021). These foster motivation and willingness among staff.

According to Chung et al. (2021) faculty and staff need sufficient digital literacy to effectively use telecommuting tools. The authors further state that managerial support is essential for effective telecommuting arrangements, especially in developing countries. Lundberg and Turel (2020) state that technical and soft skills are required to operate remotely. An assessment should include skills gap analysis and plans for training. There is a need for skilling and training for staff in digital literacy and self-management, among others.

The employees' and management's mindset, beliefs, and perceptions regarding telecommuting's effectiveness and benefits (Bailey and Kurland 2020). The acceptance and support for telecommuting among leadership, faculty, and staff influence success. Resistance or skepticism can hinder adoption of telecommuting. Surveys or interviews can gauge the attitudes of the staff and students. There is a need for cultural and attitudinal readiness at the HEI.

The availability of technical support, mental health resources, and administrative guidance significantly impacts readiness (Wang and Li 2021). The institution must have support systems and resources.

Weiner (2009) emphasizes that readiness is multi-dimensional, involving belief in the capacity to implement change, perceived value of the change, and contextual factors. This framework aligns closely with the variables influencing telecommuting adoption, such as technology acceptance models (Davis 1989) and organizational support theory (Eisenberger et al. 1986).

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3 | Materials and Methods

This study employed a mixed methods approach to gather both qualitative and quantitative data. The combination of qualitative and quantitative data in survey research offers a comprehensive understanding of the phenomenon under investigation, enhancing the validity and reliability of the findings (Babbie 2020).

3.1 | Case Description

Makerere University, situated in Kampala, Uganda, stands as one of Africa's oldest and most esteemed institutions of higher learning, tracing its roots back to its establishment in 1922 (Higher Times Education 2024). Makerere University boasts a substantial workforce (3000) comprising faculty members, researchers, and administrative staff, all integral to the university's academic and operational functions (Alliance 2024). Makerere University has made significant strides in fortifying its technological infrastructure to bolster teaching, learning, and research endeavors. Modernization efforts include outfitting classrooms and lecture halls with multimedia capabilities and SMART classrooms to facilitate interactive and immersive learning experiences. Moreover, the university has expanded its digital repository, featuring online databases, e-books, and scholarly journals, augmenting research initiatives. Makerere University has also ensured widespread internet connectivity throughout the campus and delivers comprehensive IT support services to students and staff alike. Embracing contemporary educational paradigms, the university has embraced e-learning platforms and virtual learning environments to accommodate flexible learning modalities, including distance education and blended learning approaches.

Gulu University, situated in Northern Uganda, stands as a prominent institution of higher education, deeply rooted in the fabric of the region's academic landscape. Established to address the educational needs of the northern region, Gulu University has emerged as a cornerstone of learning and development. Gulu University boasts a sizable workforce (560) comprising dedicated faculty members, researchers, and administrative personnel (Gulu University Uganda 2021). These professionals play integral roles in advancing the university's academic mission, fostering a vibrant scholarly environment. Gulu University offers a wide array of services to its students and staff, ranging from academic support and counseling to career guidance and extracurricular activities. The university's commitment to holistic student development is underscored by its emphasis on inclusivity and support for individuals from diverse backgrounds. Gulu University has made significant strides in enhancing its technological infrastructure to meet the evolving needs of its academic community. Modernization efforts have included equipping classrooms and laboratories with state-of-the-art facilities to facilitate interactive learning experiences. Additionally, the university has expanded its digital resources, providing students and staff with access to online databases, e-books, and scholarly journals. Gulu University has also embraced e-learning platforms and virtual learning environments, allowing for flexible and innovative approaches to education.

3.2 | Sampling Procedure

The study adopted a purposive sampling technique. Purposive sampling is a non-probability sampling technique where researchers deliberately select participants based on specific characteristics or criteria that align with the research objectives. Thus, in study, purposive sampling was used to recruit participants who had been involved in telecommuting in HEI of Gulu and Makerere University during COVID-19. In addition, the respondents were expected to share their opinions and experiences about the need for an ecosystem for telecommuting during the COVID-19 lockdown. This sampling technique has been employed in various researches on telecommuting. For example, Khairudin and Aziz (2020) used purposive sampling to select participants in their study on the correlation between telecommuting and work-life balance. Also, Sholesi et al. (2023) used purposive sampling to test the commitment of telecommuting employees during COVID-19. Moreover, purposive sampling technique is one of the most cost-effective and time-effective sampling methods available. Thus, purposive sampling was deemed relevant in this study because of its wide applicability.

3.3 | Study Participants and Sample Size

The study recruited participants from both Makerere University and Gulu University. This selection was deliberate, aiming to facilitate a comparison of faculty experiences between a premier public university with a robust infrastructural foundation and a young public university that is actively developing its e-learning infrastructure.

A total of 400 respondents were targeted for the study. However, 342 (~85.5%) responded to the study, a response rate that was considered sufficient to represent the opinions of the wider university staff and student community. The sample size was calculated according to the formula of Cochran of 1977—a representative sample is given by 384.16 respondents. The researchers determined the sample size as 342, and this enabled the team to decide on the number of participants in relation to the total population of each category as shown in Table 1.

3.4 | Data Collection

The primary data collection for this study employed two methods: an online survey questionnaire administered via Open Data Kit (ODK), and key informant interviews. Qualitative data was collected through interviews with technical persons from the ICT directorate to determine infrastructure readiness for telecommuting as well as to establish the requirements for a telecommuting system. Key informant interviews provided in-depth insights from individuals with specialized knowledge or experience, allowing researchers to delve deeper into specific aspects of telecommuting, such as organizational policies and technological infrastructure (Patton 1980). The key informant interviews were utilized to gather insights from selected lecturers and university administrators regarding the necessity of the Ecosystem for telecommuting (ECOSYSTEL) at Makerere University.

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TABLE 1 | Study participants.

No.	Category of participants	Total population
1.	IT support—Gulu University	6
2.	IT support—Makerere University	15
3.	HR Makerere University	35
4.	ODEL	10 support, 12 academic staff
5.	Graduate Students SCIT	240
6.	Undergraduate students SCIT	4000
7.	Gulu University graduate students	13
8.	Gulu University Lecturers and admin staff	14
9.	SCIT staff Lecturers	65

A questionnaire survey was used to collect data through closed-ended questions in the questionnaire with predefined response options, enabling researchers to quantify readiness for telecommuting in the context of users (university staff and students), enabling systems, and enabling policies. The applicability of online survey questionnaires and key informant interviews in this telecommuting study lies in their ability to capture diverse perspectives and experiences remotely. Online survey questionnaires offer flexibility and accessibility, enabling widespread participation regardless of geographical location, making them suitable for investigating telecommuting practices across dispersed populations (Shih and Fan 2008). The deployment of an online survey questionnaire facilitated convenient participation for respondents.

3.5 | Data Analysis

Subsequently, the collected data underwent initial cleaning to ensure clarity and completeness, followed by coding prior to analysis. Quantitative data was analyzed using STATA through descriptive statistics, while thematic content analysis was employed for qualitative data analysis. This comprehensive approach allowed for the exploration and synthesis of meanings and implications derived from the study, as well as the examination of participants' responses to inform the design of the model for the ECOSYSTEL.

By employing both methods, researchers obtained a holistic understanding of telecommuting dynamics within HEIs like Makerere University.

3.6 | Ethical Considerations

The study diligently obtained participants' consent and prioritized their anonymity and confidentiality by abstaining from including their names on the questionnaires. Permission to conduct the study was individually sought from all respondents. It is imperative to note that this study did not involve any human or animal subjects directly. In alignment with ethical standards, respondents were explicitly assured of the utmost confidentiality and anonymity throughout the research process.

Specifically, in this study on telecommuting within higher institutions of learning, ensuring participants' consent and safeguarding their anonymity and confidentiality was paramount, especially considering the potentially sensitive nature of the information shared. Obtaining explicit permission from individual respondents and institutional authorities prior to data collection maintains ethical integrity and fosters trust between researchers and participants. By assuring confidentiality and anonymity, researchers upheld participants' privacy rights, encouraging open and honest responses essential for obtaining accurate insights into telecommuting experiences and practices.

4 | Results

Two sets of results are presented corresponding with the two research questions. The first set of results provides answers to the first question: *what are the indicators of telecommuting readiness among HEIs in Uganda*? The second set of results answers the second question: *what system can be used to enable telecommuting?*

4.1 | Readiness for Telecommuting

A survey of 345 participants was carried out to investigate the four categories of readiness including infrastructure, enabling systems, enabling policies, and users.

4.1.1 | Educational Background and Designation of Participants

There was a diverse representation of age groups among the study participants, providing insights into the generational composition of individuals engaging in telecommuting practices.

Similarly, study findings reveal a diverse educational background among the respondents, with the majority holding bachelor's degrees, constituting 39.4% of the participants. Following closely, 36.5% possessed master's degrees, indicating a significant portion of highly educated individuals in the sample. Furthermore, 15.7% of respondents held doctoral degrees (PhDs), reflecting a notable representation of advanced academic qualifications. Additionally, a smaller percentage of participants reported holding certificates (5.5%), diplomas (1.5%), and A-level qualifications (1.5%). The study finding further shows a diverse representation of designations, with the majority identified as students, comprising 52.5% of the participants. Teaching staff constituted a significant portion of the sample at 23.8%, indicating a substantial presence of educators in the study. Additionally, 9.3% of respondents were identified as ICT personnel. Administrative staff accounted

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for 8.4% of the sample, followed by library staff at 3.8%. Support staff, lab technologists, and unemployed individuals comprised smaller percentages, at 1.7%, 0.3%, and 0.3%, respectively. The specific readiness indicators are given in the following sections.

4.1.2 | Enabling Systems

The study examined the utilization of various tools among participants engaged in telecommuting, revealing widespread adoption across different categories. Based on the findings in Table 2, LMS emerged as the most commonly used tool, with 75.4% of respondents utilizing this platform for remote learning and collaboration. Communication Systems were also prevalent, with 80.6% of participants employing these tools for remote communication and collaboration purposes. Additionally, a notable proportion of respondents reported using Human Resource systems (28.1%) for administrative tasks, while Attendance systems (41.7%) and Scheduling Systems (51.3%) were utilized for managing work schedules and tracking attendance.

4.1.2.1 | Usage of Attendance Systems. The study investigated the utilization of attendance systems among participants engaged in telecommuting, revealing diverse approaches and technologies employed for attendance management. Based on the findings in Table 3, 40.0% of respondents utilized a login/logout system for staff attendance tracking, while 52.5% utilized similar systems for monitoring students' attendance remotely. A substantial proportion of participants (61.4%) reported using manual attendance systems, indicating a reliance on traditional methods for tracking attendance in telecommuting settings. Additionally, respondents reported the use of biometric technologies, with 25.1% utilizing Facial Recognition systems and 26.8% employing Fingerprint Punch in and out systems for attendance management.

4.1.2.2 | Usage of Communication Platforms. The study investigated the usage of various communication platforms among telecommuting participants, revealing a diverse array of tools employed for remote communication and collaboration. Notably, Zoom emerged as the most widely utilized platform, with a substantial 96.3% of respondents reporting its use. Following closely, Google Meet was utilized by 87.1% of participants, highlighting its popularity for virtual meetings and discussions. Skype and Voov were also frequently employed, with 75.9% and 57.3% of respondents utilizing these platforms, respectively, for video conferencing and communication purposes. Microsoft Teams and Google Classroom were utilized by 48.5% and 30.2% of participants, respectively, indicating their roles in facilitating team collaboration and educational activities in telecommuting environments. Interestingly, WhatsApp was utilized by a smaller percentage of respondents (3.7%), suggesting its limited usage for professional communication in telecommuting settings. Study findings in relation to the platforms used by the participants are presented in Table 4.

4.1.2.3 | LMS' Usage. LMS are core to higher education teaching and learning functions. The survey found that the most highly used LMS was Moodle (91.2%), followed by Edmodo (46.7%), Blackboard (34%), and Sakai (9.8%). Since LMS's are used by both students and staff, the research also investigated the challenges faced by respondents in using the LMS and the designation and the period they have spent in the university. The results are presented in Table 5.

The results in Table 5 of Pearson's chi-square analysis examining challenges in telecommuting and their association with the participants' designation and period in the university revealed interesting findings. Regarding heavy traffic, there was a significant association with the participants' designation ($\chi^2 = 15.717$, $p < 0.05$), suggesting that individuals with different designations experienced varying levels of challenges related to heavy traffic while telecommuting. However, heavy

TABLE 2 | Platforms for telecommuting.

Tool	Frequency	Percent
LMS (Learning Management Systems)	260	75.4%
Communication Systems	278	80.6%
Human Resource system	97	28.1%
Attendance system	144	41.7%
Scheduling System	177	51.3%
Total	**345**	

TABLE 3 | Attendance systems used.

Attendance system	Frequency	Percent
Login/Logout for Staff	118	40.0%
Students' Attendance	155	52.5%
Manual System	181	61.4%
Facial Recognition	74	25.1%
Fingerprint Punch in and out	79	26.8%
Total	**295**	

TABLE 4 | Communication tools used.

Communication platform	Frequency	Percent
Zoom	284	96.3%
Skype	224	75.9%
Microsoft Teams	143	48.5%
Google Meets	257	87.1%
WhatsApp	11	3.7%
Voov	169	57.3%
Google Classroom	89	30.2%
Total	**295**	

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TABLE 5 | Designation, period in university and challenge in using LMS.

	Pearson's chi-square	
Challenge	**Designation**	**Period in the university**
Heavy traffic	15.717	0.246
Unfriendly user interface	21.235	11.492[a]
Unpredictable technological changes	20.282	3.704
Limited skills in using the LMS	24.444[b]	10.001[b]
Lack of proper integration with other systems	17.236	1.351

[a]Correlation is significant at the 0.01 level (2-tailed).
[b]Correlation is significant at the 0.05 level (2-tailed).

traffic was not significantly associated with the period spent in the university ($\chi^2 = 0.246$, $p > 0.05$), indicating that the duration of time spent at the university did not influence the experience of heavy traffic during telecommuting. In terms of an unfriendly user interface, there was a significant association with both the participants' designation ($\chi^2 = 21.235$, $p < 0.01$) and their period in the university ($\chi^2 = 11.492$, $p < 0.01$). This suggests that both the job role of the participants and their length of time at the university played a role in experiencing challenges related to unfriendly user interfaces while telecommuting. Similarly, limited skills in using the LMS showed a significant association with both designation ($\chi^2 = 24.444$, $p < 0.05$) and the period in the university ($\chi^2 = 10.001$, $p < 0.05$), indicating that individuals with different job roles and lengths of time at the university experienced varying levels of difficulty with LMS usage during telecommuting. On the other hand, unpredictable technological changes and lack of proper integration with other systems did not show significant associations with either designation or period in the university, suggesting that these challenges were relatively consistent across different participant groups.

4.1.3 | Enabling Policies

On the issue of enabling policies for telecommuting, 91% of the respondents reported a lack of knowledge of any policies to support telecommuting or telecommuting. They noted that even related telecommuting activities like e-learning, for which there are supporting policies, were silent on how productivity can be tracked. Therefore, for the continuity of higher education in Uganda during the Covid-19 lockdown, the regulator, National Council for Higher Education (NCHE), introduced the Emergency Open and Distance e-learning policy. The survey noted that the policy gaps in telecommuting are overwhelming, and hence a number of policy recommendations are given in a later section of this paper.

TABLE 6 | Benefits of telecommuting.

Benefit	**Frequency**	**Percent**
Less absenteeism	129	37.4%
More flexible work schedule	279	80.9%
Less commuting	150	43.5%
More productivity	185	53.6%
More control over your life	241	69.9%
Total	**345**	

4.1.4 | User Readiness

User readiness was premised on the ability to use online systems and all the participants had interacted with at least one online system. To further explore user readiness for telecommuting, the study sought to investigate its benefits. Table 6 presents findings on the benefits of telecommuting, based on responses from 345 participants. This study sought to explore the perceived advantages of telecommuting among the study participants. The results offer insights into the potential benefits of telecommuting, including reduced absenteeism, increased flexibility in work schedules, minimized commuting time, enhanced productivity, and greater control over one's life. Understanding these benefits is crucial for organizations and policymakers aiming to create supportive environments for telecommuting arrangements.

The study findings in Table 6, based on responses from 345 participants, reveal several notable benefits associated with telecommuting. A significant proportion of respondents highlighted less absenteeism (37.4%), indicating a reduction in the frequency of missed workdays. Moreover, a substantial majority emphasized the advantage of a more flexible work schedule (80.9%), enabling individuals to adapt their work hours to better suit personal needs. Additionally, a considerable percentage cited less commuting (43.5%) as a favorable aspect of telecommuting, contributing to time and cost savings. Furthermore, a majority of respondents reported experiencing increased productivity (53.6%) while telecommuting, suggesting a positive impact on work output. Lastly, a notable percentage (69.9%) expressed that telecommuting provided them with more control over their life, underscoring the perceived autonomy and flexibility associated with telecommuting arrangements.

4.1.5 | Benefits of Telecommuting Versus Years of Experience

Bivariate analysis was carried out on the benefits that respondents derive from telecommuting and the years of experience to investigate whether there is a relationship between the two, and the results are presented in Table 7.

The results of Pearson's chi-square analysis revealed statistically significant associations between telecommuting and several benefits. Specifically, telecommuting was significantly

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TABLE 7 | Benefits of telecommuting and years of experience.

Benefit	Pearson's chi-square
Less absenteeism	11.025[b]
More flexible work schedule	14.151[a]
Less commuting	31.868[a]
More productivity	9.903[b]
More control over your life	1.558

[a]Correlation is significant at the 0.01 level (2-tailed).
[b]Correlation is significant at the 0.05 level (2-tailed).

associated with less absenteeism ($\chi^2 = 11.025$, $p < 0.05$), indicating that employees who engaged in telecommuting reported lower rates of absenteeism compared to those who did not telecommute. Additionally, a more flexible work schedule was significantly linked to telecommuting ($\chi^2 = 14.151$, $p < 0.01$), suggesting that telecommuters experienced greater flexibility in their work hours compared to non-telecommuters.

Moreover, telecommuting was significantly associated with less commuting ($\chi^2 = 31.868$, $p < 0.001$), highlighting that individuals who engaged in telecommuting experienced reduced commuting times or distances compared to those who did not telecommute. Furthermore, the analysis revealed a significant association between telecommuting and increased productivity ($\chi^2 = 9.903$, $p < 0.05$), indicating that telecommuters reported higher levels of productivity in their work compared to non-telecommuters. However, no significant association was found between telecommuting and having more control over one's life ($\chi^2 = 1.558$, $p > 0.05$), suggesting that telecommuting did not significantly impact individuals' perceived control over their lives.

4.1.6 | Infrastructure Readiness

Interviews with ICT directorate staff were used to establish infrastructure readiness. The interviews targeted directorate heads and, through their recommendations, other staff members. The interview themes were the following:

a. Application server specifications both at the institution and on the cloud

   It was found that the institutional reservoir and cloud resources, that is, server models, operating systems, processing power, memory, and storage, were adequate for implementation of the ECOSYSTEL.

b. The applications run on the servers

The applications include web servers like Apache and Nginx, application servers like Tomcat and WebLogic, and database servers like MySQL and PostgreSQL. The others are file servers, mail servers, DNS servers, DHCP servers, print servers, virtual machine servers, and proxy servers.

c. Other resources available for the immediate future expansion

The shared bandwidth at Makerere University was 5GB against a student population of about 40,000 students, while that of Gulu University was 200Mbps against a student population of about 4,500.

d. Internet bandwidth growth trends versus projected demand level

During Covid-19, the telecommunication companies offered zero rating for e-learning websites in Uganda, and the respective institutions offered a modest internet bandwidth allowance for their teaching staff.

4.2 | ECOSYSTEL Platform

The second set of results provided requirements for the ECOSYSTEL integrative platform for telecommuting and was used for the design, development, testing, and validation of the platform.

4.2.1 | Requirements Elicitation

These system requirements were determined from the participants, and the different categories of users for the ECOSYSTEL were identified: system administrators, top management, administrative staff, academic registrar, lecturers, library staff, human resource staff, library staff, and students. Functional and non-functional requirements were established as contained in Appendix A. Essentially, ECOSYSTEL is an integrative platform that comprises pre-integrated systems for appointment scheduling, communication management, e-learning (Moodle), institutional repository (DSpace) and an activity tracking module. These are presumed to be cross-cutting in telecommuting, that is,

a. An appointment module whereby staff's physical and telecommuting schedules are accessible online. This enables prospective clients to use the schedule for a physical or remote engagement with staff as applicable.

b. A communication module for internal and external file exchanges, a module using web-based technologies to securely share sensitive documents remotely.

c. A pre-integrated module with Moodle and DSpace open-source systems to demonstrate the integrative capacity of ECOSYSTEL.

d. A tracking module for human resource departments to verify remote activities by telecommuting staff.

The integrative module is available for integrations with other existing systems at the university to holistically support telecommuting.

4.2.2 | Design

ECOSYSTEL is built on a three-tier architecture. At the base is the database tier, consisting of the database management system that manages user roles to create, delete, modify, and query the

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relational tables. On top of the database tier is the complex middle tier (backend), which contains most of the application logic and communicates data between the other tiers (database and application layers). On top is the client tier (application layer), where users interact with the application user interface via web browser software.

The most unique feature of ECOSYSTEL is an applications programming interface (API) adapter component which enables integration of different applications API endpoints in an institution adopting the system. The adapter component is secured using JSON Web Tokens (JWT) to securely communicate between the backend component application logic and the existing institutional applications APIs. The adapter component also configures a single sign-on (SSO) feature that enables users to login once and access all applications listed under the user's credentials. Figure 1 gives an overview of ECOSYSTEL design corresponding with the highlights given here.

As shown in Figure 1, the firewall is used to filter any malicious activity from the user before submitting a request to the server. It provides an additional layer of security, ensuring that the SSO feature is protected from becoming a single point of failure.

4.2.3 | ECOSYSTEL Development

The primary output of the study is the ECOSYSTEL platform that can be accessed at https://ecosystel.net. It is a one-stop center linking all existing systems within an organization where employees are supported and productivity is easily monitored. It provides a flexible, innovative, secure, and transparent platform to enable a digital identity for the exchange of documents during telecommuting. The ECOSYSTEL version 1 leverages web-based technologies to provide a virtual workspace for telecommuting and is securely accessible by the respective users (employees and students) of HEIs. The platform offers a SSO feature that enables

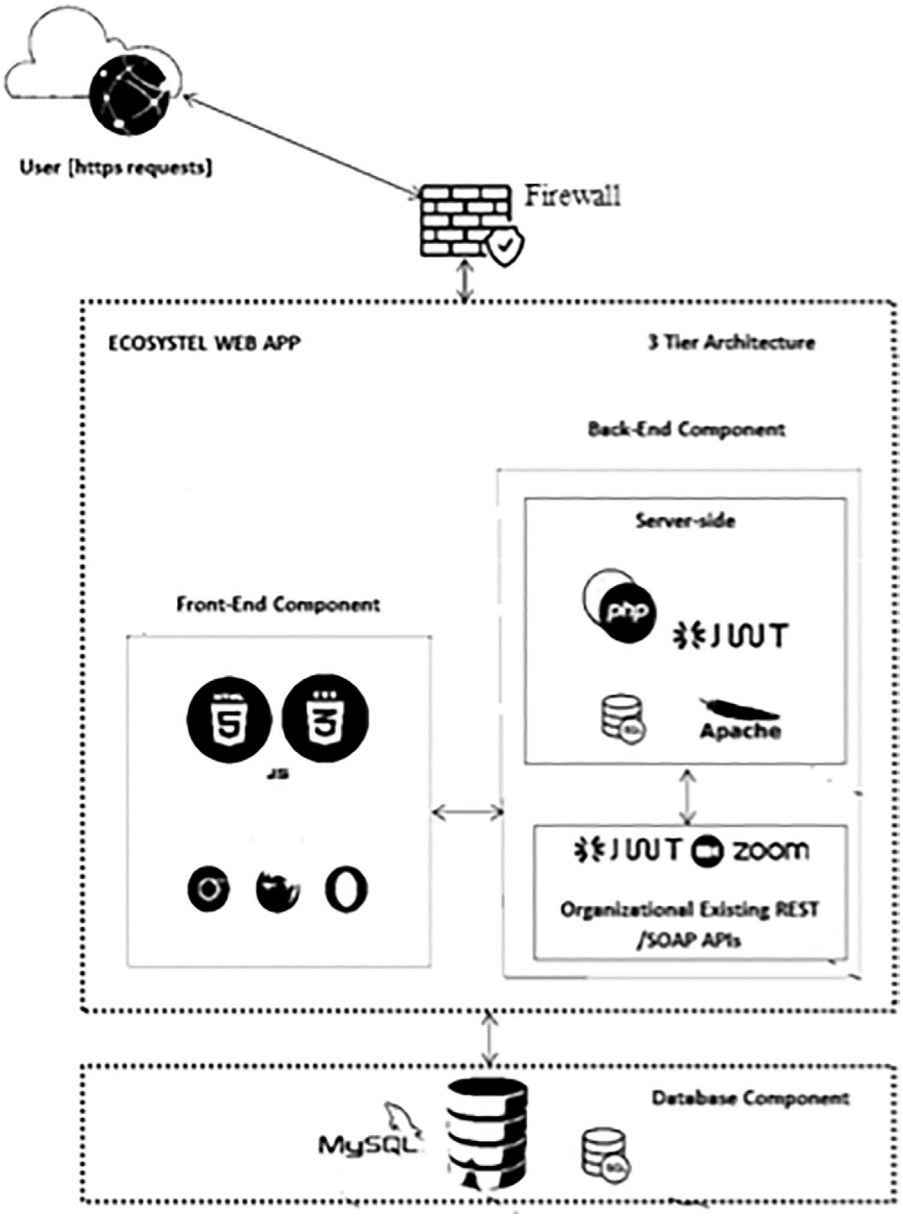


FIGURE 1 | The architecture of ECOSYSTEL.

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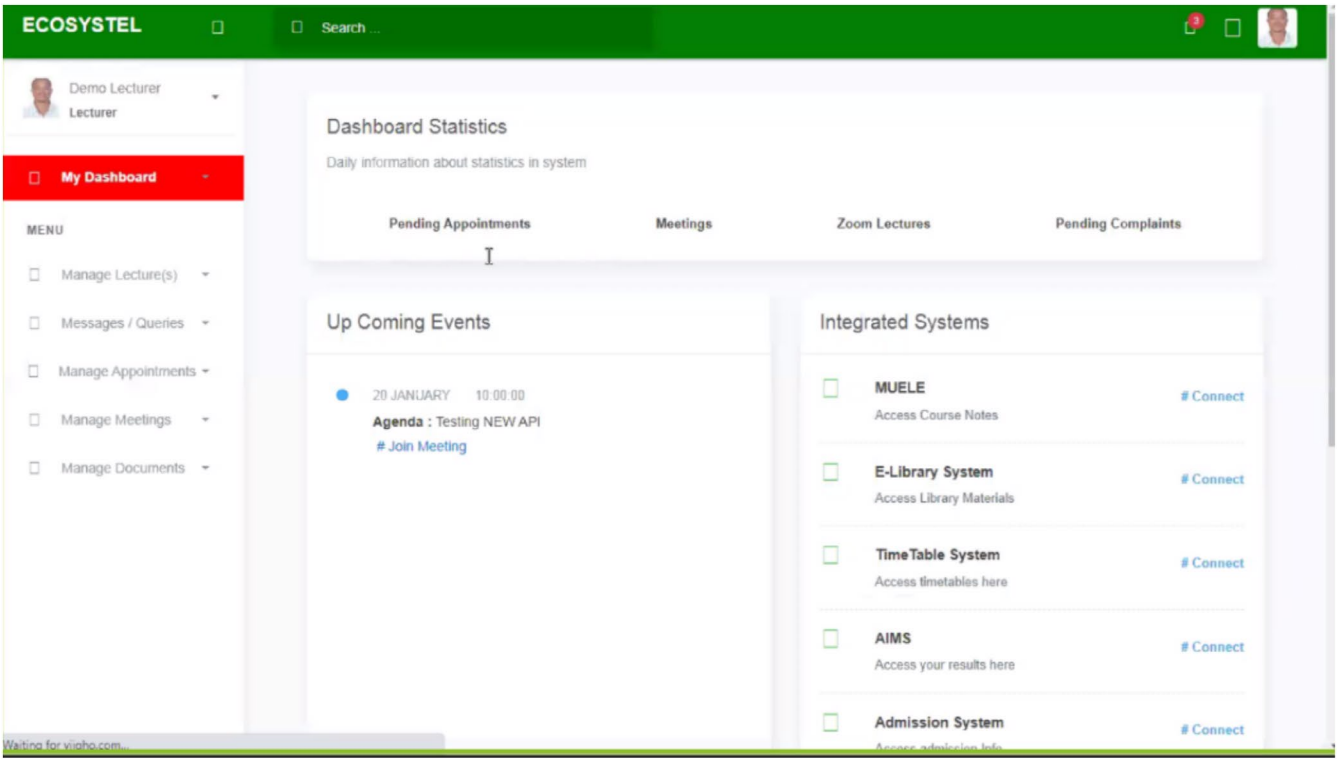


FIGURE 2 | Snapshot of integrated systems in ECOSYSTEL.

its users to access other organizations' systems for which they are eligible.

4.2.3.1 | **Sample Interface.** The sample interface in Figure 2 depicts integrations on the ECOSYSTEL platform for Makerere University. As shown, the systems integrated include e-learning system (MUELE), e-library system, timetable system, academic management system (ACMIS), and admission system. In this case, tracking telecommuting is easier for a lecturer who may perform work tasks in any of these systems.

A part from the integrated systems, the menu on the left side of Figure 2 shows cross-cutting functions (messages, meetings, appointments, documents) that the default settings in ECOSYSTEL support.

4.2.3.2 | **Advantages of ECOSYSTEL.** The key advantages of ECOSYSTEL are the host of pre-configured features and additional functions achieved through integrations with organizational systems. Specifically, these advantages are:

a. SSO feature that enables users to login once and access all applications listed under the user's credentials. It creates convenience and ease with which staff can access information from different systems without having to open different systems and recall several passwords.

b. Several default integrations with Google Apps such as: Sheet, Docs, Slides, Calendar, and Meet. These support online collaborative work.

c. Zoom platform integration, where users can easily schedule their own meetings and the ECOSYSTEL automatically sends notifications to the team and launches the meetings.

d. Generic integration end-points for flexible integration with other organizational systems.

Therefore, ECOSYSTEL provides a flexible virtual workspace where employees are supported and productivity is easily monitored.

5 | Discussion

These findings from the study highlight the varied educational attainment levels among the respondents, emphasizing the importance of considering educational diversity in understanding telecommuting dynamics and tailoring support mechanisms to accommodate the unique needs of individuals across different academic backgrounds. The low number of ICT personnel underscores the importance of technology-related roles in the context of telecommuting. The findings underscore the integral role of technology in supporting telecommuting practices, with various tools facilitating seamless communication, collaboration, and administrative tasks in telecommuting environments. The findings highlight the varied approaches to attendance tracking in telecommuting environments, ranging from manual methods to advanced biometric technologies, reflecting the adaptability of attendance systems to diverse organizational needs and preferences. The findings underscore the diverse landscape of communication platforms available to telecommuters, reflecting the adaptability of technology to meet varied communication needs and preferences in telecommuting environments.

Existing telecommuting systems are not suitable for organizations with a wide scope of work like HEIs whereby an academic staff's work involves mainstream duties (teaching, research,

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supervision, community engagements) and other work such as meetings. The ECOSYSTEL platform enables tracking of work across the different types of duties by storing work in a service information database with a unique identifier once a service (type of work) is activated. It is therefore a form of smart work system that enables employees to work efficiently anywhere, anytime, beyond the conventional office work (Bednar and Welch 2020). Loh-Ludher (2007) recommends holistic monitoring of online work to determine work adequacy. Similarly, Kim (2023) argues that telecommuting should have measurable discrete outputs such as the number of online enquiries/calls received and responded to. The ECOSYSTEL platform is able to track different work done by an employee (e.g., a lecturer) by using a unique ID when an activity is invoked from the service (work) information database.

In order to track online work done across different systems, the ECOSYSTEL platform optimizes the benefits of SSO login processes. SSO is a session and user authentication service that permits a set of login credentials (username and password) to access multiple applications. It therefore overcomes the burden for employees to recall various login details (usernames and passwords) for the different systems used in the respective organization/institution. In the context of telecommuting, SSO provides the gateway to accessing remote work stored in the service information database (Mohan and Rao 2023).

While SSO is a convenience to users, it presents risks to an institution's security as it could be used as a single point of attack (Cusack and Ghazizadeh 2016). Indeed, an attacker who gains control over a user's SSO credentials is granted access to every application the user has rights to, increasing the amount of potential damage. The risks associated with SSO are overcome in the ECOSYSTEL platform by using multi-factor authentication. Another fear is the low level of computer literacy in developing countries in general, which accounts for the low adoption of systems in organizations, and integrating systems increases complexity, which may in turn decrease the already lower adoption. Since the ECOSYSTEL is optimized for HEIs, the level of computer literacy is adequate for its adoption. Where technological challenges may arise, the ICT services department within HEIs structures is capable of providing the required support.

Several factors that hinder telecommuting include technology and infrastructure limitations. According to Nashwan and Mamoun (2022), inadequate or unreliable internet connectivity, lack of necessary hardware or software, and cybersecurity concerns can impede effective telecommuting. Poor Wi-Fi can disrupt communication and productivity. Another issue that may hinder telecommuting is a lack of managerial support and trust. Lundberg and Turel (2020) state that without proper support and trust from managers, employees may face micromanagement or skepticism about their productivity, leading to decreased motivation and effectiveness. We were given adequate support by the institutions, which made the study a success. Another factor may be communication challenges. According to Bailey and Kurland (2020), telecommuting can lead to feelings of isolation and misunderstandings due to limited face-to-face interaction, which affects collaboration and team cohesion. In addition, there may be distractions at home in the form of chores, family responsibilities, and personal devices, which can reduce employees focus and productivity (Nashwan and Mamoun 2022). Some organizations may have a traditional workplace culture resistant to change, which can hinder the adoption of telecommuting practices (Lundberg and Turel 2020). For example, at Makerere University, staffs are required to sign in attendance through biometrics, and this is hindering telecommuting.

There are several factors to consider when planning for telecommuting. Nashwan and Mamoun (2022) say there is a need to check for Technology Readiness to ensure employees have access to reliable internet, necessary hardware, and secure software solutions to support telecommuting. Bailey and Kurland (2020) highlight having clear policies and expectations in order to establish guidelines on working hours, communication protocols, performance measurement, and data security to facilitate smooth operation. During the study, we got so many queries on performance measuring; these need to be cleared to avoid misunderstandings. There is a need to provide training and support to the users of the system. Telecommuting is new in some parts of the world, like Uganda, and therefore the students, lecturers, and admin staff need to be trained. Lundberg and Turel (2020) recommend providing training for managers and staff on effective telecommuting practices, technology use, and cybersecurity awareness. There is a need to foster organizational culture. Nashwan and Mamoun (2022) highlight the need to promote trust, accountability, and open communication to build a positive telecommuting environment. There is a need for work-life balance, so policies need to be incorporated to help employees balance work and personal life, preventing burnout (Bailey and Kurland 2020). Another factor to consider is monitoring and feedback. There is a need to implement systems for regular check-ins, feedback, and evaluations to ensure productivity and address concerns proactively. To plan effectively for telecommuting, we need to address technological, cultural, and managerial factors that can hinder telecommuting. We need to be ready as an organization, foster trust, have clear communication, and ongoing support to have successful telecommuting implementation.

6 | Study Limitations, Policy Recommendations, Future Work, and Conclusion

The final section below presents the limitations, policy recommendations, future work, and conclusion.

6.1 | Study Limitations

During the COVID-19 pandemic, conducting research on telecommuting within HEIs faced several challenges that impacted the study's outcomes. Firstly, the need for physical meetings to interview stakeholders and key informants became a logistical hurdle due to pandemic-related restrictions on movement and gatherings. This limitation necessitated alternative methods of data collection, such as online surveys. However, the transition to online methods faced setbacks, including low response rates and delays in data collection. Some of the respondents required extensive interpretation of the research tool, resulting in time-consuming interactions. Furthermore, despite efforts to refine the questionnaire's length, respondents still found it

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cumbersome to complete effectively. The unwillingness among selected respondents to participate in the study due to perceived busyness with other activities and the expectation of data compensation tokens from the majority of respondents introduced biases and limitations in data collection.

6.2 | Policy Recommendation

Since the study generated a knowledge and policy brief, the ECOSYSTEL supports and contributes toward evidence-based policy making. A key recommendation for policymakers is to deliberately support innovations such as this to address the widespread integration problem in Uganda by increasing access to innovations. A key recommendation for policymakers is to develop policy guidelines that aid successful implementation of telecommuting such as: Policy on gadgets (laptops, smart phones, tablets etc.) ownership for both staff and students in HEIs to enable telecommuting, Policy on internet costs and infrastructure distribution, Policy on zero rating telecommuting platforms, more especially those used in HEIs, Policy on tracking staff and students' engagements on telecommuting platforms, Change in policy on exam and coursework marks distribution now that telecommuting calls for a lot of students' involvement, Policy on authentication to ensure that the right students and staffs are accessing and using the telecommuting platform.

We appeal to Government and the relevant Ministries, Departments, and Agencies (MDAs) and the management of HEIs to adopt the policy recommendations stated above to enable staff and students in HEIs to telecommute and to deliberately support innovations such as this to address the challenges of the widespread integration in Uganda.

6.3 | Recommendations and Future Work

The research recommends continuous sensitization of ECOSYSTEL to increase its usage, thereby reducing interruptions in higher education workflows. We recommend the integration of ECOSYSTEL with existing systems at HEI to access the functionalities that are already catered. Integration of ECOSYSTEL will first be discussed with the different teams at the HEIs to ensure security during integration.

Universities need a dashboard that integrates all their systems, which the ECOSYSTEL does. We will discuss a strategy with the management to ensure 24/7 support for the system. The leading telecoms in Uganda, MTN and Airtel, zero-rated only e-learning-related platforms like MUELE and istudent.mak.ac.ug as Corporate Social Responsibility during the pandemic. Therefore, management needs to help with negotiating with service providers to have all the university domains zero-rated.

This study used Makerere University and Gulu University as case studies, but with more funding, we shall scale it to other HEIs. It is currently being customized for implementation at the universities.

Additionally, the ECOSYSTEL will allow institutions to make subscriptions for its use, as well as partnerships with other institutions for scaling up the ECOSYSTEL across the country and to other sectors like health, business, agriculture, and so on.

The government of Uganda through the relevant ministries, departments, and agencies together with the private sector, national and international development partners should support the implementation of the ECOSYSTEL in HEIs.

6.4 | Conclusion

The study aimed to assess readiness for telecommuting and develop an Ecosystem for telecommuting (ECOSYSTEL) to enable business continuity at HEIs. A mixed methods study design was adopted, and both qualitative and quantitative data were collected from staff and students. The findings highlighted the flexibility in work schedules as one of the prominent advantages of telecommuting. Various tools, such as learning management systems, communication platforms, human resource systems, and attendance and scheduling systems, were identified as supportive aids for telecommuting. The results also indicated a notable increase in productivity during telecommuting while revealing a lack of awareness regarding telecommuting and its policies. These findings served as the requirements for developing the ECOSYSTEL within HEIs that integrate systems and track telecommuting within the higher education sector. The results revealed that the different stakeholders need to be trained in order to use the ECOSYSTEL. The results point to a need for continuous sensitization of the users in order to raise awareness of the need to use the ECOSYSTEL so as to ensure continuous business activity.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Appendix A

Requirements

Functional Requirements

- Category 1: System Administrator

The systems administrator will manage User Accounts and System Settings, Data Backups, Configure integrated Systems, Manage team collaboration (using slack and Google Calendar), Events (using Google Calendar), Appointments, Meetings (Google Meet, Zoom), Task Schedules (using Google Calendar), Documents (using Google Docs, Google Sheets, Google Slide) *and* data surveys (using Google Forms—questionnaires).

- Category 2: Technical Staff

The technical staff will Manage team collaboration (using slack and Google Calendar), Events (using Google Calendar), Appointments, Meetings (Google Meet, Zoom), Task Schedules (using Google Calendar), Documents (using Google Docs, Google Sheets, Google Slide), data surveys (using Google Forms—questionnaires).

- Category 3: Top management

The top management will Manage team collaboration (using slack and Google Calendar), Events (using Google Calendar), Appointments, Meetings (Google Meet, Zoom), Task Schedules (using Google Calendar), Documents (using Google Docs, Google Sheets, Google Slide), data surveys (using Google Forms—questionnaires).

- Category 4: Administrative staff

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The administrative staff shall Manage team collaboration (using slack and Google Calendar), Events (using Google Calendar), Appointments, Meetings (Google Meet, Zoom), Task Schedules (using Google Calendar), Documents (using Google Docs, Google Sheets, Google Slide), and data surveys (using Google Forms—questionnaires).

- Category 5: Academic Registrar

The academic registrar will Manage team collaboration (using slack and Google Calendar), Events (using Google Calendar), Appointments, Meetings (Google Meet, Zoom), Task Schedules (using Google Calendar), Documents (using Google Docs, Google Sheets, Google Slide), data surveys (using Google Forms—questionnaires) and student results via integrated existing systems.

- Category 6: Lecturer

The lecturer will Manage team collaboration (using slack and Google Calendar), Events (using Google Calendar), Appointments, Meetings (Google Meet, Zoom), Task Schedules (using Google Calendar), Documents (using Google Docs, Google Sheets, Google Slide), data surveys (using Google Forms—questionnaires), Manage and schedule online Lectures, and Manage assignments and upload course materials via integrated existing LMS.

- Category 7: Library staff

The library staff will Manage team collaboration (using slack and Google Calendar), Events (using Google Calendar), Appointments, Meetings (Google Meet, Zoom), Task Schedules (using Google Calendar), Documents (using Google Docs, Google Sheets, Google Slide), data surveys (using Google Forms—questionnaires) and books, publications, borrower transactions via integrated existing library systems.

- Category 8: Human Resource staff

The Human Resource staff will manage team collaboration (using slack and Google Calendar), Events (using Google Calendar), Appointments, Meetings (Google Meet, Zoom), Task Schedules (using Google Calendar), Documents (using Google Docs, Google Sheets, Google Slide), data surveys (using Google Forms—questionnaires), staff related operations via integrated existing human resource systems and staff Reports.

- Category 9: Student

The student will manage team collaboration (using slack and Google Calendar), Events (using Google Calendar), Appointments, Meetings (Google Meet, Zoom), Task Schedules (using Google Calendar), Documents (using Google Docs, Google Sheets, Google Slide), data surveys (using Google Forms—questionnaires), scheduled online Lectures and assignments and upload assignment via integrated existing LMS.

Non-Functional Requirements (NFR)

The NFR include Performance which is Response time that the system shall respond to user inputs within 2s for 95% of transactions and Throughput where the system shall handle 1000 transactions per second. Reliability is where the system is available 99.9% of the time during business hours. User Scalability is achieved by the system supporting up to 1000 concurrent users without performance degradation and Data Scalability is the system managing a database of up to 1 TB. Usability includes Learnability where new users shall learn the system with minimal training. Security includes Data Encryption where all sensitive data shall be encrypted, the system supports multi-factor authentication for all users, the system ensures that users only have access to the resources and data they are authorized to use. Maintainability includes the system architecture being modular, allowing for components to be updated independently and all code and system components being fully documented to facilitate maintenance and future development. Portability is the system being compatible with Windows, macOS, and Linux and the web application being compatible with the latest versions of Chrome, Firefox, Safari, and Edge. Interoperability includes API Integration where the system provides RESTful APIs for integration with third-party systems and the system supports data exchange in JSON and XML data Format.

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