Signals and Communication Technology

Emmanuel Eilu
John Sören Pettersson
Rehema Baguma
Ganesh Bhutkar
Editors

Rethinking ICT Adoption Theories in the Developing World

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Rehema Baguma • Ganesh Bhutkar
Editors

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Editors
Emmanuel Eilu
Department of Computing
Uganda Christian University
Mukono, Uganda

Rehema Baguma
School of Computing and Information Technology
Makerere University
Kampala, Uganda

John Sören Pettersson
Karlstad Business School
Karlstad University
Karlstad, Sweden

Ganesh Bhutkar
Vishwakarma Institute of Technology
Pune, India

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Preamble of the Book

A huge number ICT adoption theories, ICT Implementation theories, ICT usage theories and ICT disposal theories have been forwarded by a number of researchers. Theories such as Theory of reasoned action (TRA), Technological acceptance model (TAM), Theory of planned behaviour (TPB), Innovation diffusion theory (IDT), Resource-based theory (RBT), Michael Porter's models, Technology-Organisation-Environment framework (TOE), Structuration Theory (ST), Actor-Network Theory (ANT), Adaptive Structuration Theory (AST), Usability Design Frameworks (UDF), User Experience Design Models, Persuasive Design, Philosophical Designs, Motivational Design, Social-cultural Oriented Designs, Co-Design and other HCI design approaches have been forwarded to facilitate a successful ICT adoption, ICT Implementation, ICT usage and ICT disposal. These theories, models and frameworks have made vital contributions to ICT research and to a large extent influenced technology adoption, implementation, usage and disposal studies for decades.

However, complex economic and socio-cultural dynamics represent a major concern when it comes to ICT adoption, implementation, usage and disposal in developing countries, as more than 80% of illiterate and economically challenged adults live in developing countries. While the technologies are fast changing, many societies in developing countries are not keeping pace with the ever-challenging technologies because of the high illiteracy levels and economic challenges. This has become a challenge for conventional theories which are not only straightforward but also rigid in nature and unable to handle the constant advances in technology, and technology adoption, implementation, usage and disposal in many societies in developing countries. Conventional theories of ICT adoption have regularly overlooked the unpredictable nature of ICT adoption, implementation, usage and disposal, especially in developing countries, and due to their uncertainty, there is no practical procedure on how it can be adopted overtime. Dominant theories used to assess the values of new technology adoption, implementation, usage and disposal are becoming less adaptable; in some cases they do work, and in some they do not. ICT adoption, implementation, usage and disposal research need to undergo a change in order to overcome the deterministic conception held by these conventional theories.

This book therefore

1. Presents the extent to which conventional theories are rigid in nature and unable to handle the constant advances in technology, and technology adoption, implementation, usage and disposal in many societies in developing countries
2. Provide extended frameworks/models in ICT adoption, ICT implementation, ICT usage and ICT disposal in a development country setting, in the areas of Agriculture, Culture, Forestry, Education, Economics, Health, and Governance

Major Audience

Academia, researchers, government, policymakers and industrial practitioners.

Mukono, Uganda — Emmanuel Eilu
Karlstad, Sweden — John Sören Pettersson
Kampala, Uganda — Rehema Baguma
Pune, India — Ganesh Bhutkar

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A Model for Improving Social Media Tax Compliance in Uganda

Emmanuel Eilu, Joseph Mutemere, Peter Wanda, Justus Byamukama, and Peter Kamya

1 Introduction

For many sub-Saharan African countries, attaining the Sustainable Development Goals by 2030 requires a massive increase in investments in key sectors of the economy. These sectors include, among others, education, health, agriculture, and the energy sector. Sub-Saharan African countries also need to invest in other infrastructure needed to achieve the World Bank Group's goals of ending extreme poverty and boosting shared prosperity by 2030 [32]. Therefore, mobilizing enough tax revenue is key if sub-Saharan African countries are to adequately finance investments in these key sectors of the economy. However, according to Brahima and Gandhi [31], sub-Saharan Africa continues to grapple with a huge tax revenue deficit, estimated at about USD 230 billion a year. It remains a region with the lowest tax-to-gross domestic product (GDP) ratio of 15%, which cannot finance even basic state functions [32]. Nevertheless, there have been several attempts to improve domestic revenue in sub-Saharan Africa. For the last 20 years, many tax reforms aimed at increasing tax revenues have been implemented. These reforms include, among others, computerizing the various tax processes, transforming the tax bodies into independently run tax authorities, and widening tax bases by introducing several taxes, namely, Domestic Tax Revenue, Direct Domestic Taxes, and Value-Added Tax (VAT) [31]. Take a case of Uganda for example. As part of the tax reforms, the government of Uganda undertook major strategic reforms in the revenue sector. This began with the transformation of Uganda Customs Union into an independently run parastatal known as the Uganda Revenue Authority (URA). There were also other reforms, like widening the tax base by introducing a variety of taxes, such as the Value Added Tax (VAT), and then computerizing the different

E. Eilu (✉) · J. Mutemere · P. Wanda · J. Byamukama · P. Kamya
Uganda Christian University, Mukono, Uganda

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tax processes. As a result of the various tax reforms across the region, the World Bank statistics show that in countries where tax reforms were implemented, there was a significant increase in the tax revenue as a percentage of GDP. Countries such as Ghana, Burkina Faso, Kenya, Senegal, and Botswana increased their tax-to-GDP ratios from 11% in the early 2000s to more than 17% in 2015 [31].

However, despite the various tax reforms and the relative growth in tax collections in a few selected countries, the current tax revenue as a percentage of GDP is still low in many other sub-Saharan African countries. While tax revenues account for one-third of GDP in OECD countries, they still account for less than one-fifth in many sub-Saharan African countries [4]. For example, despite two decades of sound economic reforms, studies show a stagnation of Uganda's tax-to-GDP ratio at about 12.5% over the last 10 years. It is the lowest in the East African Community and below the government's own goal of 16% [8, 32]. This is far much lower than other sub-Saharan African countries such as Namibia (31%), Kenya (21.2%), Burundi (19%), and Ghana (17.2%), which have similar tax structures as Uganda [2, 8, 28].

The low tax-to-GDP ratio still witnessed across many sub-Saharan African countries is attributed, among others, to inadequate fiscal policy, low taxation capacity of the economies, weak enforcement, and the most prominent is a very low level of tax compliance (tax evasion) among taxpayers. Whereas low tax compliance is a global challenge, studies show that sub-Saharan Africa is the hardest hit by this scourge [34, 35]. Cobham [34] estimates that low tax compliance in developing countries costs around USD 285 billion per year. A 2015 report published by the High-Level Panel on Illicit Financial Flows from Africa identified tax evasion as one of the leading factors for the low level of economic growth and development in the region. The reports estimate a revenue loss of between $30 and $60 billion per year due to tax evasion [13]. One country in sub-Saharan Africa hard hit by low tax compliance is Uganda. A study conducted by Ali et al. [21] found out that 68% of the Ugandans think that not paying taxes is "not wrong at all" or "wrong, but understandable". About 74% of firms in Uganda do not report all sales for tax purposes, compared to 71%, 26%, and 43% for Tanzania, Rwanda, and Burundi respectively as illustrated in Fig. 1 [8]. In the Eastern District of Mbale where there are about 50,000 registered taxpayers, only 1500 remit their taxes [35].

One of the taxes with the lowest levels of compliance in Uganda is the "Over the Top services" tax commonly referred to as "social media tax".

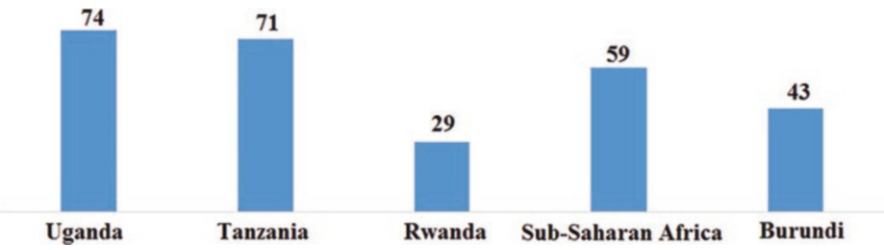

Fig. 1 Firms that do not report all sales for tax purposes (% of firms) in 2006 [8]

2 The Social Media Tax in Uganda

In 2018, three sub-Saharan African governments namely Uganda, Zambia, and Benin introduced a new form of taxes on mobile internet customers. Benin approved a similar tax in September 2018, targeting mobile messaging and "Voice over IP" calls (like Skype). The introduction of the tax rose the cost of a single gigabyte of data by nearly 250%. However, there were protests against this tax, and an appeal against it was tabled in the courts of law, which forced the government to withdraw the tax. The Zambian government also introduced a flat daily tax of USD 0.03 on IP-based voice calls in August 2018. Although there was a public outcry against the tax, the government did not relent and insisted that the tax would raise public revenues, bolster local telecommunications enterprises, and help cover the cost of investments in infrastructure [12]. In Uganda, the Parliament on the 1st of June, 2018, passed the UGX 32.4 trillion 2018/2019 budget (Parliament of Uganda, 2018). It included a new UGX 200 (0.05 USD) tax "per user per day of access" on "Over The Top services" (OTTs) commonly referred to as the social media tax. The Bill passed by Parliament meant that, for one to access any social media site such as Facebook, WhatsApp, Twitter, LinkedIn, Instagram, Viber, Skype, and others, a tax of UGX 200 (0.05 USD) was to be paid per day. The government expected to collect between UGX 400 billion (about USD 11 million) to UGX 1.5 trillion (about USD 400 million) annually from the social media revenue [18]. A week after the social media tax was introduced, many social media users in Uganda started evading the social media tax by installing Virtual Private Network (VPN) apps on their smartphones [27]. Some WhatsApp groups had shared links of VPN apps for people to download, install, and access social media free of tax [27] VPN is a technology that creates a safe and encrypted connection over an insecure network and extends a private network across a public network. The applications running across a VPN may, therefore, benefit from the functionality, security, and management of the private network. Analysis by the government showed that more than 8 million of the country's 20 million internet subscribers were not paying the fees. Besides using VPN, there was also a petition submitted to the Constitutional Court of Uganda by civil society groups seeking to nullify the social media tax. Furthermore, a campaign hashtag "#ThisTaxMustGo" was created against the social media tax and several demonstrations against the tax were held around the capital city Kampala. A sequence of events against the social media tax made headlines both in the national and international media [30]. These campaigns led to low levels of tax compliance.

The Uganda Revenue Authority (URA) acknowledged that the social media tax was among the worst-performing tax categories for 2018/2019 [36]. URA reported that only UGX 49.5 billion was collected in 2019, against the projected UGX 284 billion, hence a 17.4% performance. Now, as a result of the failure of social media tax, the government in July 2021 scrapped it and replaced the tax with a direct 12% levy on the net price of internet data, after which a value added tax (VAT) of 18% will apply [22].

URA observed that there was a need for a deeper study of social media tax to find ways of improving the performance of the tax, which is currently very unpopular among the population [36]. Ali et al. [21] acknowledge that dealing with the problem of tax evasion in developing countries calls for an understanding of the factors underlying the individual taxpayer's decision whether to pay or evade taxes. Therefore, this chapter undertook a deep study on the social media tax compliance levels and investigated ways of improving the performance of the unpopular social media tax among the population in Uganda.

3 Research Objectives

In line with this problem definition, the core research objectives were:

1. *To investigate the level of social media tax compliance in Uganda*
2. *To establish why there was low social media tax compliance in Uganda*
3. *To recommend ways for improving social media tax compliance in Uganda*
4. *Develop a model for improving social media tax compliance in Uganda*

4 Methodology

4.1 Survey

Based on the research objectives of this study, we used a survey. This survey was conducted in between July and September 2019. This was before the social media tax was scrapped in July 2021. It provided the best approach for addressing the research objectives raised in this study. A survey can be defined as a "means for gathering information about the characteristics, actions, or opinions of a large group of people" [23]. It is normally used to gather quantifiable information on the situation, subject, behaviour, or phenomenon of the study population. This can then be used to statistically analyse a target audience or a particular subject. Our survey was carried out 6 months after the introduction of social media tax in Uganda. Mbale municipality was chosen because of the following reasons:

We considered the Mbale municipality, one of the largest municipalities in Uganda, as our case study area. Mbale municipality is located in the eastern part of Uganda and lies on coordinates 1°04′50.0″N, 34°10′30.0″E (Latitude: 1.080556; Longitude: 34.175000). Mbale municipality is the second biggest city in eastern Uganda after Jinja Municipality [29] and, therefore, acted as a representative sample for the entire municipalities in Uganda. In 2014, the national population census put the population in Mbale municipality at 53,987. The population in Mbale municipality possesses most of the characteristics of a municipality in Uganda, namely: different age groups, levels of education, rural, peri-urban and urban

residence, gender, income groups, and occupation [29]. Secondly, the researchers were familiar with the local languages spoken in the municipality, that is, Lugisu, and this made it easier for the researcher to easily engage participants and adequately explain the purpose of the survey to the respondents. Finally, the research institution (Uganda Christian University—Mbale University College) where the researchers work is located in Mbale municipality. It was, therefore, convenient and cost-effective to research Mbale municipality.

Given that the population in Mbale municipality is 53,987, we then use Krejcie and Morgan's [19] approach to determine the number of participants or respondents for the study. Krejcie and Morgan [19] presented a table that researchers can use to determine the appropriate sample size for a quantitative study; they indicate that for a quantitative study of a population of 50,000 the sample size should be about 381 respondents. Using Krejcie and Morgan's approach, we arrived at a sample of 381 participants to represent the 53,987 people in Mbale municipality. A total of 381 questionnaires were given out to respondents within the municipality. This research primarily will use closed-ended questions with ordered choices. This type of questionnaire is usually used on a Likert scale and requires the respondent or participant to examine each given choice of response independently from other choices. In Likert scale, a range of statements was presented to the respondents who responded by either agreeing or disagreeing (based on a Likert scale of five, that is, strongly agree, agree, neutral, disagree, and strongly disagree) with the statement. A closed-ended questionnaire with ordered choices was mainly chosen because it is easy for respondents to answer and for researchers to analyse the data.

The research was conducted in all the three divisions that make up Mbale municipality namely Industrial Division, Northern Division, and Wanale Division. In each division, 127 questions were given out randomly to participants who had active social media accounts. In total, 381 questionnaires were given out in the three divisions, and 325 were filled out and returned for analysis, thereby contributing to an 85% response rate. The completion of these questionnaires was voluntary and responses were anonymous. Statistical programs such as SPSS and Excel were used to analyse quantitative data. SPSS was majorly used to tabulate data and excel was used to generated graphs and charts from the analysed data. Results of the study are presented in the next section.

5 Results from the Survey

From the study, the majority (88%) of respondents were below the age of 40. There was relatively higher feedback from male respondents (61%) compared to female respondents (39%). Seventy-four percent of the respondents had attained either a diploma or a degree. The results also show that 64% of the respondents earned between UGX 100,000 and UGX 299,000. A majority (61%) of the respondents were either students or worked in the informal sector, and 70% of the respondents owned smartphones. From the survey, 90% of the respondents used social media

and about 82% had at least 2 or more social media accounts. WhatsApp was the most popular social media tool used (47%), and Facebook was the second most popular social media site used (33%). Instagram was the least used (6%). Eighty-two percent of the respondents spent between UGX 1000 and UGX 5000 every week on mobile data to access social media. Having presented the demographics of the respondents, next we present responses from the respondents in regards to the questions that were asked. A summary of the demographics is presented in Table 1.

Table 1 Demography of the respondents

Age		**Frequency**	**Percent**
Valid	18–30	208	67.0
	31–40	73	21.0
	41–50	34	9.0
	50 above	10	3.0
Total		**325**	**100.0**
Gender		**Frequency**	**Percent**
Valid	Male	199	61.0
	Female	126	39.0
Total		**325**	**100.0**
Education		**Frequency**	**Percent**
Valid	PLE & below	24	7.0
	O-level	8	2.0
	A-level	51	16.0
	Diploma	76	23.0
	Degree	166	51.0
Total		**325**	**100.0**
Income		**Frequency**	**Percent**
Valid	99, 000 and below	115	35.0
	100,000–299,000	95	29.0
	300,000–599, 000	62	19.0
	600, 000–1,200,000	38	12.0
	1,300,000–1,800,000	15	5.0
Total		**325**	**100.0**
Occupation		**Frequency**	**Percent**
Valid	Civil servant	45	14.0
	Private sector	62	19.0
	NGO	20	6.0
	Informal sector	97	30.0
	Student	101	31.0
	Total	**325**	**100.0**
Type of phone		**Frequency**	**Percent**
Valid	Basic phone	98	30.0
	Smart phone	227	70.0
Total		**325**	**100.0**

5.1 The General Perception Towards the Social Media Tax

First, we set out to assess the general perception that the sample population held against the introduction of the social media tax by the government. We, therefore, asked the respondents whether the social media tax was "a fair" or "unfair". From the findings, about 243 (75%) respondents said that the social media tax was unfair, while only 82 (25%) said the tax was fair. The results are summarised in Fig. 2.

5.2 Why Government Introduced Social Media Tax

The study also went ahead to investigate the main reason why respondents think the government introduced the social media tax. We presented two major reasons. The one presented by the government is to raise revenue, and the other reason held by many in the public is that the government wants to reduce freedom of expression (social/political discussions) through social media. The study found that 68% of the respondents believed that the social media tax was an attempt by the government to reduce social/political discussions, and only 32% said it was an attempt by the government to raise revenue. The summary is shown in Fig. 3.

5.3 Social Media Tax Compliance Levels

We assessed the level of compliance towards the social media tax. Out of the 325 respondents, 130 (40%) acknowledged that they did not pay social media tax whenever they wanted to access social media; however, 136 (42%) said they always paid the social media tax, while 59 (18%) were not sure. The summary is shown in Fig. 4.

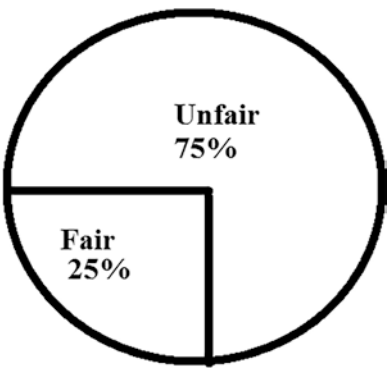

Fig. 2 The general perception towards the social media tax

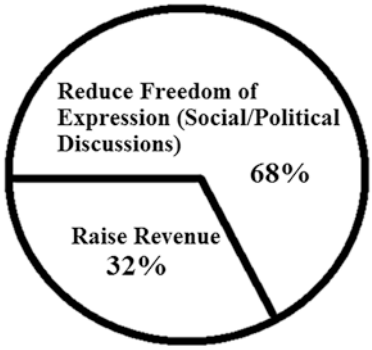

Fig. 3 Why government introduced social media tax

Fig. 4 Level of compliance with social media tax

5.4 Reasons for Non-compliances with Payment of Social Media Tax

The survey explored general reasons why the respondents were not paying the social media tax introduced by the government. Five reasons were presented, namely: social media tax is very high; inadequate knowledge on how social media tax revenue will be spent; political reasons; too many taxes already levied on people; and high levels of corruption and lack of accountability of public funds. The respondents were then requested to tick the three most important reasons why they were not paying the social media tax. A cross-tabulation was then performed between those who did not pay the social media tax (130 respondents) and the three major reasons why they did not pay the social media tax.

The findings show that 67% said the social media tax was very high, 54% said the taxes levied on people were too many, and 49% said there were high levels of corruption and lack of accountability. The study also reveals that 40% did not have knowledge on how social media tax revenue will be spent, and only 36% of the respondents who did not pay the social media tax said they did it for political reasons. The summary is shown in Fig. 3 and Table 2.

Table 2 Reasons for non-compliance to social media tax ($N = 130$)

Reasons for not paying social media tax	Frequency	Percent
Social media tax is very high	87	67
Taxes levied on the people were too many	70	54
High levels of corruption and lack of accountability	63	49
Inadequate knowledge of how social media tax revenue will be spent	52	40
Political reasons	46	36

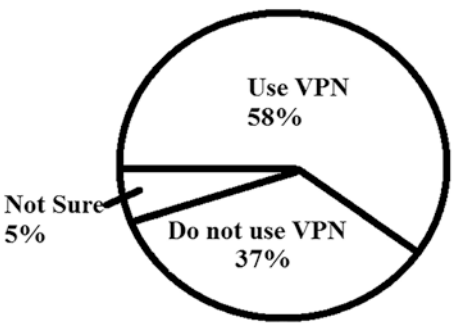

Fig. 5 The use of VPN to access social media without paying tax ($N = 130$)

5.5 *The Use of VPN Mobile Application to Evade Social Media Tax*

The study also investigated the use of VPN amongst respondents who did not pay social media tax. Using cross-tabulation between those who did not pay social media tax and the use of VPN, 58% of the respondents used VPN to evade the social media tax while 37% did not as summarised in Fig. 5.

5.6 *Improving Compliance with Social Media Tax*

The survey further explored what respondents believed the government should do to encourage payment of the social media tax. A set of nine statements were presented to the respondents, and they were asked to tick five major options that would encourage them to pay social media tax. A cross-tabulation analysis was performed between the 130 respondents who did not pay the social media tax and the 5 options that they were given to choose. The findings show that 56% of the respondents said that the government should reduce the social media tax rate, while 28% said that the government should reduce corruption. 18% of the respondents said that the government should consolidate the tax within mobile data, 18% encouraged the government to educate the people on the relevance of paying tax, and 15% said that the government should reduce political intolerance. The summary is shown in Table 3.

Table 3 Encouraging the payment of social media tax ($N = 130$)

Factors	*N*	Percent
Reduce the tax	73	56.0
Reduce corruption	37	28.0
Consolidate the social media tax as part of mobile data	24	18.0
Educate the people on the relevance of paying tax	24	18.0
Reduce political intolerance	19	15.0
Block VPN	18	13.0
Enforce strict tax laws	16	12.0
Give incentives to social media taxpayers	15	11.0
Make the payment procedure shorter and easier	4	3.0

6 Discussion of the Results

6.1 The Level of Compliance with Social Media Tax in Uganda

There is evidence that tax non-compliance leaves many sub-Saharan African countries with huge budgetary constraints. All forms of tax evasion cost African governments between 30 and 60 billion USD per year, hampering economic growth and development [13]. As indicated earlier in this chapter, Uganda's tax-to-GDP ratio is considered one of the lowest in the sub-Saharan African region primarily because of the low rate of tax compliance [28]. According to the 2017 World Bank, Uganda is one of those sub-Saharan African countries with the highest percentage of firms that do not remit taxes estimated at 74%, compared to 71%, 26%, and 43% for Tanzania, Rwanda, and Burundi respectively [8]. This trend is confirmed in our study as the results show that 40% of respondents did not pay social media tax whenever they wanted to access social media, with 75% saying the social media tax was unfair. A survey conducted by Whitehead Communications Ltd in 2018 on public opinion on the recent social media and mobile money taxes in Uganda found out that only 40% of the respondents said they paid the social media tax, and 94% were opposed to the tax. In the next section, we discuss reasons why there is a very low rate of tax compliance with the social media tax in Uganda.

6.2 Reasons for Non-compliance with Social Media Tax

1. *High Social Media Tax*

Several studies have shown that high tax rates cause high tax non-compliance [11]. Similarly, there is evidence that a high tax rate is positively correlated with a tendency for taxpayers to underreport their tax returns [7, 15]. This is in line with the findings of this study, which show that the most common reason given by the respondents for not paying the social media tax was the high tax rate. About 67% of

the respondents said that the social media tax rate was high. However, there have been mixed findings on the relationship between tax rate and tax compliance. For example, one recent study in one of the African countries found that tax rates (high or low) did not have any positive or negative effect on tax compliance [15]. Nonetheless, according to Mas'ud et al. [20], a majority of studies conducted in Africa show that there is a significant negative correlation between high tax rate and low tax compliance.

2. *Too Many Taxes Levied on People (Multiple Taxation)*

According to Izedonmi [14], multiple taxation occurs when the same income is subjected to more than one tax treatment. It is sometimes referred to as double taxation or triple taxation [14]. The concept of multiple tax practices is a common occurrence not only in developing economies but also in developed economies, and it is a panacea to a high rate of tax evasion and avoidance practices [9]. A study conducted by Sankey et al. [25] in Nigeria on the effects of multiple tax practices on taxpayers' compliance attitudes found that multiple tax practices significantly affect taxpayers' compliance attitudes and that multiple tax practices in Nigeria are corollaries of corruption, poor tax administration, greed, and unfair revenue allocation formula. This correlates with our study, which found that 54% of the respondents did not pay the social media tax because of the many taxes levied on them. Whereas it is good practice to widen the tax base to improve government revenue, there is a need to critically distinguish between widening the tax base and multiple taxation.

3. *High Levels of Corruption*

Studies have shown that tax evasion is a result of the corruption perception many people have towards government officials in many African countries [13]. Many people believe that a greater percentage of government officials are corrupt. For example, 68%, 56%, 55%, and 53% of the people in Liberia, Nigeria, Cameroon, and Gabon respectively evade taxes because they believe government officials are corrupt. However, in more economically stable countries like Mauritius (13%) and Botswana (17%), their corruption perception towards government officials is relatively lower [13]. In our study, we found out that 49% of the respondents did not pay social media tax because they believed that the corruption level in the country was high. For people to build trust in government, there is a need for accountability and transparency in how public funds are collected, allocated, and spent.

4. *Knowledge of How Tax Revenue Is spent*

Adimasu and Daare [1] conducted a survey in Ethiopia on tax awareness and found that lack of full knowledge about a certain tax was the major problem with voluntary tax compliance attitudes. The study further showed that tax awareness does not only create positive perception towards government spending but also encourages voluntary tax compliance. In our study, 40% of the respondents did not pay social media tax because they did not understand what the social media tax revenue will be used for. Therefore, there is a need to strengthen tax awareness strategies that will positively shape the mindsets of the taxpayers, hence tax compliance.

5. *Political Reasons*

According to the political legitimacy theory, tax compliance is influenced by the extent to which citizens trust their government [17, 26]. In many African countries, there is a strong relationship between tax evasion and the perception that voters have towards the way the most recent national elections were conducted [13]. Ali et al. [21] assessed factors affecting tax compliant attitude in Kenya, Tanzania, Uganda, and South Africa. They found out that people who were more satisfied with government provision of infrastructure such as roads and electricity, basic health services, educational needs are more likely to have a tax compliant attitude, with an increase of about 10% in Kenya, 8% in Uganda, and 10% in Tanzania. Also, satisfaction with the way government handles crime, conflict, and corruption increases the likelihood of having a compliant attitude in Uganda by 7%. In our study, 36% of the respondents said they did not pay social media taxes for political reasons.

6.3 Improving Social Media Tax Compliance

1. *Reduce Social Media Tax*

Mas'ud et al. [20] advise that since the average tax rate is 29.1985% in Africa, countries with tax rates above average that are experiencing non-compliance should reduce their tax rate to the mean tax rate in Africa. As shown in the study, reducing the social media tax rate was the most recommended measure (56%) for increasing tax compliance amongst social media users.

2. *Reduce Corruption*

A certain degree of transparency is required for the taxpayers to be compliant. When there is less corruption and a high rate of transparency, people tend to be committed to paying taxes. For example, corruption among the tax officials was found to have reduced the likelihood of tax compliant attitude by 5% in South Africa [21]. The second highest recommendation for increasing the social media tax compliance was that government should reduce the level of corruption (28%).

3. *Consolidate the Social Media Tax*

Governments should consider a tax policy that combines all seemingly related taxes into one slot and later discriminates it among various departments rather than having closely related but different taxes at the same time [25]. The study also found that 18% of the respondents said that the social media tax should be included in the mobile data tax and not paying the social media tax separately, which many saw as double taxation.

4. *Educate the People on the Relevance of Paying Tax*

Tax awareness is equivalent to reducing the share of people with tax non-compliant attitude by about 51% [21]. Gitaru [10] also observes that taxpayers will readily accept any new system introduced if they have ample knowledge about it.

Tax awareness programs are needed to enhance taxpayers' ability to understand the tax and to increase their confidence in fulfilling their responsibilities as taxpayers. The study revealed that 18% of the respondents said there was a need to educate the people on the relevance of paying tax.

5. *Reduce Political Intolerance*

A study conducted in Liberia and Nigeria found that about 22% of Liberians and 15% of Nigerians say they have at least once withheld tax payments as a result of their dissatisfaction with their government's political, social, and economic performance [13]. In regards to our study, 75% of respondents believe that the social media tax was introduced by the government to reduce freedom of expression (social and political discussions). The study revealed that 15% of the respondents who did not pay social media said that the government needs to reduce political intolerance.

6. *Block VPN*

Thirteen percent of the respondents said that blocking Virtually Private Networks applications installed on many smartphones would help improve social media tax compliance. We see that 58% of the respondents who did not pay the social media tax evaded the tax by using VPN app. In a similar study conducted by Whitehead Communications Ltd. in 2018 on public opinion on the recent social media, it was found that 57% of the respondents were using VPN.

7. *Enforce Strict Tax Laws*

General enforcement of tax laws on digital services should be enhanced. The capacity to enforce tax laws should be improved. The tax systems, especially the local government revenue systems, in many African countries lack strong and consistent domestic tax legislation [3]. For example, there were a few situations in Zambia where legislation had to be amended to accommodate recognition of e-reports in an official courtroom in case there was a dispute [3]. Kagina [16] observes that tax compliance can be improved if the tax bodies are empowered by enabling legislative enactments. The results from the study reveal that 12% of the respondents said that enforcing strict laws and penalties would help improve social media tax compliance.

8. *Give Incentives to Social Media Taxpayers*

Twelve percent of the respondents said that the government should give incentives to social media users, especially for registered businesses that are heavily dependent on social media for business purposes. Tax incentives are special favours given out to entice major investments. Incentives are designed to encourage foreign direct investments.

9. *Make the Payment Procedure Shorter and Easier*

Generally, the tax payment systems in Africa are considered the most complicated in the world because it takes 320 h to pay tax compared to the global average of 268 h [24]. This means that the time taken to pay tax in Africa is greater than the

global average by 20%. From the study, we see that 3% of the respondents said that the payment procedure for the social media tax should be made shorter and easier. Studies have shown that complexity in the tax payment system has been identified as a major determinant of tax non-compliance [5, 6].

7 A Model for Improving Social Media Tax Compliance in Uganda

Some models and frameworks have so far been presented for improving tax compliance, such as the "slippery slope" framework presented by Henk Elffers in 2006 and the Theory of Change for Innovations in Tax Compliance presented by Prichard et al. [33]. However, in this chapter, we use the Theory of Change for Innovations in Tax Compliance model as it provides a more a suitable taxonomy for mapping the factors for improving social media tax compliance that emerged from the study. Prichard et al.'s model focuses on three major aspects that facilitate either enforced/forced tax compliance or voluntary tax compliance namely:

1. *Enforcement:* When the government increases monitoring of taxpayers and improves tax collectors performance, which in many cases leads to enforced/forced tax compliance (which results from the enforcement power of the state)
2. *Facilitation:* Facilitating the tax process through tax awareness, simplifying the tax process, and enhancing customer care
3. *Trust:* Focuses on building fairness, equity, reciprocity, and accountability, which encourages "quasi-voluntary tax compliance". Voluntary compliance is driven by values, social norms, *and* levels of trust in the fairness, equity, reciprocity, and accountability of tax systems.

Ultimately, the outcome of either enforced/forced tax compliance or voluntary tax compliance should strengthen fiscal contracts (where the state invests according to the will and interest of the taxpayers), and generate sustained political support for reform as illustrated below (Fig. 6).

Using the above model, this chapter presents a modified model for improving social media tax compliance in Uganda. It is hoped that this model may be of great use to the Uganda Revenue Authority and other revenue bodies in developing countries seeking to improve tax compliance. The components of the model are discussed as follows.

7.1 Political Support for Reforms

First, ample evidence now suggests that political support is critical to reform in the taxation system. It should support enforcement, facilitation, and building trust. Tax reform inevitably creates winners and losers and confronts strong vested interests.

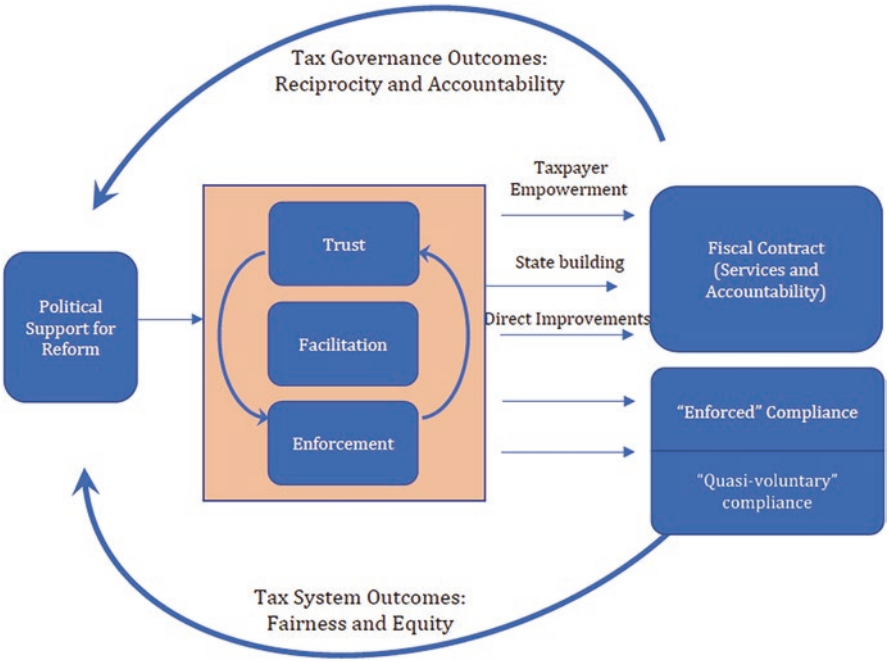

Fig. 6 Theory of change for innovations in tax compliance

It cannot succeed without political support. Political support for reform can be viewed in two ways:

(a) informing the design of reform that is most likely to succeed amid existing political constraints ("incentive-compatible reform")
(b) supporting the design of strategies to minimise resistance and build support for reform

7.2 Enforcement

Many studies conducted on tax compliance have attributed enforcement as the starting point. Understanding the enforcement tools available to governments to use is paramount. Two elements are necessary for strengthening enforcement:

(a) *Increase Monitoring of Taxpayers*

This is when the government gains information on individual taxpayers. Improving access to information has been pivotal in improving monitoring of taxpayers. It is through access to information on income, wealth, and economic transactions that governments can identify evasion and avoidance, pursue enforcement,

and impose penalties. The government should be able to identify and block various ways in which social media users evade the tax. This can be done by.

Blocking VPN Sites
As reported in our study, about 57% of the respondents evade the social media tax by using VPN app. In our study, 13% of the respondents said identifying and blocking VPN applications installed on many smartphones would help improve social media tax compliance.

(b) *Measures to Improve Tax Collectors Performance*

This is when the government aims at improving the performance of various tax processes and administration. This can be done through the creation of semi-autonomous revenue authorities run by professionals and with little interference from the government. Salary increases have been key to many reform programs, as an effort to improve staff recruitment and performance incentives. Strict monitoring of staff is needed to reduce opportunities for collusion and corruption. Improving social media tax collectors' performance can be done in the following ways.

Reduce Corruption
As presented in the results of the study, 49% of the respondents did not pay social media tax because they believed that the corruption level in the country was high. There are similar studies that show that tax evasion is a result of the common perception many people have towards government officials in many African countries [13]. That is why, in our study, 28% of respondents who did not pay social media tax said that the government should reduce the level of corruption generally in government and within the tax body. A certain degree of transparency is required for taxpayers to be compliant. When there is less corruption and a high rate of transparency, people tend to be more committed to paying taxes.

Enforce Strict Tax Laws
Many sub-Saharan African countries lack strong and consistent domestic tax legislation [3]. There is a need to enact relevant tax laws and build a strong commitment to implement the laws. The study shows that 12% of the respondents said that enforcing strict laws and penalties would help improve social media tax compliance.

7.3 Facilitation

The model presents facilitation inform of "customer friendly", with taxpayers treated as clients rather than potential criminals. Facilitation efforts are primarily aimed at reducing the cost of compliance in three ways:

(a) *Tax Awareness*

Ensure that taxpayers understood what they were required to pay and had easy access to the information required to do so. This involves simplifying and stabilizing relevant laws and making relevant information readily available. The study

revealed that 40% of the respondents did not pay social media tax because they did not understand what the social media tax revenue will be used for. Tax awareness does not only create positive perception towards government spending but also encourages voluntarily tax compliance. Social media tax awareness can be done through:

Educating People on the Relevance of Paying Tax
Our study further established that 18% of the respondents said there was a need to educate taxpayers on the relevance of paying tax. Taxpayers will readily accept any new system introduced if they are given timely and relevant information about the tax [10].

(b) *Simplify the Tax Process*

Reforms have sought to reduce the cost of compliance by simplifying policies, simplifying forms and filing requirements, and reducing redundancies and points of contact. In the case of social media tax, the tax process can be simplified by:

Easier Payment of the Tax
Africa has been identified as a region with the most complicated tax payment systems [24]. It takes 20% more time to complete tax payment in Africa compared to the rest of the world. In our study, 4% of the respondents said that the payment procedure of the social media tax should be made shorter and easier.

(c) *Customer Care*

There is a need to reduce the scope for harassment and abuse by tax officials, particularly at the point of payment. This involves reducing face-to-face contact with tax officials, reducing officials' discretion, increasing reliance on self-assessment where possible, introducing online portals, and expanding the scope for tax payments to banks (or, more recently, via SMS).

7.4 Building Trust

The model presents building trust as all the factors *other than* enforcement and facilitation that may drive levels of tax compliance. The major aim of building trust is to strengthen "tax morale" and encourage tax compliance. Tax morale is generally defined as capturing "non-pecuniary motivations for tax compliance". This can be undertaken by capturing individual values, ethics, and attitudes that are aimed at improving trust. Improvements in trust thus stand to improve these more conditional aspects of tax morale and thus contribute to enhanced tax compliance. The model presents four key areas that influence or build trust:

(a) *Fairness*

Fairness captures the extent to which taxpayers feel that the process for paying taxes is fairly designed and administered. This includes their understanding of the system, their treatment by tax collectors, the fairness of penalties, and the

availability of recourse in cases of abuse. This normally happens when the same income is subjected to more than one tax treatment [14]. It is one of the leading causes of tax evasion in many developing countries [9]. Results presented from the study found out that 54% of the respondents did not pay the social media tax because of the many taxes levied on them. In an attempt to widen their tax bases, many governments in sub-Saharan Africa have ended up implementing multiple taxes on the same services or products. For example, in Nigeria, the multiple tax practices are corollaries of corruption, poor tax administration, greed, and unfair revenue allocation formula [25]. One of the solutions for the multiple taxation is by:

Consolidating the Social Media Tax into Mobile Data
The study also found out that 18% of the respondents said that the social media tax should be included on mobile data tax and not paying the social media tax separately, which many saw as double taxation.

(b) *Equity*

Equity captures the extent to which the tax burden is felt to be fairly distributed across different taxpayers. There is now considerable evidence that taxpayers are less likely to comply or to support higher taxes when they feel that the distribution is unfair. From the results of the study, 68% of the respondents said that the social media tax was unfair.

Reduce Social Media Tax
In our study, 67% of the respondents did not pay social media because the social media tax rate was high. And 56% of the respondents who did not pay social media recommended reducing the social media tax rate to increase tax compliance amongst social media users. The average tax rate in Africa is 29.2%. Mas'ud et al. [20] advise that countries with tax rates above average that are experiencing non-compliance should reduce their tax rate to the mean tax rate.

(c) *Reciprocity*

Reciprocity is perhaps the most intuitive of the four elements underlying trust in tax systems and lies at the core of the fiscal contract: The idea is that tax revenues will contribute to the provision of valued public goods and services. This concept is frequently at the heart of government outreach and education campaigns, which stress the need for taxes to fund national development. For example, our study revealed that only 31% of the respondents said that the government had introduced the social media tax to raise the much-needed revenue for development. However, 75% said that the introduction of the social media tax was an attempt by the government to either reduce social discussions or political discussions. However, the government can reciprocate by:

Giving Incentives to Social Media Taxpayers
Results from the study show that 11% of the respondents said that the government should give incentives to social media users, especially for registered businesses that are heavily dependent on social media for business purposes. Tax incentives are

special favours given out to entice major investments. Incentives are designed to encourage foreign direct investments.

(d) *Accountability*

Accountability overlaps with reciprocity; however, the goal of accountability is, often, to provide an institutionalized way for taxpayers to demand and ensure reciprocity. Our study revealed that 49% of the respondents did not pay social media tax due to high levels of corruption and lack of accountability.

Reduce Political Intolerance
In our study, 36% of the respondents said that they did not pay social media tax due to political reasons, 15% of the respondents who did not pay social media tax suggested that government should reduce political intolerance.

7.5 Enforced and Voluntary Compliance

In our model, we distinguish between enforced compliance and voluntary compliance. Prichard et al. [33] observe that many recent studies have distinguished between enforced compliance, which results from the enforcement power of the state represented by "enforcement", and voluntary (or "quasi-voluntary") compliance, which is majorly driven by values, social norms, *and* levels of trust in the fairness, equity, reciprocity, and accountability of tax systems, which in our model is achieved through "Building Trust". Facilitation addresses customer care issues, creates awareness, and makes the tax process easier. This helps to achieve both enforced compliance and voluntary compliance. Once both enforced and voluntary compliance have been achieved, this will not only validate the political support for reforms that was given but also promote more political support for reforms in the future. Below, we present a modified model that can be of use to the Uganda Revenue Authority to improve social media tax compliance in Uganda (Fig. 7).

8 Conclusion

In an attempt to raise its tax-to-GDP ratio, the government of Uganda introduced the social media tax. However, the tax was among the worst-performing tax categories for 2018/2019. The Uganda Revenue Authority reported that only UGX 49.5 billion was collected in 2019, against the projected UGX 284 billion, hence a 17.4% performance. URA observed that there is a need for a deeper study of social media taxes to find ways of improving the performance of the tax, which is currently very unpopular among the population. Therefore, this chapter undertook a deep study on the social media tax compliance levels and investigated ways of improving the performance of the unpopular social media tax among the population in Uganda.

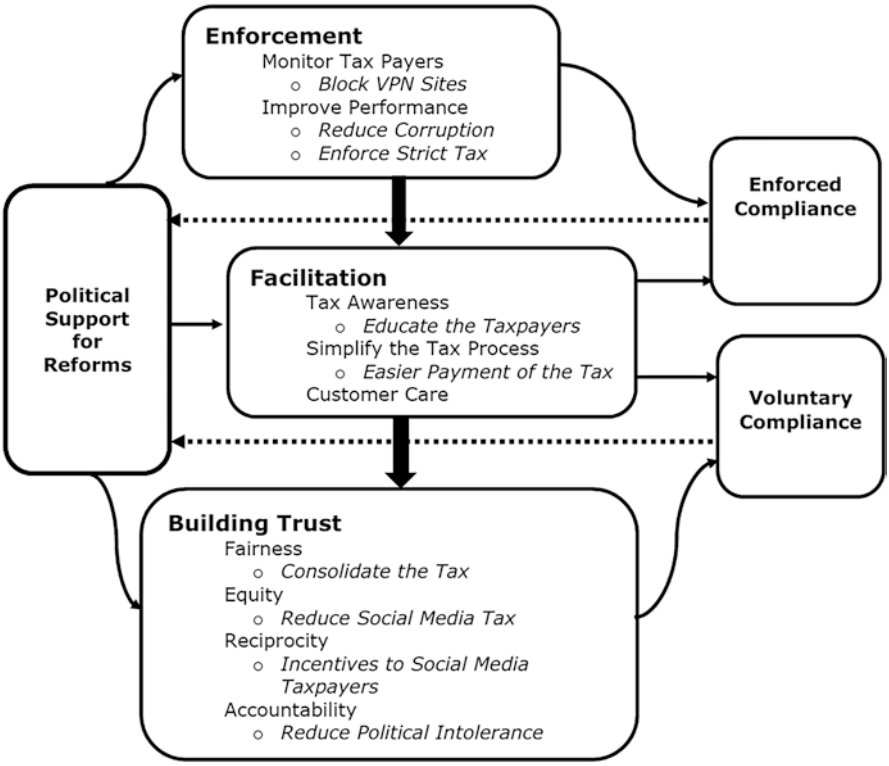

Fig. 7 A model for improving social media tax compliance in Uganda

This chapter presented a modified model for improving social media tax compliance in Uganda. It is hoped that this model may be of great use to the Uganda Revenue Authority and other revenue bodies in developing countries seeking to improve tax compliance.

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Digital Usage of Indian Teleworkers in Home Settings: A Digital Inclusion Framework

Anindita Paul, Borchuluun Yadamsuren, and Kim M. Thompson

1 Introduction

Digital technologies have enabled business continuity during the COVID-19 pandemic as workers continued working under restrictions worldwide as numerous businesses had to declare work from home for their employees. Though working from home existed long before the pandemic, often referred to as "telework" [1–3], the pandemic rather abruptly compelled organizations to follow this at a mass scale. This arrangement would not have been possible without the existence of digital infrastructure, allowing information and communication technology (ICT) adoption at a speed and in ways previously unchartered. The pandemic has compelled researchers to examine the ways the digital infrastructure and ensuing ICT adoption facilitate and/or create barriers at the intersection of professional and personal life within the home setting and the resulting challenges and tensions that arise from this overlap.

Messenger and Gschwind [2] provide a historical conceptualization of telework since its origin. They predicted that work was moving from traditional office spaces to remote work via advances in mobile technologies. Their framework presents three "generations" of telework: the home office, the mobile office, and the virtual office. The home office is self-explanatory—providing options for working from

A. Paul (✉)
Information Systems, Indian Institute of Management Kozhikode, Kozhikode, India
e-mail: apaul@iimk.ac.in

B. Yadamsuren
Quinlan School of Business, Loyola University, Chicago, IL, USA

K. M. Thompson
School of Information Science, University of South Carolina, Columbia, SC, USA

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home as well as institutional office spaces. The second-generation mobile office allows workers to reside in a larger selection of locations outside of the office, including "third places" such as coffee shops and public libraries. The third-generation virtual office has remnants of the first and second generations and adds intermediate spaces to it (elevators, parking lots, sidewalks etc.). This third-generation technology of "New ICTs" (smartphones, tablets) brings the ability to communicate and share information anytime, from anyplace, and with anyone who is likewise connected.

Studies have looked at factors affecting work from home or telework [1, 4, 5] and the role of digital technologies in working from home [6, 7]. Nevertheless, the social factors of ICT adoption and digital inclusion in this ubiquitous virtual office lifestyle need greater examination. This chapter employs a model of digital inclusion [8] to explore the social benefits and challenges of ICT adoption in light of a workforce that was forced to shift to teleworking very quickly and without much notice.

The remote work needs the pandemic instilled in our societies (i.e., work from home orders) pushed the workforce to return to the first-generation location of home offices while equipped with the third-generation technology, resulting in new social mechanisms. This evolution of telework and its various categorizations brings with it the blurring of boundaries between segments of technology in the new reality: in the virtual office, there is the ability to have little or no difference between professional and personal spaces. A person may work while biking in a park, driving to the airport, or from bed or from the bathtub, about as easily as they might work from a table at a café or a desk at the work office. This anytime-anywhere option not only blurs the lines between work life and personal life but also has the potential to affect social connections with colleagues and supervisors [2]. For example, a study by Yang et al. [9] based on data from 61,182 US Microsoft employees' calendars, email, instant messages, and video/audio calls indicates that moving to telework reduced the strength of collaboration networks and encouraged more siloed communication practices among employees. Yang et al. note that this has the potential to lead to problems related to the communication of information within the organization, and potentially be troublesome for future productivity and innovation.

At the same time, the sudden shift to telework during the pandemic led to unusually quick adoption of new technologies such as contactless digital devices [10]. This brings to the forefront an interesting take on the concept of digital inclusion. The United Nations [11] defines digital inclusion as "equitable, meaningful, and safe access to use, lead, and design of digital technologies, services, and associated opportunities for everyone, everywhere." This focus on digital inclusion is not limited to physical access to technologies and broadband or Wi-Fi infrastructures. The words "meaningful" and "safe" include aspects of social inclusion that go beyond simply being able to access spreadsheets and shared databases or being able to video conference and teach classes via the Internet and the World Wide Web. Digital inclusion acknowledges the complexities of digital use context by looking at various interactions such as problem solving and other practices with attitudes and skills [12]. The need for digital inclusion for employees has been emphasized, and

recommendations have been made (e.g., see [13, 14]). Nevertheless, there is still a lack of clarity regarding the specific factors that influence digital inclusion for teleworkers. Extant literature on digital technology use has provided broad insights on areas of digital divide (e.g., see [15]), digital adaptation, (e.g. see [16]), digital use (e.g., see [17]), digital behavior (e.g., see [18]), and digital inclusion (e.g., see [19, 20]); however, the use of digital technologies in virtual or hybrid spaces such as the home-work environment has only recently started to get attention [21–23]. These studies indicate the need for more research on the home environment and how it shapes the experience of teleworking.

In response to this need for greater understanding of the social aspects of digital inclusion and ICT adoption, Thompson and Paul's [8] Factors Affecting Digital Inclusion (FDI) framework provides a comprehensive way to examine the adoption and use of digital technologies by the teleworkers using the eight factors: physical access, device dependency, digital literacy, everyday life, professional use, time, social networking, and privacy and security (Fig. 1). This model provides eight analytical lenses through which to understand digital use in the virtual environment. Furthermore, it could suggest adequate policies to support third-generation

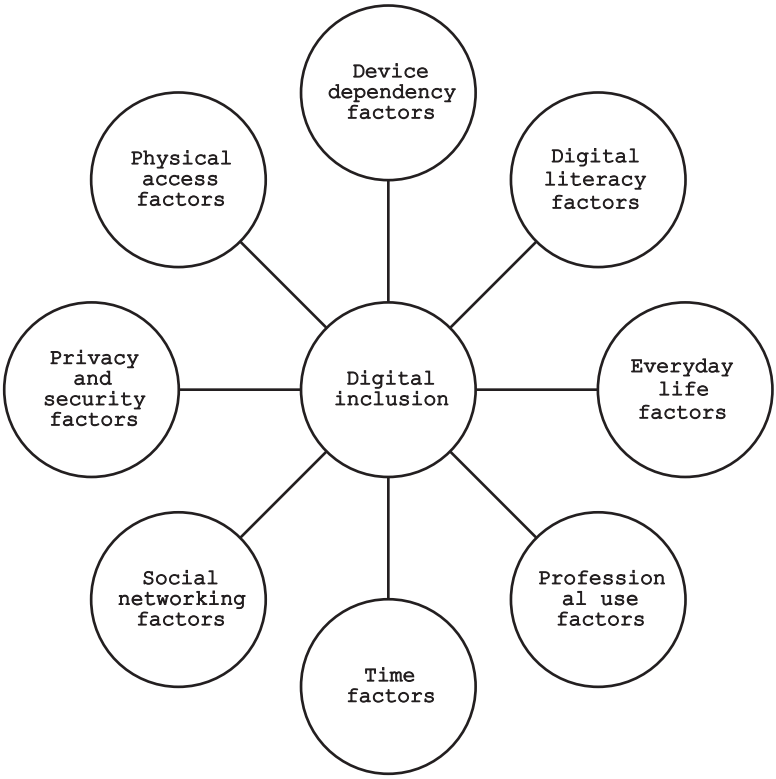

Fig. 1 Factors affecting digital inclusion framework [8]

telework in the mandated from-home scenario with the intricacies of the virtual environment.

The FDI framework was used to explore the questions: How did digital technologies mediate the experiences of workers when working in closed spaces/homes during the COVID-19 pandemic? What factors of digital inclusion impact digital use for teleworking from home? What are the challenges faced by workers in using digital technologies when working from home during the COVID-19 pandemic? What tensions arise when using digital technologies for teleworking at home?

2 Methods

This mixed method study consisted of two phases. Phase 1 involved in-depth interviews with three individuals during the pandemic (August–December 2020). The informants were selected based on their varied professional profiles and engagements in daily life when teleworking in a family setting (i.e., home). The informants had to rely on digital devices for their professional roles as well as their daily chores. The three interviews were recorded using Zoom, lasting approximately an hour each. All interviews were transcribed and analyzed with the constant comparative approach [24], leading to a conceptual snapshot of the basic lifestyle of forced telework.

Phase 2 (April–June 2021) consisted of a survey questionnaire distributed online via Qualtrics. The survey questions were developed applying the eight factors of the FDI framework. The multiple-option questions were designed based on the findings from the in-depth interviews. The questionnaire was tested with three target subjects, after which it was distributed through mailing lists to students in a business school (executive program) in India. Participants were also asked to share the questionnaire with others digitally to expand the population sampled. The respondents who consented and qualified the screening questions (age, employment during the pandemic, if they worked from home for at least 2 weeks during the pandemic) participated in the study. The questions included basic demographics (gender, age group, location in India, marital status and family size, level of education, occupation), ownership and use of digital devices individually and with family during the pandemic, social media usage during the pandemic, change in digital skills from before the pandemic, work-related digital use during the pandemic, impact of pandemic on lives and digital use, challenges faced in digital use during the pandemic, and privacy/security issues faced in digital use during the pandemic (Appendix). A total of 617 responses were collected, of which 305 were complete responses. Questions that had a significant amount of missing data (i.e., 80% of questions not answered) were excluded from analysis. The survey data was analyzed using descriptive statistics. For the brevity of this chapter, interview findings are summarized with a greater emphasis on the survey findings.

Among the respondents who reported their occupations, a major portion of them were in fields with heavy computer use (male, 36%; female, 23%), and a lesser

percent (male, 28%; female, 19%) were in management. Since the question about career was an open field, there were inconsistencies in the terminology used, such as "computer" and "management," which could mean the same occupation (e.g., computer or IT management, etc.). A lesser percentage of respondents belonged to the occupations of education, business and financial operations, sales, community, and social service, etc.

All our respondents were in active paid jobs, except for one. About 70% of respondents reported having worked from home, and 21% worked from both their workplace and home during the pandemic. Almost 70% of the respondents reported working 5 days a week, with 16% working for 6 days and approximately 7% working for 7 days a week. Recalling their worktime before the pandemic, 45% of the respondents reported working for 8 hours a day, while 48% indicated working for more than 8 hours a day. However, responding to a question about work hours during the pandemic, only 10% of the respondents reported working for 8-hour days, and a significant 83% reported working for more than 8 hours daily. This suggests that nearly 35% of the respondents experienced an increase in work hours during the pandemic. These findings support previous research that has shown that online workers, particularly in India, faced longer work hours while working from home during the pandemic [25].

Overall, 47% of respondents disagreed that their lives remained unchanged, suggesting that the pandemic had indeed impacted their lives. Additionally, a majority of respondents (63%) *agreed* or *strongly agreed* that they were spending significantly more time at home with their families. We will delve further into the acquired responses in the subsequent discussion.

3 Results

Analysis of the in-depth interviews revealed complex interactions between the personal, digital, and professional spheres of the informants. Using coding and comparison techniques using the lens of the FDI framework, we identified features that enable and hinder digital inclusion during teleworking.

While professional reasons drove digital use when teleworking, our interviewees mentioned the myriad ways they used digital technologies throughout the day and multiple factors that affected their ability to work effectively from home. Factors included ability to use the Internet to learn new skills; the need to share devices within the family; shared Internet connectivity; dependability of Internet services; affordability of work-related infrastructural basics (Wi-Fi, devices, etc.); IT support (i.e., troubleshooting, seeking assistance); and setting up adequate workspaces. The shift to working from home during the pandemic yielded a diverse effect on daily life contingent upon personal characteristics, household circumstances, and living conditions. Those managing multiple responsibilities across their professional and personal lives with limited support were likely to face greater challenges in digital utilization compared to others who had stronger family and work assistance.

Despite personal preferences, during COVID-19 work from home orders, these individuals were compelled to use digital mediums for professional tasks, leading to health concerns and disruptions to their daily routines and affecting their time management (i.e., devoting extended hours to remote work). They also reported minimal digital use for social networking, unless they had available leisure time.

The survey data analysis provided valuable insights regarding the practice of telework conducted from home. Table 1 presents the demographic details of the survey respondents. The survey results have been grouped by eight factors of the FDI related to ICT adoption, including digital literacy, everyday life, professional use of technologies, time use, social networking, privacy and security, and physical access to and device dependency, with an emphasis on common themes.

3.1 Digital Literacy Factors

The importance of digital literacy for businesses to undergo digital transformation has been emphasized in previous research [26]. However digital literacy may not be best learned through formal education alone but also through personal experience

Table 1 Survey respondents demographics

Demographic identifier	Total number	Percentage
Female	62	20
Male	242	79
Highest degree as undergraduate	84	28
Highest degree as graduate	217	71
Married	236	77
At least one minor in the home	188	62
At least one older adult (senior) in the home (>60 years)	162	53
Age 18–24	4	1
Age 25–34	95	31
Age 35–44	155	51
Age 45–54	45	15
Age 55–64	4	1
Age 65–74	2	1
Used the internet >6 years	35	11
Used the internet >10 years	264	87
Use the internet at home	298	98
Use the internet at workplace	247	81
Use the internet everywhere	193	63
Still working in pre-pandemic jobs	246	81
Changed jobs during the pandemic	36	12

and exposure to advanced technology. Activities such as playing games, searching for information, helping others, and troubleshooting gadgets in both professional and everyday contexts can contribute to improving digital literacy [27, p. 100]. In our current study, respondents also reported using digital devices for various activities that likely impacted their digital literacy, such as hobbies, learning new skills, and searching for information. In fact, the respondents indicated that their digital literacy had improved compared to before the pandemic, with 57% of them agreeing or strongly agreeing that they now know better how to connect to the internet and use mobile data to connect other digital devices to the internet. This suggests that the increased reliance on digital technology during the pandemic has led to improved digital literacy skills in many areas.

In India, mobile device usage, particularly smartphones, has shown a higher prevalence compared to desktops between 2020 and 2022 [28]. The use of mobile devices, including smartphones, experienced a surge from December 2020 onwards, while desktop (including laptop) and tablet usage declined during the same period. The shift towards increased mobile device utilization during the pandemic suggests a greater acceptance of smartphones. Our data show that a significant percentage of respondents (61% and 53%, respectively, for technology problems and computer viruses) demonstrated the ability to independently troubleshoot digital issues. Such proficiency perhaps cultivated when addressing common problems throughout the pandemic. Additionally, one's experience and the specific technical challenges encountered might have influenced their troubleshooting skills.

Nonetheless, when it comes to uncommon or advanced technology issues, users might still require assistance regardless of their experience level. More than half of the respondents (59%) acknowledged the need to learn new skills and digital applications to continue working effectively from home during the pandemic, with many of them finding it effort-intensive. The effort required to sustain their usual level of performance in the workplace was perceived as a challenge, and effort expectancy is known to be a strong factor in determining ICT adoption and use [16]. Respondents in our study indicated most of the challenges to productivity when teleworking were related to technology use (i.e., laptop, phone [smart/mobile/feature], desktop, device, digital, iPad). Although the respondents possessed a reasonable level of digital literacy (87% having used the internet for over a decade) and successfully adapted to heightened digital demands during the pandemic, a segment (>30%), including individuals with fewer years of internet usage (11%), encountered difficulties in keeping up with advancing digital skills. It is crucial not to neglect the less experienced or less adept with ICT and to offer avenues for seeking support for technology problems, including security-related concerns. Introducing training sessions and easily accessible support resources could also aid in enhancing their digital literacy.

3.2 Everyday Life Factors

As the boundaries between work and home blur, new tensions arise. Thompson and Paul [8] define everyday life factors as including organizing daily life, personal communication and information seeking and use, and entertainment. The survey respondents expressed difficulties concentrating on work while operating from their residences due to various issues related to everyday life factors. Numerous respondents reported encountering challenges in locating a dedicated workspace within their homes during the pandemic, with 48% strongly agreeing or agreeing there were issues. A considerable percentage of respondents (71% *agreed* or *strongly agreed*) indicated struggling with the challenge of balancing family and domestic responsibilities. Many respondents indicated they had added responsibility of caring for family members (77% *agreed* or *strongly agreed*) and assuming the role of the go-to person for digital assistance at home due to their familiarity with digital devices (29% of respondents). Additionally, respondents reported assisting their children with online schooling and assignments using digital tools (31%), finding it arduous to motivate their children to engage in online classes (31% *agreed* or *strongly agreed*). Sixty percent of respondents *agreed* or *strongly agreed* that they often had to aid others in using digital technology, which could contribute to elevated stress levels due to ongoing disruptions at home, and 64% of respondents *agreed* or *strongly agreed* that they found themselves without personal time and yet had to maintain a rigorous work schedule.

3.3 Professional Use Factors

The findings suggest that users who did not extensively use digital devices in their professions prior to the pandemic had to adapt to increased digital use. Existing literature has highlighted profession as a primary reason for people to adopt digital technology [8, 29–32]. Respondents noted that their employers provided various combinations of digital devices for telework, ranging from one device (such as a laptop, desktop, or smartphone) to multiple devices (such as laptop + smartphone + iPad/tablet). More than half of the respondents (56%) were provided only laptops by their employers, while 32% were provided at least one other digital device (such as smartphone, feature phone, or iPad/tablet) along with the laptop. The most common combination was a laptop and a smartphone, which was provided to 15% of the respondents. Some respondents also reported being provided other devices such as headsets, big screens, monitors, and polycom speakers along with the laptop. Only a small percentage (25 respondents or 8%) reported not being provided with any devices by their employer. The availability of first-level device support was important for respondents to effectively perform their job tasks. In fact, a significant proportion of respondents (54%) *agreed* or *strongly agreed* that they worked more efficiently during the pandemic because of digital technology.

Furthermore, responses to an open-ended question on challenges faced when adopting ICT to fulfill work during the pandemic involved work-life balance, extended meeting hours, internet and connectivity issues, power outages, excessive technology use, data security, home space or disturbance issues (internal and external noises), learning collaboration tools, support issues, difficulty in replacing physical with digital in certain roles and professions, loss of interpersonal skills, major expenditures on buying devices and connectivity plans for the entire family, and concerns about excessive digital use and its impact on children in home environments.

Therefore, it is important for businesses to consider the family circumstances and living conditions of teleworkers, which can hinder ICT adoption and may cause "digital aversion" indirectly affecting productivity.

3.4 Social Networking Factors

Our survey probed the social networking of the respondents via social media. We found that 59% of our respondents *agreed* or *strongly agreed* that they increased their social media use due to the pandemic, and 61% reportedly visit social media sites daily. This figure is somewhat close to the media reports of a remarkable spike during the pandemic in social media use [33–35], nevertheless, it is possible that our data reflects the downslide in social media usage from the early stages of the pandemic [36]. Our respondents also indicated an increase in communication or chatting as an impact of the pandemic (52% *agreed* or *strongly agreed*).

Facebook, WhatsApp, Instagram, LinkedIn, and Twitter were reported as the main social media platforms used by our respondents. A considerable proportion (69%) reported using WhatsApp "always" and reported that they adopted WhatsApp for both personal and professional communication. LinkedIn was used mainly for professional networking, learning, and job search.

3.5 Time Factors

As indicated before, 83% of our respondents reported working more than 8 hours a day during the pandemic. We tried to further analyze if this reflected in their daily work lives in adverse ways. Our data indicated that 54% of respondents either *agreed* or *strongly agreed* that they had no time for themselves but had to continue working hard, whereas 47% *disagreed* or *strongly disagreed* that their lives had "not changed much," implying that the pandemic has impacted their lives. The impact may not be attributed entirely to the long working hours at home but also to the new challenges posed by the pandemic and the new everyday order of lives that the respondents had to grapple with and reconcile to. Also, 63% of the respondents

agreed or *strongly agreed* that they spend more time with family. It indicates that working in home spaces enabled them to spend time on family responsibilities along with work. However, the majority of respondents reported that they feel like they have no time for themselves. These findings indicate that dealing with work and family responsibilities simultaneously overwhelmed the respondents, so they were unable to find time for personal care.

Thirty-one percent of our respondents reported that they use digital devices daily to help their children with online schooling, homework, and other activities (62% of participants indicated that they lived with family members under the age of 18), and 29% respondents indicated that they use digital devices daily to help other family members over the age of 18 (90% of participants indicated that they lived with family members over the age of 18). It suggests that the teleworker's time was divided between work and domestic and family duties. The increased demands for family support using ICT during the pandemic, combined with remote work from home, blurred the boundaries between work and family life, potentially explaining the extended work hours reported by respondents due to disruptions in their work routines.

Despite the duties, distractions, and demands of domestic responsibilities, the ability to effectively manage various aspects of their lives could make these long workdays satisfying for individuals, provided they have the flexibility to navigate their daily responsibilities. Forty-four percent of the respondents either *agreed* or *strongly agreed* that they balanced their online and offline time well; 53% *agreed* or *strongly agreed* that they had good self-regulation in their use of digital technology; and 68% *agreed* or *strongly agreed* that digital technology has provided them with the flexibility to manage work and home duties. These findings indicate that despite the longer work hours associated with remote work, which we previously discussed as a potential source of work dissatisfaction, individuals can still make the most of the flexibility it offers by possessing strong skills in time management and digital self-control. Self-regulation and time management are therefore important, especially when individuals are juggling multiple responsibilities concurrently. It might be beneficial for businesses to consider this and provide training to help their employees develop these crucial competencies.

3.6 Privacy and Security Factors

Surprisingly, only a single respondent expressed concern regarding information security, emphasizing the necessity of maintaining up-to-date antivirus software on their laptop to ensure the security of their digital data. Among the entire respondent pool, 53% *agreed* or *strongly agreed* that they have acquired improved methods for avoiding computer viruses compared to their pre-pandemic knowledge. In contrast, 43% *disagreed* or *strongly disagreed* with the notion that safeguarding their devices

against viruses and cyberattacks is challenging. A noteworthy subset of respondents (84 individuals, accounting for 27.54%) reported that they did not encounter obstacles while utilizing digital technology for work. It remains uncertain whether this sense of digital security arises from effective training within the workplace, robust security software, or simply a high level of self-assurance (whether warranted or not) in their cybersecurity proficiency. Still, 62% of respondents *agreed* or *strongly agreed* that they are now more adept at adjusting privacy settings in various applications and tools compared to before the pandemic.

An even split of 39% of participants *agreed* and 39% disagreed when asked whether they found it challenging to protect personal privacy while working remotely, and 29% of respondents indicated grappling with issues related to spam, fraudulent calls, or messages, and 24% encountered problems tied to passwords. A more comprehensive study is necessary to delve into teleworkers' viewpoints and behaviors as they adopt new ICTs and become aware of new ways to safeguard their privacy and engage in device security. Enhanced comprehension of the intricate interplay between individuals and digital technology is crucial for effectively addressing concerns related to security and privacy [37]. More about privacy concerns when sharing digital devices and lifestyle issues of sharing workspaces at home with others are discussed in the device sharing and health and lifestyle sections and subsections respectively.

3.7 Physical Access Factors

Achieving digital inclusion requires at least occasional physical access to technology [8], which was the case for our respondents. While our survey participants had the means to access digital technologies (as the survey was distributed digitally), we asked what ICT access they had. Nearly 89% of the respondents reported using smartphones, and 84% mentioned using laptops as their primary devices to access the internet, marking them as the most prevalent devices. Additionally, 43% of respondents reported using feature phones (keypad phones) regularly, underscoring their continued popularity in India. A smaller segment of respondents (29%) stated using iPads. While we did not ask which devices were new adoptions during the pandemic, as employers provide their employees with electronic devices, sometimes multiple, to facilitate job tasks outside of the workplace and beyond regular working hours, it is not uncommon to observe individuals carrying multiple electronic devices. As 70% of our respondents reported working from home constantly and 21% working from both home and office during the pandemic, they needed to have the necessary resources such as digital devices, connectivity, and support for troubleshooting. We covered some details related to connectivity in Sects. 3.3 and 3.8.

3.8 Device Dependency Factors

According to Thompson and Paul [8], digital inclusion can be influenced by which devices and/or applications (apps) are used for which tasks. Device design significantly influences the adoption and utilization of ICT throughout the day. Various dimensions, such as visual, functional, kinesthetic, interface, and information, converge to shape the overall user experience [38]. According to Jung et al. [39], the concept of "ecology of artifacts" describes how users determine their device usage based on the interplay between the physical and interactive attributes, functional and informational properties, and reflective values such as emotional or experiential ones.

Our findings reveal that laptop adoption (84%) was typical for teleworking and keeping up professional roles that can be executed from any location. In contrast, smartphone users (89%) tended to utilize their devices for both work-related and personal tasks, as previously indicated. This tendency is now further reinforced by the portability and easy access to documents through cloud storage, enabling file synchronization. Efficient and user-friendly digital technologies have facilitated the adoption and utilization of digital tools from various locations. This trend is ongoing, propelled by the introduction of new technologies like 5G and 6G and concepts like the Metaverse, as well as the development of novel user-centered devices that have the potential to enhance the teleworking experience. Businesses should remain attuned to these advancements and swiftly adopt technologies that enhance productivity and provide a seamless teleworking environment.

4 A New Model of Factors of Digital Inclusion with Non-voluntary Telework

Thompson and Paul's [8] FDI model was used to evaluate digital use in the teleworking context. The framework enabled us to discern how telework aligns with our comprehensive understanding of holistic digital inclusion. The FDI model offers a broader perspective on the environment in which digital adoption and use occur. Consequently, it grants us the flexibility to delve deeply into the context and assess it through the lenses it provides: digital literacy, everyday life, professional use, time, social networking, privacy and security, physical access, and device dependency. Simultaneously, it allows us to evaluate other emerging factors specific to the particular context.

By applying the FDI model within the teleworking environment, particularly within the home setting, we were able to design our survey instrument and thoroughly examine the survey responses using the aforementioned factors. Our exploration of this context also unveiled two additional factors that came to light primarily due to the sudden imposition of the COVID-19 pandemic, which compelled workers to transition to remote work: device sharing and the impact of teleworking on health and lifestyle (Fig. 2). We will now discuss these two factors.

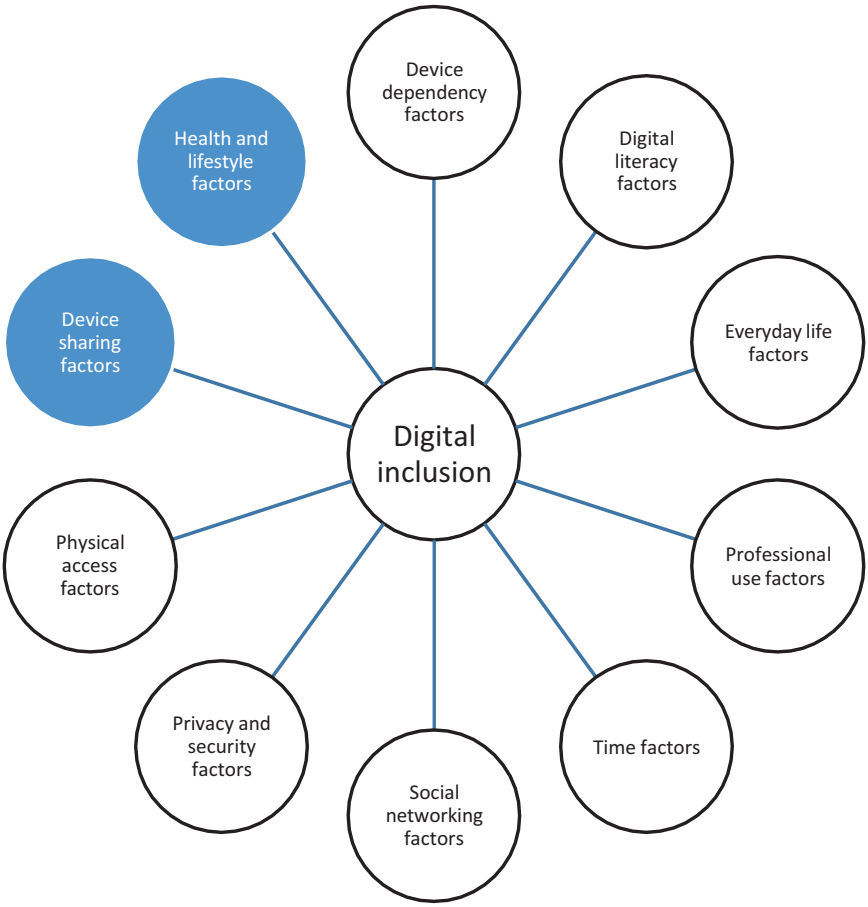

Fig. 2 Revised model of factors affecting digital inclusion with device sharing and health and lifestyle factors added

4.1 Device Sharing Factors

Related to lifestyle, physical access, and device dependency factors is individual and shared ownership of digital devices among family members. Kaltiainen and Hakanen [40] note this as well in their overview of work and non-work factors affecting employee wellbeing. They found that families with children living at home "experienced greater work-non-work interference to increased teleworking" (p. 1). From our own data, while certain devices like smartphones, laptops, and wearables are typically considered personal (78%, 82%, and 30% of respondents emphasized this), respondents sometimes reported sharing these devices within their families.

Roughly 51% of survey respondents indicated that they shared digital devices with others. In certain instances, these devices were items that might be considered communal family assets (36% sharing iPads/tablets and 64% sharing smart TVs). Not surprisingly, for families with at least one child, a higher percentage (47%) reported sharing of iPads/tablets. Even though iPads/tablets and smart TVs possess distinct characteristics such as size, functionality, and mobility, they are more frequently shared within families. This suggests that these devices are either used as secondary gadgets or for family-oriented activities such as entertainment (particularly for smart TVs) or tasks like reading and browsing (when the iPads/tablets are shared within the family, including when used by or with children).

With the new normal and rapid advancement of user-friendly technologies, businesses are increasingly considering teleworking and hybrid work models. Given the considerable importance of this factor within the teleworking context, it justified its inclusion as a distinct aspect within the FDI model. This consideration becomes especially relevant for businesses, particularly in collectivist communities that have not yet fully transitioned from shared to individual ownership of digital devices within or outside their households.

Additionally, businesses must address concerns related to privacy and security as they adopt these new work models. It is imperative that, when developing their policies, businesses take into account the needs and dynamics associated with device sharing among teleworkers and family members. Furthermore, there is a need to tackle issues related to tracking applications used to monitor the performance of teleworkers. Utilizing the FDI lens in future teleworking contexts, with a specific focus on this factor, can provide a more comprehensive understanding of these challenges and potential solutions.

4.2 Health and Lifestyle Factors

This study took place during a worldwide pandemic, a time when individuals were not asking to telework or contracting for telework, but rather, it was a time when there was little or no choice about whether or not to telework and adopt ICT in one's life in a new and unexpected way. Kaltiainen and Hakanen [40] have likewise noted that emergency (not self-selected) change in lifestyle during the pandemic resulted in a different psychological situation than a voluntary switch might have created. While they note that the results are not always negative (for example, some employees may be very glad to be instructed to work from home, especially if it means job security during an uncertain economy), there can be negative impacts on wellbeing. While not a large number, some respondents from our study reported concerns about different facets of utilizing digital technology, including physical wellbeing (n = 11), psychological wellbeing (n = 7), data privacy (n = 2), and information security (n = 1). The respondents also noted problems related to eye strain, extended

periods of sitting, and insufficient physical activity. The primary highlighted concerns were stress, depression, and feelings of monotony. Employers should prioritize digital health and explore methods to engage employees through user-centered tools that oversee and restrict excessive digital engagement to counteract its impact on health, as advised by Vanden Abeele [37].

In addition, certain respondents raised issues about the challenges faced while working from home due to the absence of personal privacy in shared spaces, such as instances of children attending online classes in multiple rooms. This scarcity of dedicated workspaces might influence work efficiency and pose an ongoing challenge in compact home settings. Intrusions into home workspaces can disrupt remote workers, even if they find remote work models convenient. Consequently, businesses need to acknowledge these concerns regarding personal workspaces and actively involve input from remote workers during the formulation of remote work policies.

Health and lifestyle factors encompass both physical and mental health issues arising from teleworking conditions. Digital technologies and remote work bring about both positive and negative effects. On the positive side, teleworkers enjoy a more flexible work schedule, saving commute time, and increased time with their family. Conversely, telework can lead to isolation from colleagues and social connections outside of the home/family environment, disrupt daily routines, increase stress, contribute to feelings of depression, and result in a sense of monotony. Moreover, technostress and related issues can also arise. Treating health and lifestyle as a distinct factor allows for a more in-depth examination of this aspect within the realm of digital inclusion, an area that has received limited attention in the existing literature.

The United Nations' 2030 agenda for sustainable development emphasized a people-centric approach with a shared goal of promoting peace and prosperity for both humanity and the planet [41]. Given the disparities between developing and developed nations in terms of digital infrastructure, usage, and adoption, it is crucial to identify and address the relevant factors that affect digital inclusion. Digital inclusion, especially concerning vulnerable populations, has remained a key focus for the United Nations in 2023. In this context, the FDI model provides a timely tool for evaluating the criteria established by the United Nations for digital inclusion across different contexts and populations. The application of this framework in diverse settings can also aid in deconstructing or refining the factors to further develop the model.

The themes discussed in our study underscore the relevance of these concepts in the context of India. Given the increasingly complex global landscape and the multitude of stakeholders involved, it is crucial to maintain a focus on a value-driven society. Businesses must continuously reevaluate their practices as they play a pivotal role in achieving the Sustainable Development Goals (SDGs) and realizing the objectives of the United Nations Sustainable Development Goals (UNSDG) 2030 agenda. The FDI model can serve as a valuable tool in this pursuit.

5 Discussion

Digital technologies had a significant role to play in the lives of the teleworkers during the pandemic, as individuals could continue working remotely from home. Our research aimed to explore how digital technology shapes the experiences of teleworkers and the factors affecting digital inclusion relevant to their digital usage. In doing so, we emphasized the challenges and tensions that arise when working from home. We leveraged the FDI framework to comprehensively examine different aspects of digital inclusion from a human-centered perspective.

Most digital literacy models constitute some or the other digital skills, stressing "knowing and using" hardware, digital tools and software, and the Internet [42]. Along the same line, effort expectancy has also been seen as a direct determinant of digital adoption and use [16]. With increasing usage of digital technologies and rapid technology developments, there is more that needs to be considered. Determinants of digital skills include personal, social, and technical factors [43] which our study's findings further reinforce. Motivation is an important underlying aspect that enables employees to improve their abilities and invest effort in acquiring new skills and mastering new digital tools needed for their job roles. Teleworking is seen as a strong incentive to such motivation as it provides the employees with the much-needed flexibility to attend to their various needs, which eventually reflects in their workplace productivity [44]. In addition, time spent online when pursuing hobbies or entertainment can enrich the digital experience, enhance digital use, and reduce resistance to ICT adoption. There have been references to the value of non-work activities on job skills in IT [45, 46]. Petter et al. [47] specifically emphasize the importance of skills acquired through non-work activities, such as online gaming, as an indicator of the essential proficiencies required for the digital workforce. Hence, we advocate that organizations could look at the extracurricular competencies when evaluating teleworkers capabilities.

The findings of our study demonstrate the significant implications of the home space when teleworking. Challenges of working in home spaces included non-availability of dedicated workspaces, supporting family members with their needs (including digital), absence of personal privacy, being subjected to disturbances, bad influence for children, etc. Cuerdo-Vilches [48] highlight the significance of physical and environmental characteristics of home workspaces (such as room size, lighting, temperature, furniture, etc.) and further relate it to the socio-economic characteristics of the cities, households, and their members as well as their ways of life and interpersonal relationships. Earlier studies also postulated the spatial implications of virtual work, suggesting that establishing a functional workspace at home can present difficulties [49]. Hence, we claim that home spaces are in a state of perpetual dominance and appropriation, rendering endeavors to recreate conventional work environments at home largely ineffective. Instead of attempting to exert control over the home environment through digital usage policies, businesses must explore novel methods for harmonizing work and home spaces. The concept of duplicating a workplace setup at home, with an emphasis on productivity and

surveillance, warrants reevaluation. While the capacity to work remotely remains essential, the significance attributed to workspaces must be scrutinized, and appropriate measures should be planned to mitigate the tensions stemming from the blurred boundaries between work and home.

Another aspect related to remote work from home is the autonomy and flexibility it offers to remote workers [50]. Home spaces blur the boundaries between work and home creating ways for family related issues to become sources of work distractions and, consequently, work-related stress [51]. However, the extent of conflict between family and work demands varies depending on an individual's career and life stages [52]. Studies illustrate the various factors that contribute to the degree of autonomy teleworking offers to workers. Thulin et al. [53] propose that more qualified workers will have more autonomy as opposed to lesser qualified counterparts. However, their findings diverged when considering social factors such as family situations and gender-related expectations of workers. Other research has indicated that the benefits of autonomy associated with teleworking can be offset by the influence of family members [54].

Our findings highlight the fact that the pandemic has set new expectations and heightened awareness regarding the advantages of flexibility and the challenges of teleworking. In such a context, it is essential for businesses to offer a range of options to employees based on their job roles and their individual preferences for remote work. The present study involved respondents with diverse educational backgrounds and roles within the organization, highlighting the need for tailored policies rather than a one-size-fits-all approach. Also, the pandemic has reshaped expectations, leading businesses to adopt teleworking and hybrid models as part of the new normal. Consequently, it would be counterproductive to apply a uniform approach to the varying teleworking needs. Additionally, our research identified factors, such as family circumstances, living conditions, and job requirements that can have distinct effects on teleworking experiences.

In our study, we unexpectedly uncovered a connection between the health of teleworkers. Existing literature has overlooked the health implications of teleworking, although there have been indirect links to psychosomatic health complaints arising from teleworking conditions [53]. Beckel and Fisher [55] have summarized the sparse research on teleworking and its effect on worker health and well-being, and they have developed a conceptual model that establishes a relationship between teleworking and health outcomes. Within this model, job characteristics emerged as a significant element, serving as both an antecedent and mediator while also acting as a moderator, highlighting the importance of the job context. Other factors, such as individual demographics and characteristics, along with the social context and gender, were seen to determine health outcomes. Additional studies have found that gender and parental responsibilities can impact health-related issues [56]. We, too, discovered references to health concerns without directly investigating them. Nevertheless, it is evident that the pandemic has pushed the boundaries, potentially exacerbating health concerns stemming from prolonged working hours. We suggest that as teleworking and hybrid work arrangements become more prevalent, the impact on health outcomes is likely to become a growing concern.

We identified device sharing as a crucial aspect of remote work, yet the existing literature has given little attention to the concerns arising from device sharing during teleworking. Literature on sharing of digital devices, conducted both in collectivist and individualistic cultures, underscores the widespread practice of device sharing within households for various reasons [57–59]. These studies examine the motivations behind device sharing, its implications for the future design of ubiquitous computing technologies, as well as the privacy and security risks associated with sharing. Trust is recognized as the foundation of sharing within households, but in the context of teleworking, it may raise valid concerns for employers. Studies in collectivist cultures that explore why people share devices highlight trust-building, expressions of affection, and the maintenance of transparency as key factors [57, 60]. Though businesses employ various safeguards to protect their information, it is valuable to comprehend the dynamics of the home environment and the cultural influences on enforced policies.

Although it is advisable to restrict the sharing of work devices among teleworkers within their households, the absence of designated workspaces and privacy in home environments can lead to intrusions and breaches of these devices. Conventional non-disclosure agreements and confidentiality policies may not translate seamlessly to the teleworking setting. Nonetheless, introducing measures that limit access to non-work-related technology can provide some advantages, especially when complemented by training and awareness initiatives designed to educate teleworkers about the diverse ways that breaches occur in home contexts and resulting repercussions. Additionally, exploring the human-centric aspects specific to teleworkers within their home environments can offer insights into additional measures for enhancing confidentiality enforcement.

6 Conclusion

Digital technologies are enabling businesses to adopt various teleworking models in the new normal. However, it is important to examine the factors that influence the use of digital technology for telecommuting. For this study, we used a two-phased mixed-methods approach to explore the digital use of teleworkers in India using the FDI model [8]. The two-phased approach enabled us to investigate aspects closely tied to digital activities while working from home. This approach revealed noteworthy trends and shed light on factors influencing digital engagement within these trends.

Based on our study, we expanded the FDI model by introducing two additional factors: device sharing and health and lifestyle. The results indicate that multiple factors related to digital inclusion could have an impact on the productivity of teleworkers; nevertheless, the key ones included digital literacy, time, physical access, and everyday life. The exceptional circumstances of the pandemic allowed us to identify and discuss the factors of device sharing, health, and lifestyle, which

emerged as significant when examining the physical access and daily life factors of the FDI model that may have been latent otherwise.

This study provides a comprehensive understanding of how teleworkers digital practices at home impact the remote work quality and offers insights for businesses to effectively manage productive remote workforce in the post-pandemic era. While digital technologies are set to play a crucial role in the new normal, there must be careful consideration of their impact on the teleworker's life based on the results of our study. The teleworker's characteristics, family circumstances, and living conditions must be carefully considered when implementing teleworking policies to maintain productivity. Businesses should adopt a forward-looking approach, taking into account the latest technological developments that are reshaping the work environment.

Findings of this study are not generalizable and limited because of the exploratory nature of the study and sampling. Recruitment of the survey respondents through the business executive class affected the selection pool, skewing the sample to a group of highly educated and dominantly male respondents working in management, computer science, and education. A survey instrument for digital inclusion (Appendix) framework developed for this study needs to be improved and validated in future studies.

Future studies can explore remote work conditions in the new normal when not everyone in the family is required to stay at home, which was the case in our study. It would be valuable to replicate the given study among representatives of different social classes, gender, age, occupations, and generations in various countries. With an increasing trend for global workforce spread across different countries, the cultural factors, such as family structure, home office space, digital device sharing and other contextual elements, should be investigated further in remote work.

Appendix: Questions for the Survey Instrument: Digital Usage in India During Pandemic

S. no.	Details
1	Description about the study
2	IRB consent
3–5	Screening questions
6	Demography details
7	Family members (age and size)
8	Occupation
9–11	Location—Country, state, city
	Digital use questions
12	Which of the following devices do you use for yourself or share with other family members
13	Years have you been using the Internet
14	How do you connect to the Internet

S. no.	Details
15	Where do you connect to the Internet?
16	How often do you use the following devices to connect to the Internet
17	How often do you use the following social media platforms?
18	Change in Digital Literacy during the pandemic
19	Continuity in work during the pandemic
20	Work location during the pandemic
21	Digital devices provided by work during the pandemic
22	Days per week are/were you working from home
23	Hours worked before pandemic
24	Hours worked during the pandemic
25	Effect of pandemic in daily life
26	Challenges faced with usage of digital technology to fulfill yourwork
27	Use of digital device for following everyday life tasks during the pandemic
28	Impact of the pandemic on your digital technology usage.
29	Challenges encountered during the pandemic
30	Social media platform used the most during the pandemic. Reasons of social media use
31	Privacy/security issues faced when working with digital technology during the pandemic

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Discriminant Validity of Factors for Evaluating Performance of eHealth Information Systems

Margaret Nagwovuma, Gilbert Maiga, and Agnes Nakakawa

1 Introduction

Governments in developed and developing economies have invested in information and communication technologies (ICTs) in different sectors to improve service delivery, like health, agriculture, education, and transport [1]. Developed economies have greatly benefited from ICTs. However, developing economies are still leapfrogging about the benefits of ICTs. For instance, in the health sector, there is an increased burden of disease, especially for developing economies [2], which continues to be one of the major priorities for sustainable development, i.e., sustainable development goal number three [3]. In this regard, there are challenges (for healthcare and healthcare systems) that require improving the quality of treatment and broadening access to medical care [4]. Thus, to deliver the desired healthcare and its benefits, like cost-effective facilities, reduced operating costs, enhanced productivity, and increased efficiency, governments and healthcare providers need to appreciate ICTs [5]. The use of ICTs in the delivery of health services is referred to as eHealth [6, 7]. Thus, eHealth is seen as a backbone for re-engineering healthcare systems and improving the effectiveness and productivity of the healthcare delivery system [8].

The WHO global survey revealed that about 46% of the low- and middle-income countries have a National Electronic Health Records system [9], set up to improve the quality and efficiency of healthcare in these countries [10], hence increased implementation and deployment of eHealth solutions. Despite the enormous implementation of eHealth ISs in developing economies, a failure rate of 70% of eHealth initiatives has been recorded [11]. Mauco et al. [11] identified the following issues

M. Nagwovuma (✉) · G. Maiga · A. Nakakawa
Makerere University, Kampala, Uganda
e-mail: margaret.nagwovuma@cis.mak.ac.ug

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that lead to the failure of eHealth ISs as lack of eHealth readiness assessment, limited funding, inadequate infrastructure, deficiency of skilled personnel to support the initiatives, failure of acceptance, absence of process guidance, poor communication of available information, and lack of evaluation.

It is important to note that most eHealth ISs in developing economies are acquired as ready products that are donor-funded and are implemented within stipulated timelines [12]. Lewis et al. [13] add that 47% of eHealth interventions in low- and middle-income economies are largely donor-dependent and employed as part of health systems programs (like maternal health, childcare, HIV and AIDS, and tuberculosis) to improve healthcare service delivery. Thus, funders of these programs have been advised to sponsor evaluations of these initiatives in order to reduce implementation failures and improve their effectiveness and sustainability [14]. In addition to the development of different eHealth solutions and efforts to support the existence of these solutions, research has shown the development of different eHealth IS evaluation approaches, i.e., models, techniques, and frameworks. In this study, these approaches acted as a source of factors for evaluating eHealth implementations. Thus, the factors obtained as part of an ongoing study for developing a mechanism for evaluating the performance of eHealth ISs were collected using surveys in 2019–2020; however, discriminant validity tests were required to test the level of unrelatedness of the constructs.

Discriminant validity refers to the degree to which a test is unrelated to other tests that evaluate different constructs. Also referred to as discriminant validity, it is intended to ensure that constructs used in social research that are hypothesized to be unrelated to one another are indeed unrelated. Discriminant validity is crucial as it examines whether the construct in question accurately targets the construct of interest or if it measures independent, inadvertently related, constructs [15].

Rönkkö and Cho [16] emphasize that conducting discriminant validity has led to the introduction of various techniques, i.e., introduced on ad hoc basis. Thus, discriminant validity is focused on techniques that are associated with multiple distinct measurement methods for different studies. For example: In Foote et al. [17] study, the validity of eHealth Literacy among military SMS was used to identify an intervention to increase "medical readiness, well-being, and quality of life" for personnel. In the Sumayyah et al. [18] study, discriminant validity of constructs led to the creation of a quality-enhanced eHealth technology for improving online health and online information-seeking in eHealth environments.

Whereas different tools exist to appraise factors that are associated with the evaluation of eHealth ISs, a number of them have used structural equation modeling [19] i.e., exploratory and confirmatory factor analysis to validate an instrument to evaluate the success of electronic health records in a hospital setting [20], concentrated on the health consumers' perspective [21], used a socio-technical approach to evaluation [22] and evaluated models for the evaluation of e-learning in vocational education [23].

In this study, structural equation modeling was used to conduct discriminant validity tests for the factors identified for evaluating performance of eHealth ISs. Details are highlighted in the sections that do follow.

1.1 Factors for Evaluating Performance of eHealth Implementations

1.1.1 Performance Evaluation of Information Systems

Moucheraud et al. [24] point out that eHealth ISs improve disease surveillance, quality improvement, program management, and strategic use of information when sustained in developing economies. Thus, as part of program management, evaluations and performance measurement play a pivotal role in availing the required information to decision-makers to ensure that desired results are obtained in organizations [25].

1.1.2 Existing Approaches for Evaluating eHealth Information Systems

Evaluation of eHealth ISs is at minimal levels in more than 90% of the 70% of African countries that deployed these initiatives [26]. Different authors [12, 26–28] have pointed out that evaluation in these economies is not considered a key activity. Other issues affecting less evaluation include the unavailability of funds, lack of knowledge about evaluation, and lack of national guidelines to help implementers and evaluators conduct evaluation [27, 28].

Frameworks for evaluation of eHealth IS include: the Infoway Benefits Evaluation framework [29, 30]; Human Organization and Technology-Fit (HOT-Fit) [31]; Health Information Technology Research-based Evaluation Framework (HITREF) [32]; the evaluation framework for Laboratory Information Systems (TTP-LIS) [33]; Performance of Routine Information Systems (PRISM) [34]; and the Clinical, Human, Organization, Education, Administrative, Technical, and Social (CHEATS) [35]. Infoway Benefits framework measures the benefits of eHealth ISs [29]; however, it misses out some aspects needed for evaluation of eHealth ISs, like strategy and culture. HOTfit provides categorizations for continuous evaluation of eHealth ISs [31]; however, it does not provide the professional contextual aspect of evaluation [36]. HITREF focuses on accepting eHealth IS with the health service research aspect [32]; however, it does not show how and when to evaluate the systems. TTP-LIS is an extension of HOTfit, and it is used in detection and prevention of errors for laboratory services [33]. TTP-LIS is limited to laboratory activities, and it attracts few collaborations since interactions are based on sensitive data. PRISM considers the evaluation of routine eHealth ISs using three significant constructs: technical, organizational, and behavior factors [34]. However, PRISM lacks other determinants of performance for eHealth ISs like user satisfaction, used only in the formative phases of systems and does not consider detailed information of participants [37]. Last, the CHEATS model was developed by Shaw [35] to evaluate eHealth ISs. However, relationships between different variables for evaluation are not known. The approaches discussed for evaluation of eHealth IS consider different aspects with a few aspects for performance evaluation [38–40]. Irreversibly, different factors have been established by different researchers to evaluate the performance of ISs in general.

1.1.3 Factors for Performance Evaluation

[38, 39, 41–43] agree that evaluating an IS/IT performance is not an easy task, but organizations still demand to know the impact of IS/IT on them, as well as for the individuals that work with them. Saunders and Jones [41] state that performance evaluation goes beyond cost analysis and service levels to understanding soft benefits like a strong strategic advantage, improved decision making, and added flexibility. Saunders and Jones [11] and Chang and King [39] state that IS/IT performance evaluation requires a multidimensional approach. There are many approaches that exist in the literature, and theories for evaluating the performance of an IS/IT. These abundant theories differ in perspective and allow different aspects of an IS/IT to be measured. The choice of the measures to be evaluated depends on the budget a particular organization has for that task [44]. For example, the works of DeLone and Mclean [45], Sulaiman [38], Saunders and Jones [41], Platisa and Balaban [46], among others, are explained below.

Torkzadeh and Doll [47] performed a study concerning the perceived impacts of information technology on work life, in which a set of four criteria were derived from a larger set of questions. These criteria were task productivity, task innovation, customer satisfaction, and management control. It should be noted that the tool only measured the opinions about whether a technological artifact had had a good impact; there were no factual measurements [47]. A study by Kaplan [48] developed a balanced score card approach to measuring a set of criteria from four different points of view [49]. These points of views are business value, user orientation, internal process, and future readiness. Each perspective contains a set of criteria. For example, does the future readiness perspective contain criteria like the age distribution of IS staff and expertise with specific emerging technologies. Jiang and Klein [50] have studied the evaluation of IS from the users' point of view and have summarized earlier literature into four categories of criteria: performance issues, decision quality, personal impact, and organizational impact. While the study was focused on measuring how important users felt these criteria were, the list of criteria is interesting in itself because of its concreteness. Irani [51] has categorized a number of semi-operationalized criteria. He has first divided the criteria into three major categories: strategic, tactical, and operational benefits, and then examined the criteria to determine what kind of benefit they bring. He sees that benefits can be financial, nonfinancial, and intangible. It should be noted that his article, however, is focused on measuring whether an investment is justifiable. Still, his categorization is interesting since it lists some 30 criteria that can be reformulated to fit into the current context.

DeLone and Mclean identified over 100 performance measures and categorized them into six: system quality, information quality, service quality, use, user satisfaction, and net benefits. System quality (usability, functionality, reliability, flexibility, and importance of a given system); information quality (potential accuracy, timeliness, completeness, and consistency of the information captured by the system); service quality (responsiveness, tangibility, and other contextually driven quality dimensions of a technological system); the Use (includes all the behaviorally driven

attributes like frequency and duration). The variable use has been acknowledged by the dual as troublesome because use may be seen in different ways, for example, voluntary, mandatory, effective, non-effective, and so on. In their refinement of the model, they had to use intention to act as a proxy to measure use. The user satisfaction variable has been conceptualized as the overall user cycle experience with the system. It captures attributes like attitude and repeated use of the system. Finally, net benefits capture various organization and personal impacts that are facilitated by the IS/IT. The D&M has been used as seen in several studies in evaluating the success and effectiveness of IS/IT.

Sulaiman [38] identified over 30 performance measures and characterized them also *into six themes/categories*: financial performance, system development performance, operational performance, managerial performance, personnel performance, and strategic performance. Operational factors include quality of system, quality of information, system utility, and user satisfaction. Abugabah and Sanzogni [52] conducted a study review and identified six criteria: performance aspects and measures, information at different levels, information systems and analytical approach, information systems and organizational context, information systems and type of business and the results, and productivity paradox.

Saunders and Jones, through a delphi technique of three rounds with IS experts, identified ten performance dimensions and their associated measures. The dimensions included IS impact on strategic direction, integration of IS planning with corporate planning, quality of information outputs, IS contribution to organizational financial performance, IS function operation efficiency, user/management attitudes about IS function, IS staff competence, integration with related technologies across other organizational units, adequacy of system development practices, and the ability of IS function to identify and assimilate new technologies.

Platisa and Balaban [46] state that the main aim is upgrading and especially improvement in the quality of maintenance. They identified eight performance measure factors that include functionality of information system: data quality, expected usefulness of information system, expected usage simplicity of information systems, self-efficiency of information system users, usage of information systems, influence of information systems on individuals, information system users satisfaction, and organizational factors. They further state that information system users satisfaction is used in the evaluation of IS/IT function performance. The relationship between a user and IS/IT is that a user interacts with the technology, which determines their subjective rating of the increased quality of his/her work.

The Information System Functional Scorecard (ISFS) model is another model for evaluating the performance of IS; it is based on IS's role to support organizational performance and business process effectiveness [39]. The model considers dthree dimensions, which include: system performance, information effectiveness, and service performance. The product quality model ISO/IEC 25010:2011 is used as a basis for assessing the properties of software products. The model considers eight quality characteristics. These include functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and Portability [53].

Analysis of eHealth IS Performance Evaluation Factors

The analysis of performance evaluation factors shows that Sulaiman's taxonomy of performance evaluation factors combines work from other researchers. For example, the product quality model ISO/IEC 25010:2011 can improve the operational factors in Sulaiman's taxonomy, specifically the quality of system construction. Other improved factors include "*service quality*" from ISFS model [39], where emphasis is put on evaluating user's experience with services provided by eHealth ISs. Ebener [40] also suggests that eHealth ISs performance can be improved by geo-enabling these systems as a quality of information, especially in the health sector since every activity is executed at a point in time. Pournasir [54] differs from Sulaimain [38] by demonstrating that *financial* resources influence strategy. In addition, most of the eHealth initiatives are donor funded with pre-established budgets apart from maintenance of the eHealth ISs. In this regard, financial factors are established within Strategic factors in the taxonomy. Silver and Markus [55] emphasize the level of attaining the purpose of an eHealth ISs is determined by its capabilities, development, and implementation methodology, among others. Thus, quality of system as presented by Sulaiman [38] can be improved by including system development as an attribute. In summary the following factors for eHealth ISs performance evaluations have been identified, and these include quality of information, quality of system, system utility, user satisfaction, personnel, organization (strategic and managerial), and service performance. These factors were used to identify a better approach for evaluating the performance of eHealth ISs.

1.1.4 Comparative Evaluation

As governments, policymakers, and researchers in developing countries access health data from eHealth ISs to guide planning, research, and solicit funds, they should devise measures to evaluate the performance of eHealth ISs using their national eHealth strategies, in turn improving healthcare delivery and patient outcomes [56]. A summary of performance evaluation factors of IS presented in Table 1, Sect. 1.1.4, i.e. Quality of information, Quality of System, System Utility, User satisfaction, Personnel, Organization (strategic and managerial), and Service performance, was used to identify a suitable approach for performance evaluation of eHealth ISs as follows:

The results from Table 1 show that INFOWAY, HOTfit, and TTPLIS have the highest score. However, INFOWAY does not add any other aspect apart from those aligned to the Delone and Mclean IS model [45]. HOTfit extends the Delone and Mclean IS model [45] by creating categories like organization that includes factors like Structure and Environment factors that affect the performance of eHIS and are generic in nature. Within the structure, aspects of strategy and management are taken care of, and the environment caters for a number of aspects, not limited to population served, inter-organizational relationships, politics, and government, among others [31]. TTP-LIS is an extension of HOTfit, but it is specifically designed for laboratory services. Out of three approaches, HOTfit bares a high score and it is

Table 1 eHealth IS performance evaluation factors vs eHealth IS evaluation approaches

No.	eHIS performance factors	PRISM	INFOWAY	HOT-fit	TTP-LIS	HITREF
1.	Quality of information	None	Quality of information	Quality of information	Quality of information	Quality of information
2.	Geo-enabling	None	None	None	None	None
3.	Quality of system	Quality of system	Quality of system	Quality of system	Quality of system	Quality of system
4.	System development	None	None	None	None	None
5.	System utility	None	Use	Use	Use	Use
6.	User satisfaction	None	User satisfaction	User satisfaction	User satisfaction	None
7.	Personnel	Behavior	None	None	None	None
8.	Organization	Organization	None	Organization	None	None
9.	Strategic	None	None	Strategic	None	None
10.	Managerial	None	None	Managerial	Managerial	None
11.	Service quality	None	Service quality	Service quality	Service quality	Service quality
12.	Net benefits	None	Net benefits	Net benefits	Net benefits	Net benefits
13.	Level of emphasis	Transparency and accountability of health systems in DC	Evaluation of HIS	Evaluation of eHIS	Error limitation and control in laboratory information services	Barriers or facilitators to adoption
Score		*3/12*	*6/12*	*9/12*	*7/12*	*5/12*

suitable for use in this study. In addition, it encapsulates factors from other approaches. However, it lacks, like "*Technical*," certain aspects of the "*behavior*" constructs from the PRISM framework [34, 37], which were still inclusive of the comparative evaluation. Other factors that were considered to be part of the comparison that are lacking in HOTfit framework included "*geo-enabling factors*" from Ebener et al., [40], "*personnel factors*" and "*system development factors*" both from Sulaiman [38] review for performance evaluation measures of IS. Sockolow et al. [32] emphasize that HOTfit lacks technical support, limited communication between technical and collaborating partners, and external context. All these gaps can be catered for using the "personnel" construct from Sulaiman's research, as well as consolidating a few aspects that cater to knowledge sharing and transfer, among others. In addition, "personnel factors" have not been explored by a number of researchers as a measure for performance evaluation, thus the need to consider them in further developments of IS performance evaluation [38].

Whereas there are a number of approaches forwarded for evaluating the performance of eHealth initiatives [33, 36, 57, 58]. However, they do not capture the

diverse aspects and amalgamative nature of eHealth in a particular contextual setting. Many approaches majorly focus on the technological aspect of eHealth ISs and put little or no consideration on aspects such as personnel, system development, behavior, geo-enablement, cultural, and organizational aspects of the initiative in a particular kind of setting [28, 40, 58]. There is also no "fit it all" standard performance evaluation approach designed for evaluating eHealth [58, 59]. Back in 2008, the ITU stressed that there is as yet no universally acknowledged methodology for evaluating eHealth solutions, either in industrialized countries or in the developing world. In 2020, Bonten [59] still observes that eHealth researchers find it difficult to determine the most suitable evaluation approach to evaluate their novel eHealth. Yusof et al. [31] recommended that more work be required on human and organizational factors because existing studies do not explain why eHealth IS work is not well defined in specific user settings since eHealth IS evaluation focus is always on technical or clinical processes. Kanaan et al. [60], urge that the updated Delone and Mclean IS success model [61] is widely used by IS researchers for understanding, organizing, and assessing IS success in different domains like ehealth. The Delone and Mclean IS success model comprises six major variables, i.e., information quality, system quality, service quality, use, user satisfaction, and net benefits. Maryati Mohd Yusof, Papazafeiropoulou et al. [62], extended the Delone and Mclean IS model [45] with the Technology Task Fit model and developed the HOTfit framework. HOTfit is comprised of the following categories or groupings: human (use and user satisfaction), technology (information quality, system quality, and service quality), organization, and net benefits. Thus, this study attempts to extend the key modules of the HOTfit framework to build a robust approach to evaluate performance of eHealth IS in the developing country's context, as elaborated in the following subsection.

1.1.5 The Identified Factors to Support Performance Evaluation of eHealth Solutions

Evaluating the performance of information systems is not an easy task [38, 39, 41–43]. However, organizations still demand to know the impact of IS on them and the individuals who work with them [38, 43]. eHealth performance presents an accurate picture of the state of these systems based on several factors like financial, strategic, service, personnel, system development and operational factors [38]. Thus, in developing economies, there is a need to employ approaches that consider the changing nature of healthcare concerning the environment of a project and undertake summative evaluations [63]. Since there exists no "one size fits it all" standard performance evaluation approach for evaluating eHealth ISs [58], there is a need to use available approaches for evaluating eHealth ISs and factors for performance evaluation of ISs to design an approach to evaluating performance of eHealth ISs.

Based on the comparative evaluation, the following factors were identified: quality of system, quality of information, service performance/quality, system use, user

satisfaction, personnel factors, and net benefits. Each construct contains a number of constructs that are used to measure it and elaborated as follows:

Quality of System (QOS): Quality of system is defined as a measure of the extent to which the system is technically sound [64]. Governments have adopted the use of eHealth ISs to improve service delivery in the health sector, both web-based and mobile applications. In this regard, it becomes important to identify aspects required to measure system quality from existing studies [31, 45]. Sulaiman [38] recommends that system development should be considered in IS performance evaluation because it promotes an organized approach to system design, development, and documentation throughout the organization.

Quality of Information (QOI): The quality of information produced by an information system/technology is used to measure its operational performance [31]. eHealth IS produces information that is used as a basis for system development and enables users to execute their tasks [38]. As for the quality of information, Ebener et al. [40] urge that it is also important to improve the performance of eHealth IS by using spatial data and technologies to improve healthcare delivery.

Service Quality: It is important to note that IS/IT departments operate as service units for various users in organizations, and organizational achievements depend on how well the IS services are delivered. Service quality can be measured through responsiveness, assurance, flexibility of services, empathy, cost reductions, training for eHealth IS, and service provider quality [31, 39, 45, 65]. *System Use*: System use is measured by amount of use, frequency of use, nature and purpose of use, motivation and acceptance, knowledge, and belief and expectations [31, 38, 45, 65]. *User Satisfaction*: Measure of user satisfaction in include satisfaction with functions, overall satisfaction, perceived usefulness, enjoyment, software satisfaction, and decision making [31, 45, 65].

Personnel Factors: Personnel factors are measured by technical capabilities, personnel training, career satisfaction, business knowledge [38, 45, 66]. *Organization Factors*: Yusof et al. [31] extended the Delone and Mclean IS model [45] with organizational factors pertinent to IS evaluation in the healthcare domain. Organizational factors enable people in healthcare institutions to achieve their targets or purposes using an electronic health information system. These will be measured by structure and environment. The structure will be further measured by nature (type, size), culture, planning and control systems, strategy, management, clinical process, autonomy, communication, top management support, medical staff sponsorship, and teamwork. And the environment will be measured by financing sources, government/regulatory authorities, politics, localization, competition, inter-organizational relationships, population served, and external communication. *Net Benefits of eHealth IS/Performance of eHealth IS*: eHealth IS benefits a number of stakeholders and agencies, both public and private. Net benefits measure the difference between

the positive and negative impacts of eHealth IS among different stakeholders and organizations.

The identified factors were later tested for reliability. Results for reliability are presented and assessed against a threshold of 0.7, which is widely accepted as the standard [67]. Reliability tests revealed that all the constructs met the minimum criteria, with all the values of Cronbach's alpha exceeding 0.7 except for the user satisfaction construct, which had a Cronbach alpha value of 0.235. Thus, it was eliminated from further analysis. After testing the reliability of the performance evaluation factors, there was a need for further tests on their validity and related sub-factors, guided by the following question: *What is the discriminant validity of the identified factors?* The objective of this chapter is achieved in the following subsections: Sect. 2 *presents the methodology*; Sect. 3 *presents presentation of results for discriminant validity of performance evaluation of eHealth IS*; Sect. 4 *presents the discussion*; and Sect. 5 *presents the conclusion*.

2 Methodology

The methodology followed the research that was conducted earlier in 2019–2020 to answer the research question raised in the study, i.e., based on a survey that was conducted in Uganda. Uganda was chosen as a representative developing country. Within Uganda, a sample of 15 districts was chosen, i.e., Gulu, Kampala, Lira, Apac, Mbarara, Jinja, Namayingo, Iganga, Busia, Mubende, Oyam, Nakaseke, Mityana, Luweero, and Otuke. These districts were selected because they are connected to the National Internet Backbone Infrastructure (NIBI) and have electronic health system projects running in some health centers. In addition, some districts are close (urban) to the NIBI, while others are a little distant (rural) from it. The nature of eHealth IS to consider in the study was not clearly established because, on a daily basis, key eHealth IS users would interact with one or more systems depending on his/her role in the health sector. The respondents' organizations included ministries, district health offices, religious medical bureaus, health implementing partners, health facilitating partners, ICT regulators, and health facilities. Lastly, private providers for eHealth IS, among others. Category on respondents included biostatisticians, data managers, DHO, health information officers, HMIS focal point persons, ICT personnel, M&E officers, medical directors, medical records officers, clinical officers, and other categories. Stratified sampling was used to categorize users of eHealth IS in both rural and urban settings. Purposively sampling was later used to select respondents who knew the subject matter. Quantitative techniques in the form of structured questions were used to obtain quantitative data, and qualitative techniques in the form of interview guides were used to gather qualitative data. Quantitative data were analyzed using Stata 15.0 software and partial least squares—structured equation modeling (PLS-SEM). In this chapter, only quantitative results are presented. Fornell and Lacker criterion and the heterotrait-monotrait ratio of

correlations (HTMT) criterion were used as techniques to test the validity of the results. Only quantitative results are presented in this chapter. Confidentiality of respondents was maintained irrespective of their positions. Lastly, the validity of the study was sought through introduction letters and making appointments with respondents.

3 Presentation of Results

3.1 Demographics

Gender, qualifications, and experience of respondents: Data was collected on the gender of the respondents, their qualifications, and their level of experience about eHealth-related activities as shown in Table 2.

In Table 2, results from gender show that most of the respondents were male (60%) and 40% were female.

3.2 Validity Tests

After obtaining the descriptive statistics for the different constructs, factor analysis was undertaken to calculate their validity, including convergent and discriminant validity. Factor analysis, as a statistical method, attempts to identify unexplained factors that influence covariation among multiple outcomes through data reduction and analysis [68]. Both SPSS and PLS-SEM were used to provide results for validity. The first component explains the highest level of variance observed in the set of variables, and the second explains the second highest variance, so is the third one. The discriminant validity of the factors was further tested using Fornell and Larcker Criterion and Heterotrait-Monotrait Criterion on construct validity and item

Table 2 Demographics of the study population

No.	Demographic	Details	Frequency	Percentage (%)
1	Gender	Male	108	60
		Female	72	40
2	Qualifications	Certificate	47	26.1
		Diploma	70	38.9
		Degree	62	34.4
		Masters and above	1	0.6
3	Level of experience	Less than 1 year	10	5.6
		Below 5 years	100	55.6
		5–10 years	65	36.1
		Above 10 years	5	2.8

validity, respectively. Details of factor analysis are presented in the following subsections.

In the validity of constructs, the factors and sub-factors that had an Eigenvalue lower than 0.50 were discarded. Considerations for benefits of eHealth ISs, quality of system, quality of information, system use, service quality, personnel factors, and organization factors are presented. Benefits of eHealth ISs include efficiency, communication, effectiveness, and decision-making. Quality of system considered reliability, technical support, ease of use, learning/research, eHealth ISs accessibility, responsiveness, data accuracy, data currency, eHealth ISs security, eHealth ISs flexibility, response time, performance efficiency, eHealth ISs accessibility, transfer of knowledge, cost-effectiveness, perceived usefulness, maintainability, timely development and completion, completion within budget, user needs, system documentation, timely response, compliance to standards, skilled developers, and user involvement. Quality of information is considered to include legibility, usefulness, reliability, timeliness, contextualization, relevance, understandability, governance structure, technical capacity, data specifications, common geographical information, geospatial technologies, map production/use cases, and decision-making. System use considers amount of use, frequency of use, nature and purpose of use, motivation and acceptance, use of knowledge, and beliefs and expectations. Service quality includes responsiveness, assurance, flexibility of services, empathy, reduction of costs, training for eHealth ISs, and quality of service providers. Personnel factors considered were technical skills, personnel training, career satisfaction, and business knowledge. Organizational factors considered financing source, localization, external communication, culture in the organization, strategy, management, clinical process, top management support, and teamwork. Other sets of construct discriminant validity were conducted to ensure that the constructs selected were robust enough for evaluation of the performance of eHealth ISs.

3.2.1 Discriminant Validity of Constructs Using Fornell and Lacker

The discriminant validity of different constructs that were used in this study was evaluated, and the results are presented in Table 3. Discriminant validity tests establish whether measurements that are not supposed to be related are actually unrelated. The Fornell and Larcker [69] criterion was used in order to establish the discriminant validity of the constructs through comparison of the square root of the average variance extracted from each construct with the correlation values that were obtained from the constructs. A construct achieved discriminant validity because the values of the square root of the average variance extracted that is represented in the diagonal are greater than all the correlation values of the construct against the other constructs. Seven components were obtained to explain the levels of variance observed.

Table 3 Construct discriminant validity based on the Fornell and Larcker criterion

Construct	1	2	3	4	5	6	7
Personnel-1	0.759						
System use-2	0.483	0.736					
QOI-3	0.448	0.554	0.694				
Service-4	0.721	0.598	0.499	0.683			
QOS-5	0.553	0.646	0.657	0.657	0.571		
Organization-6	0.682	0.579	0.520	0.707	0.612	0.683	
Net benefits-7	*0.462*	*0.499*	*0.461*	*0.482*	*0.664*	*0.541*	0.601

The Fornell and Larcker criterion established discriminant validity when the item in the diagonal (first item in each column) is greater than the rest of the items in that particular column. From Table 3, it is observed that 0.759 is the highest value in column one, 0.736 is the highest value in column two, 0.694 is the highest value in column three, 0.683 is the highest value in column six. The value 0.683 is, however, not the greatest in column four as there is a value of 0.707, and the value of 0.571 is not the greatest in column five as it is less than both the other values in the column (0.612 and 0.664). From the results obtained in Table 3, the results in the diagonal of the construct table were higher than the columnar equivalents in most cases, with the exception of the service and system quality constructs. Therefore, it was concluded that the service and system quality constructs failed to meet the Fornell and Larcker criterion for establishing the discriminant validity of a construct. Thus, the constructs were further scrutinized using a more robust criterion to establish discriminant validity.

3.2.2 Construct Discriminant Validity Using Heterotrait-Monotrait Criterion

Henseler, Ringle, and Sarstedt [70] highlight that the use of approaches such as the Fornell-Larcker criterion and cross-loadings to determine the discriminant validity of a construct is not reliable in common research situations. They, therefore, proposed an alternative approach in heterotrait-monotrait ratio of correlations (HTMT) to establish discriminant validity based on the multitrait-multimethod matrix. If the HTMT value is below 0.9, it implies that discriminant validity has been established between two reflective constructs [71], as shown in Table 4.

In Table 4, all the HTMT values between the constructs are below 0.9; hence, discriminant validity is established between all the constructs using the heterotrait-monotrait ratio of correlations (HTMT) criterion. All the constructs are therefore adopted for further analysis since the discriminant validity has been established using the HTMT criterion, which is a more robust measure of discriminant validity than the Fornell and Larcker criterion, which also utilizes cross-loading comparisons.

Table 4 Construct discriminant validity using the Heterotrait-Monotrait criterion

Path	HTMT value
Information quality → benefits	0.669
Organization → benefits	0.613
Organization → information quality	0.735
Personnel → benefits	0.445
Personnel → information quality	0.512
Personnel → organization	0.768
Service → benefits	0.603
Service → information quality	0.737
Service → organization	0.820
Service → personnel	0.826
System quality → benefits	0.736
System quality → information quality	0.752
System quality → organization	0.607
System quality → personnel	0.594
System quality → service	0.773
System use → benefits	0.553
System use → information quality	0.777
System use → organization	0.694
System use → personnel	0.537
System use → service	0.647
System use → system quality	0.683

3.2.3 Item Discriminant Validity Based on Fornell and Larcker Criterion

Table 5 presents the measures of discriminant validity for each of the items in the individual constructs using the criterion of cross-loadings. The criterion makes use of the loadings of the items on their respective constructs being higher than their loadings on all the other constructs. The factors are represented as QOI for quality of information, QOIG for quality of geo-enabled information, OE for organization environment factors, OS for organization structure factors, PF for personnel factors, SF for service quality, QOS for quality of system, QOSSD for quality of system development, and SU for system use.

As shown in Table 5, all the items in the different constructs loaded highest on their respective constructs; hence, item discriminant validity was established. Therefore, all the items in the respective constructs were adopted.

4 Discussion of Results

The study objective was to establish the validity of factors identified for performance evaluation of eHealth IS after conducting a reliability tests. Thus, questionnaires were distributed to 195 respondents from Gulu district, Kampala, Lira, Apac,

Table 5 Discriminant validity based on the Fornell and Larcker criterion

Factor	Item	Benefits	Information quality	Organization	Personnel	Service	System quality	System use	Discriminant validity achieved
Benefits	Communication	0.698	0.312	0.296	0.224	0.294	0.407	0.291	True
	Decision making	0.719	0.477	0.364	0.192	0.299	0.428	0.307	True
	Effectiveness	0.847	0.494	0.377	0.355	0.375	0.571	0.384	True
	Efficiency	0.862	0.515	0.518	0.365	0.472	0.557	0.411	True
Quality of information	QOI1	0.429	0.685	0.558	0.415	0.510	0.547	0.478	True
	QOI2	0.332	0.631	0.428	0.283	0.395	0.461	0.456	True
	QOI3	0.474	0.701	0.514	0.287	0.446	0.490	0.513	True
	QOI4	0.403	0.806	0.565	0.347	0.569	0.550	0.562	True
	QOI5	0.473	0.777	0.520	0.284	0.460	0.435	0.510	True
	QOI6	0.407	0.672	0.462	0.336	0.393	0.367	0.499	True
	QOI7	0.544	0.689	0.478	0.298	0.486	0.577	0.582	True
	QOIG1	0.312	0.599	0.442	0.398	0.344	0.456	0.389	True
	QOIG2	0.380	0.781	0.478	0.332	0.454	0.464	0.465	True
	QOIG3	0.293	0.626	0.315	0.250	0.403	0.494	0.392	True
	QOIG4	0.399	0.672	0.378	0.214	0.456	0.542	0.501	True
	QOIG5	0.375	0.636	0.397	0.262	0.398	0.405	0.352	True
	QOIG6	0.340	0.583	0.366	0.234	0.357	0.370	0.322	True
	QOIG7	0.374	0.734	0.383	0.215	0.381	0.530	0.480	True

(continued)

Table 5 (continued)

Factor	Item	Benefits	Information quality	Organization	Personnel	Service	System quality	System use	Discriminant validity achieved
Organization factors	OE1	0.320	0.407	0.686	0.340	0.436	0.414	0.334	True
	OE2	0.382	0.517	0.760	0.378	0.497	0.420	0.458	True
	OE3	0.331	0.484	0.700	0.367	0.435	0.396	0.399	True
	OS1	0.517	0.555	0.798	0.435	0.446	0.435	0.513	True
	OS2	0.197	0.356	0.645	0.551	0.456	0.280	0.203	True
	OS3	0.324	0.534	0.670	0.515	0.516	0.351	0.415	True
	OS4	0.241	0.257	0.485	0.275	0.379	0.242	0.258	True
	OS5	0.264	0.381	0.622	0.497	0.473	0.323	0.414	True
	OS6	0.403	0.444	0.659	0.419	0.471	0.384	0.494	True
Personnel	PF1	0.252	0.330	0.442	0.787	0.542	0.365	0.290	True
	PF2	0.300	0.372	0.508	0.821	0.552	0.421	0.293	True
	PF3	0.294	0.327	0.500	0.836	0.541	0.347	0.284	True
	PF4	0.334	0.357	0.506	0.732	0.525	0.461	0.355	True
Service	SF1	0.335	0.530	0.486	0.463	0.744	0.568	0.487	True
	SF2	0.397	0.589	0.467	0.367	0.733	0.542	0.510	True
	SF3	0.401	0.480	0.570	0.564	0.743	0.451	0.469	True
	SF4	0.235	0.363	0.448	0.579	0.733	0.484	0.259	True
	SF5	0.216	0.197	0.368	0.576	0.657	0.277	0.214	True
	SF6	0.300	0.324	0.363	0.434	0.593	0.348	0.228	True
	SF7	0.378	0.555	0.544	0.330	0.649	0.453	0.456	True

Quality of system	QOSSD1	0.405	0.280	0.324	0.285	0.272	0.513	0.261	True
	QOSSD2	0.431	0.296	0.212	0.171	0.294	0.573	0.211	True
	QOSSD3	0.376	0.394	0.308	0.238	0.355	0.523	0.284	True
	QOSSD4	0.299	0.339	0.240	0.186	0.315	0.582	0.308	True
	QOSSD5	0.472	0.501	0.418	0.395	0.491	0.760	0.423	True
	QOSSD6	0.454	0.461	0.357	0.415	0.365	0.669	0.357	True
	QOSSD7	0.478	0.453	0.466	0.402	0.395	0.644	0.348	True
	QOSSD8	0.357	0.303	0.241	0.259	0.313	0.514	0.286	True
	QOS1	0.252	0.371	0.240	0.300	0.347	0.558	0.230	True
	QOS2	0.339	0.372	0.318	0.454	0.385	0.546	0.280	True
	QOS4	0.206	0.201	0.228	0.265	0.297	0.424	0.196	True
	QOS5	0.224	0.425	0.262	0.326	0.368	0.585	0.424	True
	QOS6	0.423	0.465	0.296	0.269	0.320	0.657	0.333	True
	QOS8	0.272	0.288	0.193	0.123	0.201	0.469	0.246	True
	QOS9	0.312	0.150	0.266	0.215	0.261	0.436	0.206	True
	QOS10	0.357	0.411	0.240	0.211	0.351	0.663	0.423	True
	QOS11	0.391	0.400	0.348	0.386	0.513	0.671	0.327	True
	QOS12	0.303	0.474	0.349	0.335	0.531	0.594	0.440	True
	QOS15	0.287	0.531	0.368	0.273	0.510	0.550	0.443	True
	QOS17	0.362	0.346	0.283	0.170	0.273	0.496	0.276	True
	QOS19	0.384	0.367	0.184	0.182	0.338	0.488	0.377	True
	QOS21	0.485	0.556	0.381	0.249	0.392	0.567	0.489	True
	QOS22	0.361	0.461	0.364	0.247	0.380	0.508	0.379	True

(continued)

Table 5 (continued)

Factor	Item	Benefits	Information quality	Organization	Personnel	Service	System quality	System use	Discriminant validity achieved
System use	SU1	0.315	0.473	0.373	0.286	0.409	0.546	0.759	True
	SU2	0.430	0.595	0.521	0.329	0.451	0.427	0.799	True
	SU3	0.277	0.490	0.444	0.250	0.384	0.356	0.674	True
	SU4	0.181	0.426	0.358	0.269	0.293	0.326	0.643	True
	SU5	0.329	0.521	0.456	0.283	0.443	0.466	0.766	True
	SU6	0.388	0.470	0.425	0.270	0.412	0.458	0.726	True

Mbarara, Jinja, Namayingo, Iganga, Busia, Mubende, Oyam, Nakaseke, Mityana, Luwero, and Otuke. The response rate of 92% (180) was received, and it is in line with Fincham [72], who states that the response rate of >60% must be the goal of every researcher. In this regard, the study attracted more responses. Especially in developing countries's research, it is important to highlight how different groups contribute and are distributed with different services in the society [73]. During validity tests, gender differences, constructs and item discriminant validity tests were made. ***Gender differences*** have been observed in the use and attainment of skills for ICT where male colleagues dominate [74]. This is because: science and technology are seen as male fields; available technologies are tailored to men's interests; and male counterparts own and highly have access to technology than female counterparts [74, 75]. In the validity of constructs, the factors and sub-factors that had an Eigenvalue lower than 0.50 were discarded. Eigen values help in establishment of the significance of dimensions; hence, they are referred to as valid [70]. ***During construct discriminant validity using the Fornell and Larcker criterion***, all the constructs, with the exception of the service and system quality factors, loaded highly. Thus, further scrutiny of the constructs using a more robust criterion will establish discriminant validity. Hair et al. [70], highlight that the use of approaches such as the Fornell-Larcker criterion and cross-loadings to determine the discriminant validity of a construct is not reliable in common research situations. They, therefore, proposed an alternative approach in heterotrait-monotrait ratio of correlations (HTMT) to establish discriminant validity based on the multitrait-multimethod matrix. *If the HTMT value is below 0.9, it implies that discriminant validity has been established between two reflective constructs* [71]. Due to challenges obtained while using the Fornell and Larcker criterion, further construct discriminant analysis was carried out using the heterotrait-monotrait (HTMT) criterion, and all the constructs passed. An in-depth analysis using the item discriminant validity based on the Fornell and Larcker criterion was conducted, and for all the items loaded highest on their respective constructs, discriminant validity was established for all items on their respective constructs. Therefore, all the items in the respective constructs were also adopted. ***The results of the factor analysis*** indicated that the scale that was developed to measure the variables was highly reliable. The high factor loadings of the model show a significant level of convergent validity. Nunnally and Bernstein [76] advised relying on a minimum factor loading of 0.6. Items 3,14,20,21, and 26 were eliminated from the Quality of System construct, which had loadings of 0.425, 0.431, 0.431, 0.490, and 0.405, respectively were discarded. These items are information sharing, functional suitability, awareness of job function, portability, and the presence of an active helpdesk. Item 15 on the quality of information construct (resource sustainability), which has a loading of 0.498, was discarded because it has an Eigen value lower than 0.50. The factors of *system use, service quality, organizational factors, and personnel factors* were investigated, and the respective variables had scores above 50% in agreement. This implies that over 50% of the respondents who were interviewed as part of this study agreed that the constructs used were relevant in measuring the respective aspects of the performance of eHealth ISs in Uganda.

5 Conclusion

In summary, the following factors for eHealth IS performance evaluations passed the validity tests: i.e., quality of information, quality of system, system use, personnel, organization, and service quality. Sub-factors that had eigen values lower than 0.5 were discarded. The heterotrait-monotrait ratio of correlations (HTMT) criterion was used to establish the discriminant validity of major constructs based on the multitrait-multimethod matrix, where all values were below 0.9. Hence, the constructs were adopted for the study. Limitations of the study included expertise in the analysis of the data, eHealth IS deployment levels where clinicians stop at data input in manual registers, timey delivery of study results, and failure to navigate the western region due to a lack of access to an experienced research assistant. The way forward is to design a fit-for-all performance evaluation approach for eHealth ISs in a developing country's based on valid factors identified.

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Digitizing Development: Enablers and Inhibitors of Mobile App-Based Population Census Adoption

Kingsley Ofosu-Ampong

1 Introduction

Digital transformation has created countless opportunities and approaches for training and data collection [1], supporting developing countries' agendas to analyze population and housing dynamics [2]. The challenging nature of data collection in these regions , such as the lack of accurate, updated district maps and poor telecommunication networks, has opened possibilities for computer-assisted personal interviewing (CAPI) [3]. Even though the paper-and-pencil interviewing (PAPI) remains the most commonly used household surveys in developing countries [4]. Previous censuses have been marred by long data entry and processing time, poor handwriting or field officer errors and the potential loss of surveys through paper destruction [5, 6]. CAPI can significantly improve quality of data, reduce processing time and address most of PAPI's limitations [7].

Previous national housing surveys (NHS) and population and housing censuses (PHC) implemented in 1960, 1970, 1984, 2000 and 2010 in Ghana relied on PAPI and face-to-face instruction to train trainers and field officers. However, the Ghana Statistical Service (GSS), a body that oversees the efficient production and management of quality data for Ghana, introduced motivational information tools like gamification elements to complement face-to-face training and digital census as essential features of the 2021 PHC. However, there were challenges with access to ICT resources, not to mention the uneven access to ICT in different populations, districts and households [8].

The general presumption is that for Ghana to get good economic, educational, health and international comparison data, ICT and advances in artificial

K. Ofosu-Ampong (✉)
Alliance Bioversity International & CIAT, and Heritage Christian University, Accra, Ghana
e-mail: k.ofosu-ampong@cgiar.org

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intelligence should be prioritized [9]. In this regard, the use of digital censuses is to ensure efficient data collection, management and processing. The introduction of the geographical positioning system (GPS) is to capture the coordinates (location) of all structures to ensure complete coverage. Notwithstanding the novelty of ICT in PHC, this study examines the experiences of trainers and field officers whose training, performance and ease of use of digital census are critical to the success of collecting data on the socio-economic, demographic and living conditions of persons living in Ghana [10].

This study aims to propose a framework for empowering digital census implementation. This framework will focus on successful training programs for data collection and the ongoing use of digital censuses for population and housing data collection. The chapter begins with a brief overview of Ghana's population censuses. It then identifies challenges faced in online training and digital census adoption during the 2021 PHC based on experiences of rural trainers and field officers. The study also explores potential concerns identified in the literature regarding digital census adoption and training delivery methods, including gamification. The underlying research question guiding this investigation is: How effective are online training, face-to-face instruction and digital census adoption in the context of Ghana's 2021 population and housing census. Limited research currently exists on integrating Information and Communication Technologies (ICT) into PHC. This study aims to contribute to this gap by sharing the benefits achieved, challenges encountered, and potential solutions to inform improved planning and implementation of future censuses.

1.1 Digitizing Development—Ghana 2021 PHC

The Government of Ghana invested GHS521 million (approx. $43.4 m) to ensure the success of the 2021 population and housing census as recommended by the United Nations (UN). Since 1981, Ghana has been conducting population censuses at approximately ten-year intervals. Currently, five censuses after independence have been conducted, with 2010 being the latest. The 2010 population and housing census recorded a total population of 24.7 million. Following the census sequence, Ghana was supposed to conduct its PHC in 2020, but due to the novel COVID-19 pandemic, the exercise was rescheduled for the first half of 2021, with June 27, 2021 as the census night.

The rationale for the periodic censuses in Ghana is to update the socio-demographic and economic data and further ascertain the population's structural changes over the last decade. The census gives a sense of the total number of persons and housing types in every village or town in Ghana. Such information is essential for government and local planning of educational, health and other social service needs. Therefore, the GSS adopted three phases for the census process—the pre-enumeration (planning stage), enumeration (data collection stage) and post-enumeration phase (data processing, post-enumeration survey and dissemination stage). To streamline the collection of quality data from the enumerator end, a data scenario was developed (see Fig. 1).

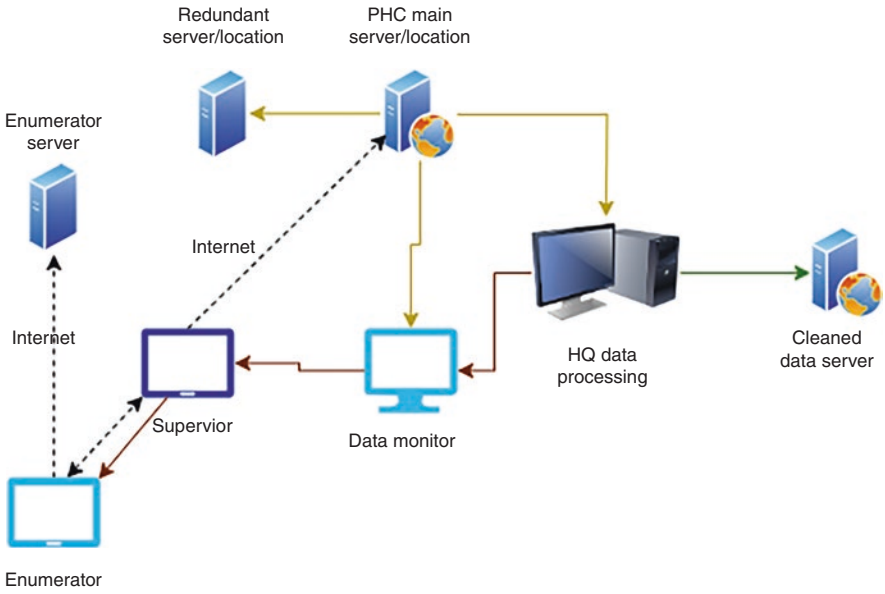

Fig. 1 Adapted data collection and reporting scenario [10]

This secure data flow model (Fig. 1) ensures quality census data collection: after supervisors transmit data, it's monitored, cleaned, and stored in designated servers for current use, backup, and historical analysis by central processing teams.

To commence the national exercise, the GSS set up a three-tier trainer of trainer groups, namely master trainers, national trainers and regional trainers at all levels of the sixteen regions of Ghana. In this regard, the master trainers train the national trainers, who train the regional trainers and finally, the regional trainers train the field officers (supervisors and enumerators). For the objective of this study, the regional trainers and the enumerators are the focus since they fall within the category of rural areas facilitators.

1.2 Digital Census Enablers in National Surveys

Digital technologies are now deployed for training purposes in developing countries. However, research suggest that participants in online training programs in these regions are more likely to withdraw or not complete their training compared to their counterparts in developed countries [11]. This can be attributed to a lack of motivational features within the online systems that could encourage continued engagement [12, 13]. Studies have shown greater improvement in training outcomes with face-to-face training sessions compared to online-only approaches, even though both methods can lead to sustained learning over time. Despite these mixed findings, blended learning, which combines online and traditional training methods,

is considered to be the most effective approach [14]. Recognising this, and faced with the challenges of COVID-19 pandemic, the PHC adopted online training platforms with CAPI capabilities as a promising alternative.

Based on the contrasting views on online and traditional training methods, this study sought to investigate participants' experiences at the 2021 PHC in Ghana. Potential concerns examined in the literature on online training include high cost, basic IT skills, acceptance of e-training by field officers and poor internet connection [15]. To enhance the capabilities of online training, practitioners and researchers in the last decade have introduced game design elements as a major component of online technologies. Due to the researchers' interest in gamification, the capabilities of the online system for PHC were explored further to examine its characteristics for motivation. The next section focuses on the gamification elements introduced by GSS to the online training, specifically the badges. During the COVID-19, online training has gained popularity in most training sessions in Ghana.

Gamification is a new concept, and developing countries are still coming to terms with its application and benefits [13]. Gamified online training is beneficial for engaging and motivating learners, but its effectiveness for meeting desired outcomes is contextualized and details mixed results [16].

Gamification uses game elements and features like badges, points, rewards, scores, and instant feedback to promote training. This practice motivates learners to accomplish a task and engage in the activity. Aside from the motivational powers of gamification, it provides feedback on learner assessment for formative purposes and helps assess successful training outcomes [17]. Through learner assessment, gamification reveals the merits and shortcomings of the game design element deployed to the users.

Gamification was incorporated into Ghana's PHC Field Officers Training to enhance field officers' training performance and engagement. However, only a few online training programs have incorporated gamification elements to assess and encourage training in Ghana, especially as a formative assessment for research and data collection [13]. Hence, a knowledge gap exists in the literature as regards the effect of using gamification for assessment. The present study examines the first-time involvement of gamification elements (i.e., badges and points) in population and housing census training of field officers in Ghana. Figure 2 shows forty-one

Fig. 2 Ghana 2021 PHC online training—41 gamification badges upon completion

badges that trainers must attain before successfully passing out to the next phase (face-to-face training).

2 Mixed-Method Design

This study adopted a mixed-methods approach [18]. Initially, the study was to qualitatively survey the views of regional trainers and field officers towards the acceptance of online training tools for PHC. However, after interviewing and categorizing the participants' responses, we identified constructs similar to the works of [19]. The identified constructs were examined quantitatively to determine the use of online training tools such as CAPI tablets for PHC.

2.1 Methodology—Qualitative & Quantitative Approach

A qualitative narrative inquiry approach was used to investigate the national and regional trainers' and enumerators' experience with the gamified online training and the practical CAPI session for the population and housing census, especially those in rural areas in Ghana. It should be noted that the national and regional trainers only had online training before face-to-face training with the CAPI—the reason being that GSS would consult them for future survey training. Hence their depth of statistical training was important. The enumerators, on the other hand, experienced only face-to-face training for the PHC. The central phenomenon in a qualitative study is the idea, concept or process being studied. Accordingly, the researcher learns more from the participants by exploring their experiences and critical incidents. Consequently, the data was collected through interviews.

Quantitatively, to have a homogeneous group of participants for this study, we contacted the 40 respondents who partook in the earlier interview. All 40 participants contacted, responded and returned their questionnaires (24 online and 16 paper-based). The study employed purposive sampling to recruit participants based on 2021 PHC experience. Consequently, the 40 participants are justified since they effectively capture the variations and perspectives of the census within Ghana.

Table 1 indicates the participants' profiles. The survey instruments were adapted from the [20] scale, while items on organizational influence were adopted from the [21] studies. Some of the constructs of UTAUT identified under the technological, individual, environmental and administrative context of this study form part of grounding proposed solutions to existing literature on technology adoption models and, hence, testing of the constructs.

Instruments

The researcher used interviews to understand the behavioral changes of the participants in the PHC. A semi-structured guide that comprised the guiding research

Table 1 Demographic characteristics of respondents

Category	Frequency
Gender	
Male	22
Female	18
Total	40
Occupation	
Teaching	10
Nursing	10
Unemployed	15
Self-employed	2
Retired	3
Total	40
Role in census	
Census Technical officers/advisors	7
Regional and district census officers	10
Field supervisors	6
Field enumerators	15
Monitoring	2
Total	40

questions was used to interview participants. Open-ended questions were used, which afforded the respondents space to provide their broad perspectives on the subject. The scope of the interviews was recurring themes from literature in general and those relevant to Ghana.

Population and Sampling

Ten (10) regional trainers and field officers (supervisors and enumerators) were taken from two rural areas of the Eastern region of Ghana. All trainers and field officers assigned to the Eastern rural areas of Ghana formed the target population. Twenty (20) of the trainers and field officers were thus randomly selected to join the study. The trainers were basically from universities—some indicated teaching assistance and trained teachers, while the supervisors and field officers were professionally engaged in teaching, national service personnel, and trained nurses. The majority of the enumerators were unemployed graduates from universities, polytechnics and training and vocational colleges, while others were self-employed.

Procedures

The approval to commence research on the subject matter was approved by the district census officers, and their views on the research items were incorporated. Trainers and field officers were randomly contacted during the census period from May 20 to June 25, 2021. The study's objective was sent to the randomly selected respondents to seek their consent to be part of the study. An appointment was scheduled for each participant to give their consent to the study. The interview was conducted via voice call.

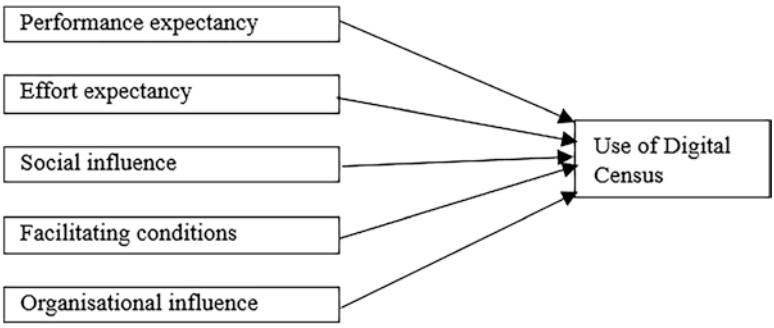

Fig. 3 Proposed Conceptual Model

Identified Constructs

Based on the identified constructs synonymous with the unified theory of acceptance and use of technology (UTAUT) [19], the study proposes the following model (see Fig. 3) as the antecedent of online training and digital census use. Thus, assessing the identified constructs further aims to extend the UTAUT model by integrating organizational influence to examine the determinants that affect field officers' intention to use CAPI tablets and online training for PHC. The constructs identified include perceived ease of use and usefulness, facilitating conditions, social influence, and organizational influence as well as field officers' behavioral intention to use tablets in data collection.

Performance expectancy: several studies confirm that users are likely to adopt technology if they perceive it as useful and promoting favorable outcomes [22]. Further, in the context of innovation or new technology adoption, extant literature confirms the positive relationship between performance expectancy and behavioral intentions [23]. In this regard, we hypothesize that:

H1: Performance expectancy will influence field officers' behavioral intention to use online training and tablets during PHC.

Effort expectancy: users prefer technologies with maximum benefits and are easy to use with less effort [19]. According to [24], effort expectancy is a strong predictor of behavioral intention to use innovation or new technologies in various individual or organizational contexts. Thus, we hypothesize that:

H2: Effort expectancy will influence field officers' behavioral intention to use online training and tablets during PHC.

Social influence is how an individual is influenced based on peer-group decisions to use a particular innovation. Extant literature supports social influence's impact on users' behavioral intention to use new technologies [24]. In this regard, we hypothesize that:

H3: Social influence will impact field officers' behavioral intention to use online training and tablets during PHC.

Facilitating conditions: The trainees asserted that internet access and other training resources were essential to the success of PHC in Ghana. Thus, this study proposes the effect of necessary resources as a condition for conducting a successful PHC. Extant literature supports the relationship between facilitating conditions and users' behavioral intent to use new technologies [25]. We, therefore, hypothesize that:

H4: Facilitating conditions will influence field officers' behavioral intention to use online training and tablets during PHC.

Organizational influence: Extant literature emphasizes how organizations influence results and users of new technologies [26]. Field officers similarly reported that the GSS expected them to be proficient in computerized data collection. This study introduces the concept of organizational influence as a novel construct within the UTAUT model, specifically addressing the context of technology adoption in Ghana. Investigating organizational influence in census emphasizes the importance of ensuring data integrity and accuracy and also improves the census process in building trust in government agencies. According to [26], competency increases the performance of users or employees in the data collection. In this regard, we hypothesize that:

H5: Organizational influence will impact field officers' behavioral intention to use online training and tablets during PHC.

Figure 3 shows the proposed model for field officers' intentions to use online training and tablets during PHC.

3 Results and Discussion

This section discusses the online training experience of regional trainers with game elements and their experience with computer-assisted personal interviewing in the 2021 population and housing census in Ghana. Almost all the indicators for effective CAPI use and the barriers identified in the literature review were found in the Ghanaian context of PHC. Table 2 shows a summary of the interviews conducted, which indicate the salient constructs for mapping future PHC. The study findings suggest that online training with gamification elements was ineffective for training compared to the in-person and interaction sections in Ghana's PHC. The trainers revealed a lack of cultural elements of the badges though getting the badges was a sign of accomplishment, reward and dedication to learning the PHC manuals online.

Further, the field officers' experience with the CAPI improved the previous censuses conducted in Ghana. The CAPI practical was effective and easy to collect data, though there were challenges generating the GPS with the CAPI.

Table 2 Qualitative groupings and sub-categories of the interview

Categories	Sub-categories (enablers)	Identified constructs	General Challenges
Effectiveness and barriers to gamified online training	Game elements Cost Household name (social interactions) Traditional and online training with ease	Perceived ease of use and usefulness of online training and digital technologies [19]	*Technological and environmental contextual challenges*
Effectiveness of digital census	User friendly Social interaction Reduced data collection time Organizational need	Attitude towards digital census for data collection and training Social influence Organizational influence to use [19, 26]	*Individual and technological contextual challenges*
Barriers to digital census use (listing of structures)	Digital census Asset Exposure myth Limited training on digital census Internet and GPS access Digital census and tablet challenges	Adoption of online training and digital census [19]	*Administrative contextual challenges*

Data Analysis I—Qualitative Analysis
The data was analyzed and transcribed using NVivo 11.0 and grouped into categories and sub-categories. To ensure transcription accuracy, the interviews were played severally and analyzed and transcribed verbatim. Also, to ensure confidentiality, the researcher used pseudonyms for each respondent. Table 1 shows the demographic characteristics of the participants.

3.1 Effectiveness of the Online Training

Game Elements Though the trainees felt a sense of accomplishment with the introduction of badges in the PHC training, the game elements were not tailored to meet their level of motivation. The game elements failed because a one-size-fits approach was used without considering the user characteristics. The future application should consider the user players and the kinds of game elements they feel accustomed to.

> Well, the game elements or badges that were displayed on the 2021 PHC Field Officers Virtual Training Platform did not motivate me that much. I liked it as an accomplishment badge, but the pictures on the badges did not communicate to me. I felt badges should be cultural to depict hardworking individuals in Ghana. [“Eunice” – Regional Trainer]

> Whenever I received the badge, I felt satisfied. However, I felt annoyed at the initial stage when I saw the number of completions of my colleagues. There were 40–45 tasks to be completed, and within three days, some trainees had completed more than 30 readings and assignments. I felt pressured initially, but it propelled me to catch up. ["Silas" – Regional Trainer]

> Sincerely, I did not feel any connection with the rankings and the badges awarded to me. I sometimes download it for downloading sake. However, seeing the badges was a sign of relief that I am drawing close to completing the field officer's manual. ["Patty" – regional Trainer]

Cost Data for the virtual learning was a significant challenge for the participants. The cost of the data bundle per day for training was too much for the trainees.

> OK, what I can say about the data is that it is very expensive. Online training is more expensive than one can imagine. Though GSS decided to prefinance the data used per day, the amount was too small. They initially agreed to pay GHS50 but ended up paying GHS40 (approximately $7/day). Interesting, we spend 7 hours online per day, can you imagine? ["Moses" – Regional Trainer]

Social Relatedness (Household Name) Most trainers felt a sense of relatedness and household-relatedness in online training, which affected their training and gave them a sense of belonging.

> The online training was one of the most memorable social learning I have experienced in my life. We hardly knew ourselves during the first three days though we were all from the same district (from the Eastern region of Ghana). Nevertheless, as time progressed, some household names became popular. They almost answered every question and raised their hands in all Zoom meetings (we used the household name because population and household census- PHC- brought us together). The fun of hearing some names made us know the image or personality behind every voice. One can imagine the joy and social relatedness when we met at the face-to-face training. In all, it positively affected my training behaviour and made me want to learn always as a team. ["Joshua" – Regional Trainer]

Traditional and Online Training Most of the trainers preferred the two-week traditional mode (face-to-face) of training over the two-week online training sessions because of its effectiveness and high-level of participation.

> There is no way I can compare the power of traditional learning to online learning. Online training was difficult and distracting. I wish you lived with me – so much intrusion and family check-ups. When we camped at Koforidua for the face-to-face training, I spent more than two weeks on the online platform, with no practical experience. However, it did compliment the face-to-face teaching, such that most of the terms were not new to me. ["Felix" – Regional Trainer]

> Online training is too much work. I barely focused throughout the period. There was "dumsor" (light-out) while I was due to present at a point in time. The factors that prevent online learning are too much for us to adopt. At one point, I connected and left the phone while receiving a visitor. They had to call my phone to answer the question posed by the facilitator. [Foster – Regional Trainer]

> During the Zoom meetings, I had many internet disruptions. I barely completed a day successfully without the internet, not messing up the meeting. I am in a typical rural area, so I blame the organizers for considering all trainers as staying in the Greater Accra capital. ["Irene" – Regional Trainer]

3.2 Effectiveness of the Digital Census and Gamification

Most of the enumerators and supervisors indicated that the CAPI is very easy and fast for collecting data compared to the PAPI. Though some of them participated in yearlong surveys, this was their first time conducting a population and housing survey with CAPI.

User Friendly An ample number of field officers quickly learned how to use the CAPI and navigate the tablet without difficulty because the features were like their smartphones. Other officers stated the convenience of using the CAPI instead of the PAPI.

> The digital census has made this year's PHC easy and faster as compared to the PAPI in previous censuses because it was straightforward to handle and use. This 2021 census is my third as an enumerator. My Android phone has similar features, so I did not expect challenges handling it. However, taking GPS is challenging because you might excuse yourself during the interview to take coordinates or information. Just imagine leaving the room during the interview to collect the information outside….It sometimes creates an awkward moment and a sign of mistrust. ["Patience" – Enumerator]

> For convenience's sake, handling the digital census is way better and easier than the PAPI. I can recall my experience in the last census – 2010, where I listed almost 400 structures. So, that should tell you the number of questionnaires I was handling throughout the month. I do not think we will ever go back to PAPI for a national assignment again, maybe for small surveys like sanitation and agriculture. ["Mercy" – Enumerator]

Social Interaction Most of the enumerators felt bonding and interaction among the facilitators and trainers when using the CAPI for practice. The interaction between enumerator-enumerator and supervisor-enumerator positively affected the effectiveness of the digital census use

> You know, during the face-to-face training, our facilitators grouped us into eleven groups – each group was ten trainers to begin the digital census practice. Out of the ten, one was made the supervisor who assigned us the enumeration area, and I felt that was the beginning of our social bond with digital census. Sometimes, you will hear a colleague making a joke about digital census exposing him because he could not fully cover my assigned area. Moreover, since we were all recruited from this district, bonding and establishing good working relationships with the digital census was easier. In all, it was a friendly exercise, and the same thing is what we are facing now at the Listing stage of the 2021 PHC. ["Pauluto" – Supervisor]

Table 3 Psychometric Properties ($n = 40$)

Construct	Loadings range	CA	RhoA	CR	Ave	VIF	Disc. validity
Performance Expectancy (PE)	0.765–0.813	0.706	0.886	0.929	0.814	1.15	Yes
Effort expectancy (EE)	0.794–0.910	0.885	0.866	0.918	0.789	2.45	No
Social Influence (SI)	0.807–0.921	0.866	0.755	0.856	0.665	1.39	Yes
Facilitating conditions (FC)	0.834–0.893	0.750	0.736	0.826	0.617	3.34	Yes
Organisational influence (OI)	0.738–0.792	0.790	0.850	0.897	0.745	5.06	Yes
Behavioral intention	0.865–0.950	0.828	0.895	0.934	0.825		Yes

Reduced Data Collection Time Majority of the field officers indicated that the PAPI would have consumed more time to complete the volume of questions. However, CAPI is robust enough to include built-in skip patterns and filters. For example, it skips fertility questions when a male responds.

> My first time using it, but I find it very useful and user-friendly with good skip patterns and auto-fill features. Digital census makes the work of an enumerator easier and helps us input much data within the shortest time. New data can also be aggregated and checked daily for consistency. The response time to input information on the digital census is swift, but the questions are many in this year's PHC. [“Nana” – Enumerator]

3.3 Data Analysis II—Quantitative Approach

The researcher employed the partial least squares using the SmartPLS to test the research hypothesis [27]. PLS is the most preferred statistical technique for small-to-medium-sized samples and a powerful tool for estimating the path coefficient and model parameters under non-normality conditions [28].

3.3.1 Measurement Model

The first stage assessed the reliability and internal consistency, as well as the convergent and discriminant validity. As shown in Table 3, the factor loadings of each item are significant, indicating that the values are all above the minimum threshold of 0.70 [29, 30]. Also, Table 3 indicates that the average variance extracted values are all above the minimum acceptable value of 0.5 [29]. We assessed the reliability of the indicators using Cronbach alpha and composite reliability, and all the coefficient values were above the minimum threshold value of 0.70. The collinearity assessment was estimated using the variance of inflation factor (VIF). A VIF value of 5 or less shows no collinearity issue [27]. Table 3 shows that among the constructs, only organizational influence is slightly above the threshold of 5.

Table 4 Path co-efficient and effect sizes

Path	Path Coefficient	*P*-value	STDEV	f^2	Supported
PE→BI	0.159	0.045	0.079	0.395	*H1: supported*
EE→BI	0.068	0.153	0.057	0.031	*H2: not supported*
SI→BI	0.781	0.010	0.302	0.021	*H3: supported*
FC→BI	0.114	0.042	0.056	0.009	*H4: supported*
OI→BI	0.549	0.000	0.056	0.015	*H5: supported*

3.3.2 Structural Model

The significance of the path coefficients is determined by the p-values, which represent the prediction of specific endogenous constructs by specific endogenous constructs. The R^2 value was 0.623, indicating a 62% prediction of the endogenous variables. This implies that performance expectancy, effort expectancy, social influence, facilitating conditions and organizational influence jointly explained 62% of the variance for behavioral intention for a digital census. Since R^2 values of 50% are considered high in behavioral and technology adoption studies [19], 62% indicates a good model's predictive power for a digital census in a developing country. The effect size was also determined using f^2. The *f^2 values less than 0.02 proved there is no effect, while 0.02, 0.15 and 0.35 indicate small, medium and large effect sizes, respectively.*

The structural model generally predicted an acceptable fit since the standardized root mean square residual (SRMR) of 0.078 was below the required threshold of 0.08 [27]. The significant values shown in Table 4 indicate that four hypotheses were supported out of the five independent variables. The four supported factors are PE, SI, FC and OI, with *p*-values below the 0.05 threshold. Consequently, EE was rejected with a *p*-value greater than the 0.05 threshold. In other words, performance expectance, social influence, facilitating conditions and organizational influence significantly predicted behavioral intention to use online training and CAPI tablet for PHC. On the contrary, effort expectancy did not predict behavioral intention in PHC. The empirical data of the PLS approach also confirms that social influence (β =0.781; P = 0.01) and organizational influence (β =0.549; P = 0.00) are predominant factors that drive field officers' digital census intention.

The empirical result regarding the determinant of field officers' intention to use online training for the census is that performance expectancy leads to technology adoption. This means that Ghanaians who tend to partake in PHC focus on the perceived usefulness and favorable outcomes of the digital census. In other words, when government statisticians and agencies responsible for PHC consider users perceived usefulness of the digital census, Ghanaian field officers are more likely to consider the CAPI and thus promote the collection of quality data. The results also indicate that effort expectancy does not have a significant direct effect on online training behavioral intention for PHC.

As expected, our findings from Table 4 strongly indicate that social influence is positively related to behavioral intention to use. Thus, this study is consistent with

previous literature on technology adoption [25]. Consequently, the results can infer that a high degree of intention to use digital census and online training is formed when Ghanaians develop social relatedness and influence during the training. The greater the social influence during the training, the more digital tools and online training use intention among the field officers.

Findings of the PLS-SEM analyses also indicate that internet access and other training resources are essential facilitating resources that drive field officers' intention to use digital technologies in the census. In this regard, agencies responsible for PHC should provide all available resources on and off the field for the enumerators to avoid initial technology rejection. Finally, organization influence on digital census increases the likelihood of field officers' behavior intention to use digital technologies in PHC. This means that managers of PHC would have to develop strong organizational influence and attitude toward digital technologies in collecting data and also in training the field officers.

3.4 Barriers to Digital Census Transformation

Technology Asset Exposure Myth One of the major challenges mentioned by the enumerators is how the interviewers want to withhold information, especially when capturing data with the digital census. According to 45% of field officers, some households withheld information because they believed that they would be taxed or found out in the future if they provided accurate information to the officers. In Ghana, most people are conservative with their items to invade taxes and other responsibilities, which affect national surveys. For example, to evade higher electricity bills or fear of being exposed to the actual bills to pay, some interviewers would not list all the electrical gadgets in their household.

> My experience has been good so far. As you may know, using the digital tool makes work easier but scares some interviewers, especially when taking the GPS location. In taking the GPS, we must move to an open space to get the required threshold of 5. However, when that happens, the respondents feel you are capturing them for tax collection (examples of these locations are stores, bars, clubs, churches etc.). I think some information is withheld in typical rural areas where we cannot control what they think or know. ["Sandra" – Supervisor]

Limited Training on Digital Census Tools Field officers complained about the limited time for the training, especially the field practice. While some accepted the two-week training as effective, others said the time was too short to learn all the nineteen chapters of the PHC and include field practice and economic survey questions.

> I hope you see the Field Officer's Manual. The facilitators were good at covering the full manual, but other groups might find it difficult to download all these materials for effective learning and practice. The disadvantage is that when the enumerator is not taught enough to

> understand the software, it becomes a disaster as quality data and complete coverage might be a challenge. Secondly, the training time frame was very short as I said, which most people could not understand enough. What you feed the system is what you will get. We know most trades in Ghana, like foodstuff sellers and dressmakers, regarding economic activities, but it was not easy to find them. It would have been prudent to have checkboxes ticked, and then move on, but that was not the case. Going through that long procedure to look for their professions is not a joke, my brother. But in the end, we provided respondents with the right professions. [“Kwame” – Enumerator]

Internet and GPS Access Accessing the internet for syncing with headquarters and getting a suitable GPS threshold of five was one of the significant challenges mentioned.

> I presume you know the challenges with poor internet unless you are new in our district. The two main telecommunications that work best here are MTN and Vodafone. However, in my area, MTN has the best internet access. Unfortunately, I subscribe to Vodaphone, so I struggle very much during data synchronization with HQ unless I move to Kade (the district’s capital). But with the GPS reading, some of my enumerators have complained to me, but I have no solution but to report to the district census officer. These are our main challenges in getting quality data. [“Madison” – Supervisor]

Digital Census Challenge The respondents provided general challenges to the technology adoption and tablets used for collecting the data, which included screen misfunctioning, poor GPS coordinate reading, slow app and frequent app errors.

> My main barrier is that at times the screen turns out not working and as such slows work at times. It comes when it pleases, but I am told to come for a new one. [“Vera” – Enumerator]

> The best thing about the digital training is the about is the filters. Though it brings out errors, it sometimes does not detect some errors that it is understood to detect. Making it slow and confusing and also generating the GPS was a bit of a headache. [“Millicent” – Enumerator]

> The technology makes the work much easier and user-friendly, but many times runs very slow even after restarting it. Taking GPS coordinates is another hell of a time, sometimes over ten times before being able to read accurately. [“Sammy” – Enumerator]

> The application runs slow at your peak time. Also, I realized that GPS reading is a bit of a challenge when it is getting late. Overall, the use of the system is a good experience, but there's a difficulty when correcting unintentional mistakes. [“Michael” – Enumerator]

> The technology has made the work simple and smart... but my problem is when you mistakenly select "yes household population" and move forward, it will not allow you to come back and choose option No. I mean, the No will not appear again. For that, do you have the right to delete such a structure and redo it? You answer for me. [“Rich” – Supervisor]

> One thing I realized during the listing stage is that when two Enumerators in one EA are notified of an error in the system by the data management team, it is difficult to identify the error. Funny enough, our supervisor could not see the error either. So, how then do you know the error to correct? [Judith – Enumerator]

3.5 General Challenges That Impact Digital Census Transformation

Political Interference and Poor Recruitment Sixty percent of the participants indicated that the selection of field supervisors and enumerators did not follow laid-down procedures. Though assessment tests were conducted on three occasions, none of the tests were used for selection, as revealed by enumerators. Regional trainers revealed that they submitted a qualified field officer list to the district census officer. However, most of the qualified candidates were removed from the shortlist for the exercise. Thus, due to the limited competence of some field officers, poor total coverage and poor-quality data were recorded. There is a need to promote transparency in publicly reporting on census methodologies, standardized recruitment process and potential limitations.

Financial and Remuneration Constraints Four out of five census officers indicated that the inadequate financial package could affect the entire exercise, which ultimately may affect the quality of data collection. There were a series of petitions concerning the remuneration package addressed to the secretariat. Field officers, i.e., supervisors and enumerators, were paid approximately GHS 2520 and GHS 2950 (approx. $ 215 and 252) for the exercise. Establishing a union can give enumerators a collective voice in negotiating better wages and working conditions.

Software Upgrade One in five field officers reported that the digital census did not have the latest CSEntry version, which slowed the exercise. This issue distorted training sections since all participants needed to be on the same page. There is a need to implement software version control practices for future data collection exercises.

Based on the respondents' views, four categories were identified, namely: technological, individual, environmental and administrative context. Table 5 shows a summary of identified barriers and strategies for effective online training.

3.6 Effective Adoption of Digital Census in National Surveys

What to Consider When Integrating Digital Census in Training and Collecting Data

During our interaction with regional trainers, supervisors, and enumerators, we identified several issues discussed in Table 5, technological, individual and environmental, that need to be solved to achieve effective digital census integration in training and collecting data. Based on our research output, we make seven recommendations to any country or institution interested in integrating digital censuses and digital technologies into training and data collection for massive national surveys (target of 30 million population and more).

Table 5 Summary of barriers and strategies to effective digital census

Category (enablers)	Barriers/Inhibitors	Strategies
Technological context	Issues with online learning Poor internet connection or Poor motivation for learning online Unmotivated game design elements Poor communication between trainees and instructors Limited access due to tablet and manual sharing Software requirement	Embracing acceptance of online training by field agents to improve self-efficacy. Collaborative online training improves the learning experience Online training personalization (a tailored approach based on users' experience) Update CSEntry software before training Improve the IT procurement process
Individual Context	Poor reporting to training Stress in combining census training with other work, e.g. private and public teachers Difficulty adjusting to CAPI training and learning style Practical concern Lack of essential accessories to promote learning Inadequate trainers' skills	Prior digital literacy for field officers Incentives and rewards as motivation Provide funding and data support Conduct a needs assessment survey among trainees and district facilities Keep an updated record of field officers and trainers Competent-based assessments and training Review and assessment of district census officer and statistical products
Environmental context	Family interruption during training (district level) Knowledge gap in training and field practice Bribery for selection as enumerator Poor transparency in the selection Power interruption Long hours of sit-down training	Field supervisor, support and evaluation Ensure open channels of communication among administrators, community leaders, trainers and field offices Reduce travel time Digital transformation agenda Integrating tradition and emerging technologies into systems Forms processing capabilities
Administrative Context	Limited training opportunities Poor organization and administrative issues Untimely delivery of training materials Faulty tablets for training Education and residential concerns Discriminatory resources in many census centers at the district level	Provide sufficient training devices and materials to enhance practical training sessions. This is important because some field officers reported sharing tablets during the training. Keep a record of trained field officers for future survey activities Infrastructure and technical support Encourage blended learning Quality control checks Improve organization census reporting

1. Identify the field officers early and their familiarity with the digital census
2. Address environmental challenges to training per district or regional level, e.g., access to electricity, internet and classroom
3. Trainers should be highly familiar with the digital census and modules
4. The national census team must ensure closer work with the district IT coordinators
5. Ensure the digital census is an integral component of the training and of sufficient in number for trainees
6. Describe key features and functions of the CAPI tablet on the first training day (why digital census) in data collection and how to achieve complete coverage with digital census)
7. Tablet distribution should be done carefully, especially at the local level to avoid infrastructure limitations

4 The Mixing of Results: Model for Enhancing Digital Census Transformation

By conducting a mix of qualitative and quantitative results, we identified important themes that have the potential to enhance digital census research and practice. The first theme identified is the *digital census capabilities* (technology, i.e., online training) with the intended goals for the census activities. Providing enough details of the digital census functionalities to dispel the one-size-fits-all approach of online training systems. This study has shown that identifying the characteristics and capabilities of the field officers (FO) is essential to a successful census. Thus, future

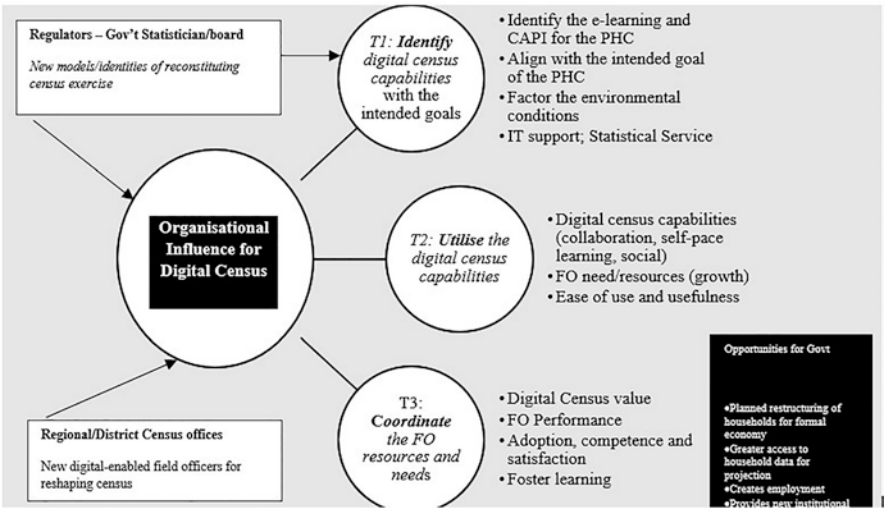

Fig. 4 Proposed model for enhancing digital census

census programs need to investigate the various capabilities of the field officers and the learning system to reinforce the intended purpose of conducting PHC. It is also important to consider the country-level environment and the quality of field officers recruited. The second theme is to *utilize the digital census capabilities* and tools to initiate field officers-centric training approaches. This provides the field officers with the autonomy to develop training in different forms, such as interpersonal skills, self-paced training and self-awareness. The third is to *coordinate the field officers' resources and need*s and the objective of implementing a digital census. Thus, there should be an appropriate interplay between the source materials and how they can successfully achieve the goal of PHC. As shown in Fig. 4, this is a proposed model for enhancing digital census training in a developing country context.

5 Conclusion

The study investigated the behavioral enablers and barriers of the digital census in Ghana by validating a research model and conducting an in-depth analysis. A qualitative and quantitative approaches were used to examine the issue of digital census. Qualitatively, the study found general challenges in household surveys to include political factors and poor remuneration, financial and remuneration constraints, issues with software upgrades and GPS access. All in all, the barriers and strategies can be classified into individual, technological, environmental and administrative contextual factors. Quantitatively, the study found performance expectance, social influence, facilitating conditions and organizational influence as significant enablers of field officers' intention to use digital census for PHC or NHS in a developing country.

The digital census's introduction into the PHC has shown promising signs of collecting quality data. Most of the supervisors and enumerators revealed the effectiveness of the CAPI compared to the PAPI. However, future digital census use for PHC should address the challenges outlined in this study to achieve complete coverage.

5.1 Theoretical and Practical Implications

Theoretically, this study extends the adoption model by integrating organizational influence, which is an important determinant in examining the case of online training and data collection tools for national assignments. Thus, the relationship between organizational influence and behavioral intention has not been considerably studied. Consequently, the results of this study enhance existing knowledge in technology adoption by confirming the significance of integrating the user's attitudes and beliefs in online training and closing the digital divide in developing

countries. Additionally, the findings from this study contribute to the advancement of prior research on online training by empirically testing the role of performance expectancy, effort expectancy, social influence and facilitating conditions in Ghanaian field officers' online training intentions. The research explains 62% of the variance in users' intentions. This confirms the study's robustness of the UTAUT model [19] in a developing country context.

Practically, in developing countries, our study identifies performance expectancy, social influence and organizational influence as the most significant predictors of field officers' intention to use online training and CAPI tablets to collect quality data and ensure complete coverage. Thus, our study presents some important strategies for other emerging countries that want to conduct population and housing censuses through digital technologies that are still in their infancy in developing countries. Specifically, we have shown that organizational influence can boost technology acceptance for national activities in the case of rural and urban dwellers in Ghana. This study also indicates that social influence and organizational influence are predominant factors driving individual digital census use.

Limitation

The generalization of the study is difficult due to the small sample size. The study focused on regional trainers' views of the in-person and online training and supervisors' and enumerators' perspectives on the use of CAPI in Ghana's 2021 population and housing census without including the voices of regional census officers, district census officers and district data officers managing the entire exercise. Further, the study participants were from two rural areas in the eastern region of Ghana, while Ghana has 16 regions with many field officers taking part in the census.

5.2 Future Direction and Recommendation to Achieve Effective Future PHC/NHS

Based on the analysis and review of relevant sources in this study, a recommendation is proposed for future household surveys in developing countries. We realized that recommendations for future PHC/NHS should cover best practices for more effective use of the CAPI system in NHS at different stages. Hence, the following key recommendations:

(a) *Embrace online self-enumeration*: As developing countries continue to improve internet penetration, a secure and user-friendly online platform for citizens can enhance the quality of data collection throughout the year. Furthermore, logistical complexity and cost will be reduced, and this online activity boosts overall participation and empowers individuals with increased convenience. More IT literacy programs are needed to address the digital literacy gaps and ensure technology access in rural areas.

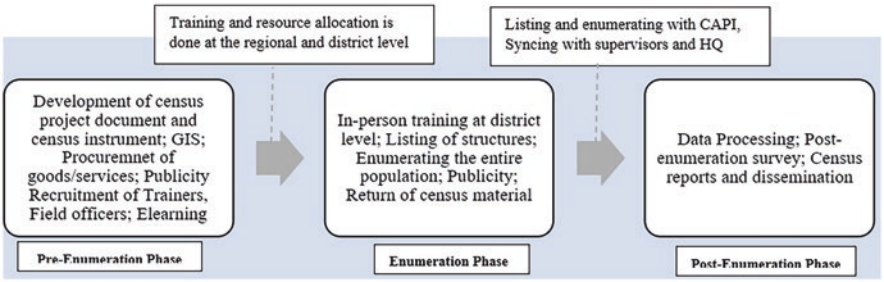

Fig. 5 Adapted Proposed Framework

(b) *Offline functionality*: Inasmuch as enumerators are resourced with mobile technology for data collection for enhanced accuracy, priority for offline functionality should be critical, especially for rural areas in developing countries. Implement offline functionality for places with limited connectivity and safeguard data security.
(c) *Leverage real-time data analytics for deeper insights:* The governing statistical services must invest hugely in advanced analytics to extract valuable and real-time insights from census data. The problem with developing countries is the delay in generating predictive trends to inform resource allocation and support evidence-based decision-making for all sectors of the economy.

5.2.1 Framework for Unlocking Digital Population Census

As shown in Fig. 5, the recommendation framework for census entails three phases: the *pre-enumeration phase*—development of project documents and census instruments, procurement of goods and services, publicity, and recruitment; the *enumeration phase*—listing of structures, enumerating the entire population, publicity and return of census materials; and *post-enumeration phase*—data processing, post-enumeration survey, census reports and dissemination. At the heart of this exercise is the resource allocation at the regional and district levels.

With the huge amount of money and resources allocated to training national and regional trainers, the statistical bodies should retain these trainers for future NHS. Employing their services will reduce costs and ensure the continuity of training modules. However, the GSS must issue a training certificate and accomplishment to the trainers—to certify them for future programs. The same ideology can be applied to the supervisors and enumerators at the regional and district levels.

Future national surveys and PHC virtual platforms should incorporate gamification elements that have cultural meaning and motivate users. This can be achieved when designers systematically examine the user characteristics, considering the context of the learners. Adopting one-size-fits-all game elements, which have been the case for most gamified systems, is a recipe for failure. Ghanaians are intrinsically attached to some game design elements, and designers and instructors must

identify them and incorporate them systematically into the intended outcomes. Lastly, this study calls for future research to explore the gender differences in the perception of digital censuses and examine the role of artificial intelligence (AI) in the data collection for achieving more efficient, accurate and inclusive results [9, 31]

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Gamifie: A Gamified Framework as a Strategy to Increase Motivation and Engagement Among Employees in IT Industries

Narsha Bachoo and Leckraj Nagowah

1 Introduction

Every week, across the globe, billions of hours and dollars are spent on video games. The video gaming industry is estimated to be worth $178.73 billion in 2021, which is an increase of 14.4% from 2020 [1]. This industry is one of the most profitable that exists today, starting with the kids up to the adults. With all the inventions in technology, one concept becoming more and more useful and common these days, is gamification.

Gamification can be defined as the use of game-design elements in non-gaming contexts [2] and has gained popularity in the last few years as it is being applied within several organizations. It can be applied in different areas, for example, education, finance, governance, healthcare, risk management, and human resource management, among others.

Studies show that gamification is a notion whereby it tries to motivate employees by integrating some elements and mechanisms of game design within organizations. Gamification aims at increasing a user's engagement, motivation, and performance while performing a meaningful task while combining game mechanics and elements, hence making the activity more appealing. Keeping employees motivated and engaged in their work at all times is quite challenging. Through gamification, it becomes increasingly possible to improve the work environment, motivate the workers and keep customers happy and loyal.

N. Bachoo · L. Nagowah (✉)
University of Mauritius, Réduit, Mauritius
e-mail: narsha.bachoo1@umail.uom.ac.mu; l.nagowah@uom.ac.mu

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A study conducted on students by Singh [3] concluded that only 11% of respondents considered money as a primary motivator, and 67% agreed that recognition, autonomy, and engagement in the work itself influenced their motivation. Therefore, in this chapter, we investigate and try to propose a framework that can be applied and used by employers in companies in an endeavor to increase motivation at work.

Despite the advances and new strategies being used by the management team, we still have lots of people who feel demotivated and less engaged with their tasks. As per Dauti et al. [4], some factors that demotivate employees are lack of evaluation of efforts, absence of promotion, lack of professional education and training, low participation in decision-making and poor management among others. In addition to the factors mentioned, collaboration among team members, teamwork, and leadership also play a crucial role in the Software Project Management (SPM) process. The work by Assen [5] showed that a lack of training and commitment are cited as major causes of unsuccessful continuous improvement initiatives.

Existing research indicates that employees who believe their job to be connected with their interests and values are happier and more pleased than those who put effort into work primarily for external reasons, such as being paid or obtaining a higher position [6]. This is called autonomous work motivation, where people put in effort at work because they want to, rather than because they feel they have to. On the contrary, on days when they are confronted with high-hindrance job demands, employees may find it challenging to locate the sense of fulfillment, meaning, and value (i.e., autonomous work motivation).

Therefore, this raises concerns about what can be done to lessen these demotivating factors within the workplace so that employees feel more encouraged and valued. This research is aimed at shedding light on how the application of gamification as a management strategy will help employees feel more satisfied and happier with the work/duties being conducted. This study aims at proposing a framework, using the concept of gamification, to increase the motivation and engagement among employees in IT companies. To achieve the above aim, the following research questions have been devised for this study:

RQ1: Which gamification design frameworks are available in literature?
RQ2: Which gaming elements have been used in existing gamification projects?
RQ3: What challenges are being faced by IT companies when applying gamification for people management?
RQ4: Does gamification actually increase employees' motivation and engagement?

2 Literature Review

This section mainly describes the two main areas behind the chapter: Software Project Management (SPM) and gamification.

2.1 Software Project Management

One of the most important aspects of the development and management of information systems is project management, which can relate to a variety of methodologies. The art and science of planning and leading software projects is known as Software Project Management (SPM). It is a project management sub-discipline in which software projects are planned, implemented, monitored, and controlled [7].

Organizations require a solid strategy to achieve success in their endeavors, which includes gaining a competitive edge and generating profits from their operations. However, for an organization to achieve a sustainable competitive advantage, one that can be maintained over an extended period of time and difficult for rivals to replicate, it is necessary for the organization to have the human resources to effectively achieve the organizational goals. Therefore, the need to earn the employees' loyalty becomes important.

Jurison [8] stated that managing projects is not always easy, and although some projects fail for technical reasons, most project failures are caused by people who ignore the principles of good project management. Many managers usually tend to focus on technical issues while neglecting employee problems. Hence, it is important to look after the employees and make them feel wanted in the organization. Marcão et al. [9] stated that since one of the dimensions of project management is the management of human resources, it is crucial to value the motivation of employees and to identify concepts that allow addressing it, such as the concept of gamification.

SPM, a sub-discipline of project management, also includes some essential elements in terms of human resource management (HRM), risk management, cost management, communication management, and procurable management. HRM is basically the process of managing people in a predetermined and organized manner. Numerous businesses are heavily reliant on the level of expertise and experience possessed by their workforce. As a result, businesses need to focus more on their human resources since effective management of such resources enables companies to maximize their employees' abilities inside the organization [10].

Rahman et al. [11] stated that if employees are satisfied and committed to the organization, it helps to reduce turnover costs, absenteeism, and low productivity. It is therefore fundamental to maintain a high level of morale and motivation among the employees in order to ensure the efficient operation of the company and its continued existence.

Mansaray [12] explained that it is important to understand the link between the motivation of the staff and their performance. In the same vein, it is essential to be familiar with the methods that can be used to oversee the performance of the staff and the ways in which they can be rewarded, not simply in terms of money but, also, through recognition and other incentives.

2.2 Gamification

When people think about gaming, they typically think of it as something they do in their spare time. Every day, an endless number of hours and millions are spent by people across the globe on computers and video gaming [13]. Gupta and Gomathi [14] stated that all this time and money is ideally being spent by people for indulging in a repetitive and non-value-adding activity. Since most people enjoy gaming, the term "gamification" was coined to take advantage of the human tendency to participate in gaming activities and incorporate elements of gaming into non-gaming contexts, such as work. This method has since been applied to improve business and management practices, including training, customer service, and employee morale.

Gamification can also be explained as the process of using game mechanics and game design strategies to engage people in their goals and motivate them to work toward achieving those goals. The basic wants and needs of the users' impulses, which revolve around the concepts of status and achievement, are catered to by gamification, which makes use of their competitive nature. Basic gamification strategies appeal to and affect people's intrinsic needs for recognition, competitiveness, self-expression, and accomplishment.

Studies conducted over the years have demonstrated that gamification yields fascinating outcomes in terms of the organization's levels of production and quality of services provided, and it brings along many benefits, some of which have been mentioned below:

- Employees motivation
- Increase in user engagement
- Fast staff training
- Stress reduction
- Productivity acceleration
- Team building
- Cost reduction
- Employees motivation

Using gaming elements such as leader boards, points, and badges, employees feel more engaged in the tasks they do as the need to achieve and be rewarded becomes important. When workers become more motivated, this creates a domino effect, which results in higher productivity and effective results. When employees are recognized for their hard work, they feel more connected and satisfied with the work, and eventually they become loyal to their work and the company. This reduces the cost of turnover as employees will stay with the company for longer periods of time. Some duties are conducted in teams, and gamification encourages healthy communication and interaction between different departments and groups. With the implementation of game mechanics, new joiners too will find the work more interesting and easier to learn, making the training process much faster and easier. Applying gamification in an organization helps in equally distributing the work

among employees and eventually making work a playful and less stressful environment.

Gaming Elements

Gamification elements are the guidelines that determine how the game will really function. There are several game elements that can be used in a Gamified environment.

- Points—A player's growth and development can be tracked in terms of points earned and spent. Unlocking features is another use of points. What makes this feedback mechanism special is that it can be applied to a variety of situations and strategies.
- Leaderboards/Rankings—During a competition, the names, scores, and standings of all participants can be found on a board called a leaderboard. Using leaderboards, users may see where they are in comparison to others and get a sense of their own progress. A person can gain respect from their peers and rise in the ranks by earning points or recognition while displaying them on a leaderboard [15].
- Badges/Achievement—In gamification, users are rewarded with virtual symbols representing their efforts in the form of badges and awards. Credentials earned by a user in the form of badges serve as visible proof of that person's proficiency in each area. They are important for keeping the game challenging over time [16].
- Progress bar—An easy-to-implement method that can prompt consumers to act is to display a progress bar. Visual aids like progress bars make it easy to see how far one has come and how far one still needs to go. It's natural to want to finish a task and rewarding to see the progress bar move to 100% [17].
- Win states—The game's win states represent the many points at which the player might claim victory. In most cases, it implies that you have triumphed over a difficult obstacle of some type.
- Quests—All players must follow a specific set of instructions and conduct certain actions to progress through the game and earn their rewards. Missions and quests have similar structures, with each one containing several tests. One can find out how many points can be earned and how to complete each quest by consulting the quest list [18].
- Challenges—The use of challenges is an effective method of encouraging users to perform as intended, to finish a task, and to progress in their ability to work together effectively and gain new knowledge. Users can put their newfound knowledge to the test by attempting to complete the task at hand. Consequently, the user feels as if they have truly earned the reward [18].
- Voting—If you want to make improvements that everyone likes, you should let the users decide. Including consumers in decision-making is a great approach to show appreciation for their thoughts and ensure that the final product serves the needs of the largest possible audience [18].
- Rewards—In games, the ability to earn rewards is crucial. Games are played for a variety of reasons beyond the rewards, but it's undeniable that they play a role in keeping players engaged and motivated.

2.3 The Relationship Between Gamification and SPM

There are some strong similarities between projects and games. Typically, games are motivated by clear objectives, well-defined player roles, and useful measurements to provide feedback on growth. The same holds true for projects that have been managed successfully; they have clear goals, the members of the team know their specific responsibilities, and they use insightful metrics to track their progress.

Many of the characteristics of gamification are well-suited for use in a project management setting, where they may be used to add fun, inspire employees, and boost team productivity [19]. Gamification is centered on the concept of fostering the development and maintenance of a positive relationship between a product's end user (or employee) and the product itself (the project). The inclusion of fun games and other activities in the workplace is intended to appeal to and excite both gamers and people who aren't usually drawn to that genre.

The current generation has grown up in a world where technology plays an essential role. The ways in which they interact with one another, share information, and work together socially have all been altered by technological advancements [14]. Therefore, it has become more difficult for the management to keep them engaged and interact with each other in a creative manner. A feeling of belonging within a project or organization can be fostered by gamification. It has been observed that employees are eight times more engaged when they receive little prizes on a regular basis than when their salaries are negotiated annually [20].

Keeping everyone on the same page is essential for the success of any endeavor. Employees might be encouraged to work harder by receiving rewards. Gamified projects can use both monetary and non-monetary incentives to motivate their teams. Gamification has the potential to be a useful tool for both the project manager and the team, as it can help both parties better comprehend the tasks at hand and the manager's demands and expectations.

3 Methodology

The research methodology used for this research includes three main parts, (1) an in-depth literature review, (2) gathering data before using the framework through surveys; and (3) obtaining feedback on the applied framework via surveys. The literature review has been used to answer RQ1, RQ2, and RQ3 while RQ4 has been answered by applying the proposed framework in an organization with appropriate feedback gathered through surveys. Figure 1 shows the research methodology used for this study.

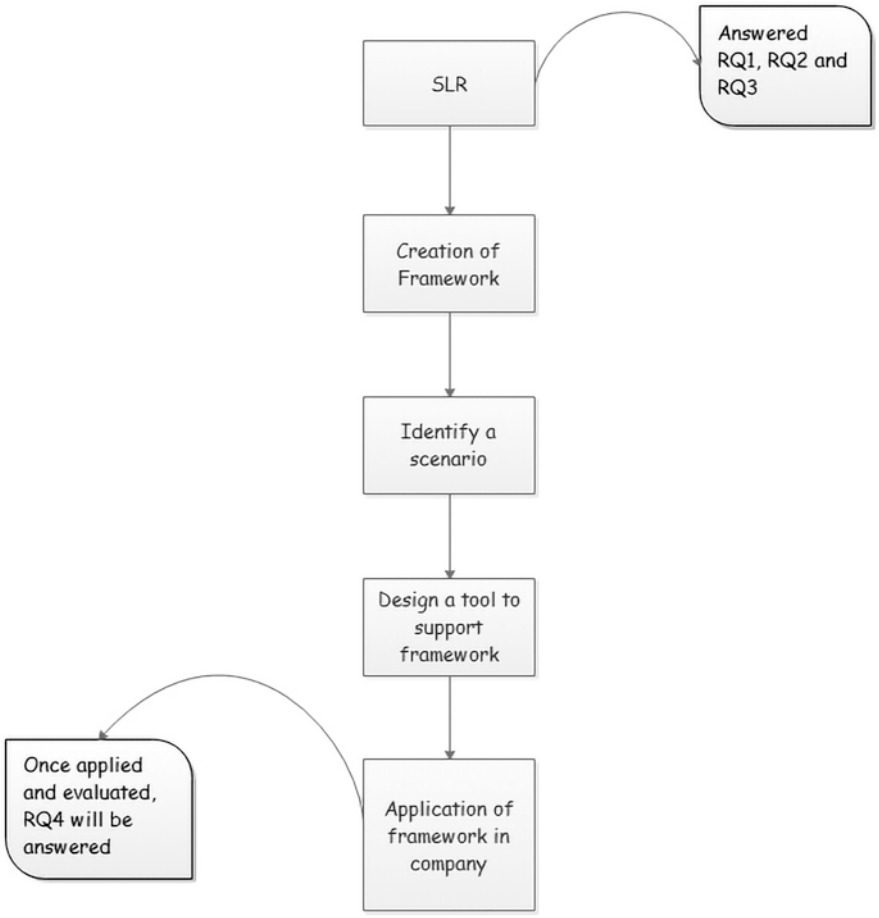

Fig. 1 Research Roadmap

3.1 Systematic Literature Review

Systematic literature reviews (SLRs) are used to find, critically evaluate and aggregate all relevant research papers on a specific research question or research topic. The methodology is intended to ensure that the literature review is unbiased, rigorous, and auditable [21]. The guidelines to conduct a systematic literature review proposed by Kitchenham and Charters [22] has been used for this study, which is widely recognized in software engineering. These guidelines include three phases: planning, conducting, and reporting the review. In this work, a mini-systematic literature review has been conducted.

Planning the Review
The planning phase includes defining the research questions, developing the research strategy, and determining the inclusion and exclusion criteria to be used in filtering the results obtained from the result string. The most important aspect of any systematic review is the formulation of research questions which have been highlighted earlier.

Once the research questions have been devised, it is now important to develop the search strategy. To be able to achieve this, related search terms were identified based on the research questions to narrow down the result to a more specific one. The search was conducted on Google Scholar as it indexes papers from several scholarly publishers and professional societies and contained the following texts: "gamification framework" AND ("resource management" OR "software project").

The inclusion and exclusion criteria have been detailed in the Table 1.

Conducting the Review
This part of the process focuses on executing the protocol that has been defined in the previous stage. The search was done on November 28, 2022, using the search string mentioned above on Google Scholar, and 231 results were returned. Based on the inclusion and exclusion criteria, 24 papers were initially selected. An analysis of the full texts was carried out to assess the quality of the research papers to ensure that they were research based, included a clear aim and objectives, used an appropriate design method, and included a clear statement of their findings. As a result, 11 papers had the highest weight and were kept for the review. The number of papers retained after each phase is shown in Table 2.

Reporting the Review
This section describes and disseminates the findings of the review. Table 3 shows all the papers that were reviewed and the research questions that they help to answer.

RQ1: Which gamification Design Frameworks Are Available in Literature?
To be able to address RQ1, the selected papers were analyzed thoroughly to understand better the gamification frameworks that are currently used or have been used in the past. Several authors have identified the first item behind designing a framework as defining their business objectives [23–26]. Before diving into the creation of a framework, it is crucial to evaluate and understand the objectives of the organization and whether it is feasible. However, in a framework proposed in [27], the first

Table 1 Inclusion and exclusion criteria

Inclusion/exclusion criteria	Research Paper
Inclusion criteria	Terms fulfil the search string Papers written in English Publication date: from 2017–2022 Academic journals, conference papers and articles
Exclusion criteria for full text	Papers presenting a summary of a workshop Duplicate work

Table 2 Selection process for the in-depth literature review

	Initial results	Eligible papers	Included papers
Electronic search	231	24	11

Table 3 Relevant papers and research questions

No	Paper Title	Reference	Research Question
1.	Challenges of gamification in software process improvement	[31]	RQ3
2.	Game design principles in enterprise web applications	[29]	RQ1, RQ2
3.	Applying gamification for mindset changing in automotive software project management	[24]	RQ1
4.	A framework for gamification in software engineering	[32]	RQ2
5.	Gamification for software process improvement: a practical approach	[27]	RQ1, RQ3
6.	Definition of a framework for organizational management	[25]	RQ1, RQ2
7.	Case study of the introduction of game design techniques in software development	[33]	RQ2
8.	Gamification Design for Indonesian On-Demand Staffing Platform	[26]	RQ1, RQ2
9.	An architecture for software engineering gamification	[34]	RQ2
10.	Designing a comprehensive gamification model and pertinence in organizational context to achieve sustainability	[28]	RQ1
11.	Toward gamification to software engineering and contribution of software engineer	[23]	RQ1

step is assessing the feasibility of implementing the framework, and then stating the business objectives comes second.

The following step has been used to understand who will be using the framework based on the objectives set. Some refer to it as candidate assessment [24], composition of participants [25], or even delineate target group and area focus [26], whereas in the framework used by Prakash and Manchanda [28], this step is named to decode the player's mind. In the framework mentioned earlier [27], the third step is classifying the activities and behaviors to be enhanced whereas the fourth stage is defining the players.

The next step differs according to the framework. In the framework proposed by Herranz et al. [27], Ren et al. [23], Prakash and Manchanda [28] and Briciu and Filip [24], the next stage is listing appropriate gamification elements and trying to map those in the processes that are meant to be gamified. This part is mainly focused on defining each component that fits best the organization and players. Mancilha Da Silva and Pinho [25] proposed a framework in which the third step is events/cooperative score. Nurcahyo et al. [26] slightly modified the six-step design framework in which the third one is user experience journey. The aim of this stage is to lead the user to enjoy and keep them engaged in their tasks.

The remaining steps of the frameworks refer to the actual implementation, evaluation, and feedback [23, 26–28]. In another study done by Briciu and Filip [24], the step before implementing the framework is assessing the risks first. However, the model proposed by Bankov [29] is quite different compared to the others mentioned. It consists of four parts that go into a loop: motivation, actions, rewards and achievements. The analysis of the above frameworks provides the basis for the selection of steps to be included in the proposed framework, which is described in Sect. 4.

RQ2: Which Gaming elements Have Been Used in Existing gamification Projects?

Table 4 summarizes the most frequently used gamification features across the research included in this review. Based on the findings, the gamification elements used were the progress bar, points, leader boards, rewards, win states, badges, quests, challenges, levels, rankings, experience, and voting. All these elements have been highlighted in Sect. 2.

RQ3: What Challenges Are Being Faced by IT Companies when Applying gamification for People Management?

Below are some of the challenges faced by organizations when implementing gamification to their processes or organizations [27, 31].

- Lack of detailed analysis on the different roles involved in the gamification process
- Importance in recognizing and considering the differences between several roles
- Issues when choosing gamification elements
- Participants find it complicated and as an additional task to use the gamified process
- Implementing the correct method can be challenging and must meet the objectives of the research work

RQ4: Does gamification Actually Increase Employees' motivation and Engagement?

The RQ4 has been answered in Sect. 6.

Table 4 Relevant papers and gamification elements

References	Gamification elements
[25]	Scores, game levels, objectives, and ranking
[29]	Progress bar, point-based reward system, and leader boards
[26]	Progression, reward, win states, badges, points, and quest
[32]	Points, levels, rankings, badges, and challenges
[33]	Experience, badges
[34]	Points, badges, levels, quests, and voting

3.2 Surveys

A pre-test and post-test survey have been conducted by the users who tested the proposed framework. As soon as the framework was developed and the users were identified, a pre-test survey was sent to them. Therefore, the target population was the users who participated in the application of the framework at their workplace. The data collected was analyzed using both Google Forms and SPSS software. The pre-test and post-test questionnaires consisted of 21 questions, with two open-ended questions and the remaining being closed-ended questions. The purpose of conducting this survey was to understand the current state of mind and working conditions of the employees. Moreover, once the proposed framework has been implemented at their workplace, the participants are required to retake the same survey again. The purpose was to compare and understand the behavioral changes that might have been brought due to the introduction of the gamified framework.

4 *Gamifie* Framework

This section highlights the proposed framework, which has been developed and applied in a real-life scenario. The requirements for the framework were based on the results of the in-depth literature review and, more specifically, the answers to the research questions RQ1, RQ2, and RQ3. The gamified framework has been named "*Gamifie"* and is illustrated in Fig. 2. *Gamifie* framework consists of six steps, as follows:

1. Feasibility study
2. Identify objectives
3. Players' typology
4. Game mechanism
5. Implementation
6. Evaluation and feedback

The six steps of the *Gamifie* framework have been described below.

1. Feasibility Study

The first step in using the framework is to assess whether the organization can practically apply the framework. It's important to identify whether the resources available will be enough to implement the framework. Moreover, before implementing it, we must ensure that top management is on the same wavelength and is willing to devote resources to this endeavor.

2. Identify Objectives

Once we have identified that implementing the framework is feasible, the formulation of SMART objectives (Simple, Measurable, Achievable, Relevant, and

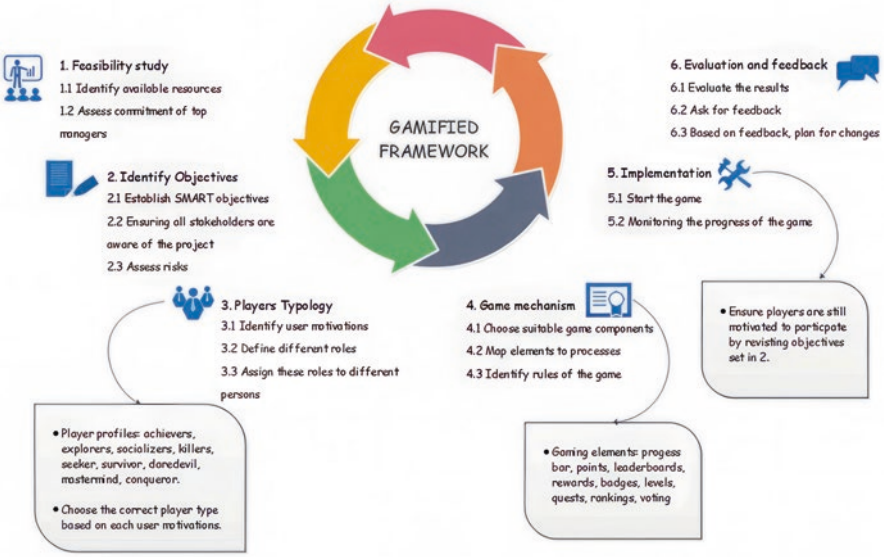

Fig. 2 Gamified framework *Gamifie*

Time-based) must be done. In addition, all the stakeholders need to be informed of the initiative, which can be accomplished by conducting a meeting and providing them with a briefing on the goals and possible risks of carrying out the same.

3. Players' Typology

Identifying the different types of players within the relevant department is essential for determining whether gamification is appropriate for all the users. This step focuses on knowing more about what motivates a person while doing their work and choosing the appropriate roles that define them. Several player categorizations were identified based on the Hexad framework and must be assigned to each user. It consists of six categories [35]:

- Philanthropists are inspired by purpose only.
- Socialisers like to interact with others.
- Free Spirits prefer to operate independently of outside influences and are drawn to doing so within a system.
- Achievers are motivated by challenges and ways to improve themselves.
- Players are driven by extrinsic benefits. They'll do everything to gain a reward, regardless of the activity.
- Disruptors like to challenge and alter the system.

4. Game Mechanism

This step focuses on choosing the right gaming elements from the ones described earlier in Sect. 2.2 and then for each task or process that is being done, these

elements would be mapped to them. Some of the gaming elements are progress bars, points, leaderboard, badges, rewards and amongst others. At this stage, the rules of the game need to be also identified.

5. Implementation

In this step, the gamification proposal is put into action and fully implemented. However, before implementing the gamification plan, steps 2 and 3 must be revisited to ensure that the employees are still in sync with the goals and see if the participants are still inspired to take part in this endeavor.

6. Evaluation and Feedback

The final step is the evaluation and feedback part. After implementing the framework, it is crucial to evaluate the success or the failure of the framework. Feedback would be gathered from several players and if required, changes would be made for subsequent iterations.

5 Application of Gamifie

This section focuses on the application of the framework proposed and, on the tool, developed to support the framework. The framework has been evaluated in the testing life cycle of a private company, elaborated in this section, along with a description of a basic testing methodology. Due to confidentiality, the company has been referred to as Company X.

5.1 Chosen Process—Testing Life Cycle

The process in which the framework has been used and evaluated is the testing phase of company X. Company X is specialized in software quality assurance and testing with more than 30 employees in Mauritius. It has supplied the Mauritian market with more than a hundred experienced testers, making it the only company in the country whose entire focus is on software quality assurance and testing. It also provides its services to several other companies and mostly make use of the agile methodology. Before describing the process of testing used at some of company X clients, it is crucial to understand the steps involved in a normal testing life cycle. The main phases of a testing life cycle are requirements analysis, test planning, test case development, environment setup, test execution and test cycle closure [30].

5.2 Adapted Testing Lifecycle

The test lifecycle described above is a general one. However, several organizations may follow their own test lifecycle, which can be an adapted version of the previous one. Some of Company X's clients use the agile methodology; therefore, an adapted version of the lifecycle is explained below, alongside a detailed example. In the adapted version some of the steps are not included and the orders are not the same. As illustrated in Fig. 3, the steps are: test planning, requirement analysis/user story, test case development, test execution, and test cycle closure.

In the agile methodology, every team works in sprints. A sprint normally lasts 14 days, but the time frame is not fixed, and it can be changed depending on what the company wants. In company X, the sprint is for 10 days, and different teams tackle different sprints with the objective of conducting a monthly release. One day before the sprint starts, a sprint planning is conducted with all the team members to decide on things like the goal of the sprint, assignment of tasks, capacity planning, and assignment of story points for each task.

A product backlog contains all the tasks of the whole company, while a sprint backlog is only for a specific team or project. During the sprint planning, the team decides which items have higher priority, and these will be added to the sprint starting the next day. Work on a backlog item or other task might be estimated in 'story points', which are equivalent to a certain amount of time spent on the task. Teams use story points to indicate the difficulty, scope, and uncertainty of a task.

When the sprint planning has been conducted, the sprint starts the next day, and the team will start working on their tasks. This study focuses on the testing part done in three environments which are the test environment, integration environment, and staging environment. Testing in the test environment involves more steps,

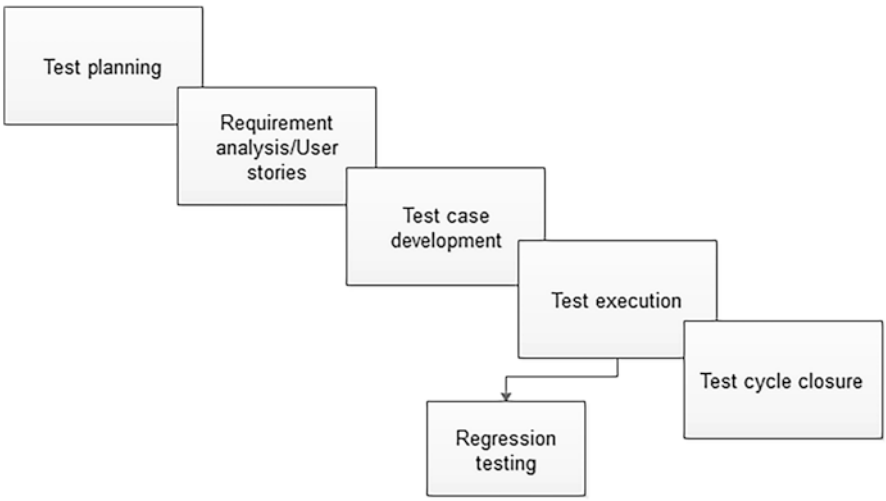

Fig. 3 Adapted testing life cycle

as this is where testing starts, and it requires test case development. Since testing on the integration and staging environments is done by team B, the focus is solely on team A for this study. Figure 4 shows a detailed diagram of how the testing lifecycle works in an agile environment.

1. Test planning is done at the very beginning and is done only once. Things like allocation of teams, test management, and test automation tools are decided and planned in this phase. Once this has been done, the team members can start with their tasks.
2. Requirement analysis takes the form of user stories here, where all the details are captured. User stories are concise descriptions of features based on the viewpoint of the user who will be using or interacting with the product. Before starting the sprint, user stories are ranked according to their priority or story points. Once the sprint starts, each tester starts to analyze the user stories. This is the part where they decide which testing technique would be used or whether there are already some test scripts available to test the functionality.
3. The third step is the test case development, which is the same as in the original test lifecycle.
4. Test execution is like the original lifecycle. However, in addition to the test cases that are executed, testers also perform regression testing at this stage.
5. The last day of the sprint is the test cycle closure. A sprint review is conducted with all the stakeholders, and if there are no issues or blocking points, the user

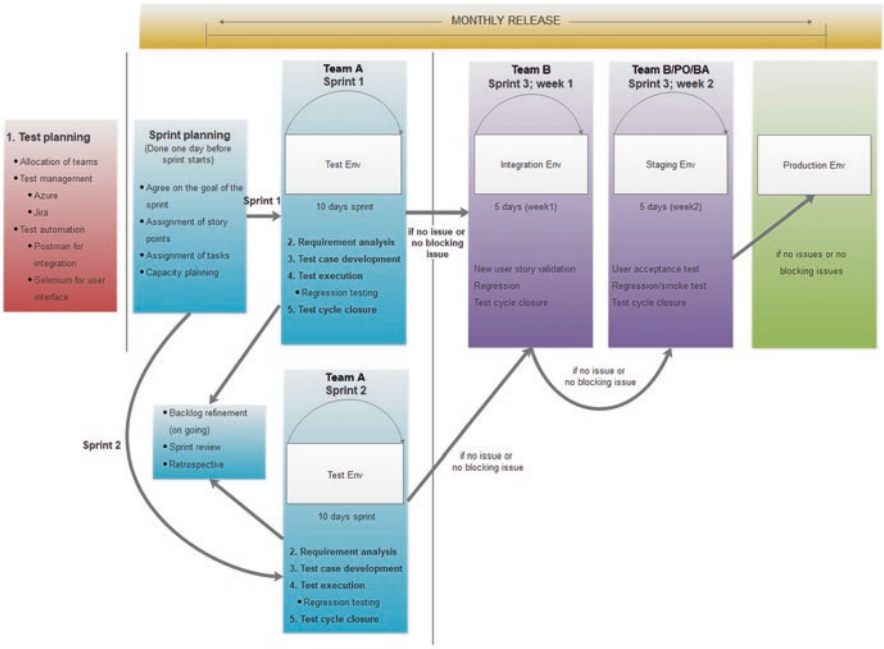

Fig. 4 Adapted testing lifecycle in an agile environment

stories are assigned to team B. The latter then start their sprint, which last for ten more days. Five days are for the integration environment, and the rest of the week are for the staging environment. In week 1, tests are done by team B, and there are new user story validation and regression testing done. In week 2, the product owner and business analyst are involved as UAT are conducted altogether with regression and smoke testing. Once all has been validated, this would be released to the production environment, and the monthly release would be accomplished.

5.3 Application of Gamifie

Once the *Gamifie* framework has been developed and the process to which it is to be applied has been identified, the two must be combined. Figure 5 below illustrates the detailed testing lifecycle including the steps from the *Gamifie* framework. The added parts are highlighted in different colors with a red border. The steps numbered starting with 'T' refers to the steps found in the testing life cycle and the ones starting with 'GF' are from *Gamifie* Framework.

As mentioned above, the focus for this study is on team A. Therefore, most of the steps are done in the sprint planning phase with steps 5 and 6 (GF5 and GF6) being carried out in the actual sprint. Team A of company X consisted of six persons who participated in the study and evaluated the framework.

5.4 Development of a Tool to Support Framework

To support the framework that has been developed, a tool is required to ease the use and tracking of the progress of different players. A tool has therefore been developed in Microsoft Excel and acts as a checklist for the team leader and as a dashboard where the leaderboard, rankings, and points of each player are displayed. The Excel file consists of seven sheets in total with only four being visible to the team while the remaining three are for calculation purposes and are hidden.

Sheet 1—Checklist
The first sheet of the excel is named checklist. This is where all the details and proof for each of the steps found in *Gamifie* are stored. The aim of this sheet is to keep track of the progress of the whole game and this checklist can be used by other teams or companies as well. As shown in Fig. 6, all the steps of *Gamifie* have been listed and can be differentiated by various colors. The same color scheme from the framework has been used for each step. There are checkboxes in the second column which once checked, the steps associated with it are struck through indicating that step has been completed. The purpose of the third column is to fill in what has been done to achieve that step. For example, for the first step which is feasibility study,

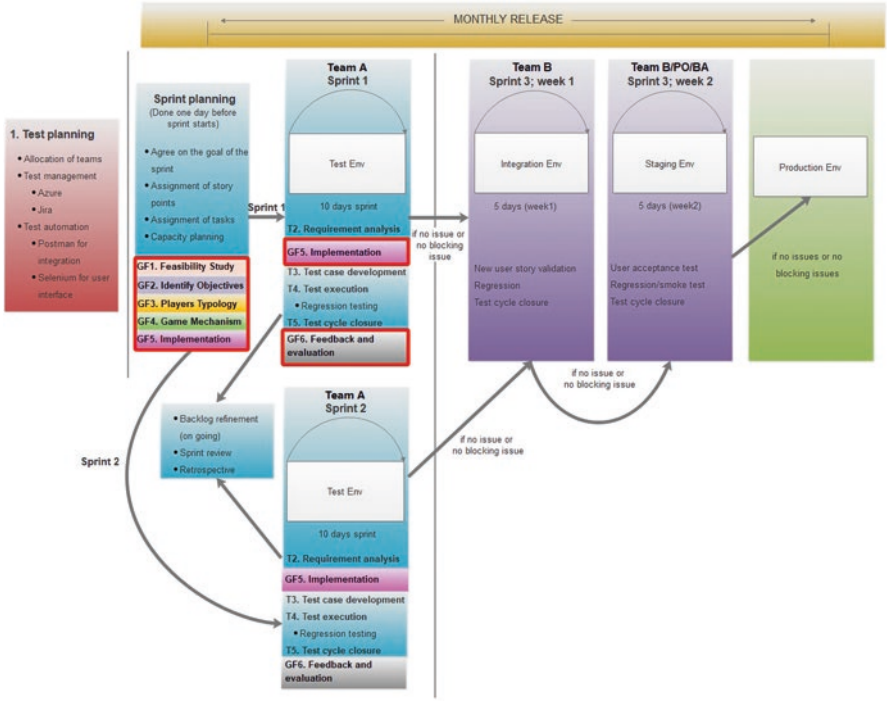

Fig. 5 Application of *Gamifie* on testing lifecycle

there are three options from which we can choose what has been done to complete it. To identify the available resources, a capacity planning was done, and the team leader has chosen this option. The next column is where the proof of what has been filled in the previous column are browsed or entered. By clicking on the folder icon, any files or photos can be browsed, and the link is made available on the excel sheet.

Sheets 2 and 3—Sprint 1 & Sprint 2

Sheets 2 and 3 are concerned with the scores, player type, and progress related to each of the sprints. Also, it has the different badges which all the players are eligible to earn and are as follows:

- 2 points badge—User finds a bug while doing regression testing
- 5 points badges—User finishes documentation first, or user participates in backlog refinement or asks questions to decide on acceptance criteria
- 10 points badges—User completes user story before estimate or volunteers to conduct regression testing before sprint review
- 15 points badges—User automates test which has been done within the sprint
- 20 points badge—User volunteers to take a hot fix that came from live environment

	A	B	C	D	E	F
1	Tasks		What has been done? (Select from the drop-down list or enter your own)	Notes/Proof	Additional proof/notes	Browse
2	1. Feasibility Study					
3	1.1 Identify available resources		Capacity planning/Sprint planning	pacity planning.png		
4	1.2 Assess commitment of top managers	☑	Snapshot of all team members Stand up meeting Capacity planning/Sprint planning	approval mail.png		
5						
6	2. Identify Objectives					
7	2.1 Establish SMART objectives	☑	Define objectives in sprint planning	objectives.png		
8	2.2 Ensuring all stakeholders are aware of the project	☑	Conduct meeting with stakeholders	stakeholders meeting.png		
9	2.3 Assess risks	☑	Conduct a SWOT analysis	swot analysis.png		
10						
11	3. Players Typology					
12	3.1 Identify user motivations	☑	Answer quiz on "What type of player are you?"	https://take.quiz-maker.com/QAW41D3CG		
13	3.2 Define different roles	☑	Answer quiz on "What type of player are you?"	https://take.quiz-maker.com/QAW41D3CG		
14	3.3 Assign these roles to different persons	☑	Answer quiz on "What type of player are you?"	https://take.quiz-maker.com/QAW41D3CG		
15						
16	4. Game mechanism					
17	4.1 Choose suitable game components	☑	Ranks, Points, Leaderboards, Rewards	Gaming elements were selected by researcher		
18	4.2 Map elements to processes	☑	Discussion done between researcher and team leader	Gamified elements was applied on the test life cycle		
19	4.3 Identify rules of the game	☑	Create a task on Jira/Azure on rules	rules.png		
20						
21	5. Implementation					
22	5.1 Start the game	☑	Sprint planning			
23	5.2 Monitoring the progress of the game	☑	Ask for progress in daily stand up			
24						
25	6. Evaluation and feedback					
26	6.1 Evaluate the results	☑	Sprint review/retrospective meeting			
27	6.2 Ask for feedback	☑	Retrospective meeting			
28	6.3 Based on feedback, plan for changes	☑	Retrospective meeting			

Fig. 6 *Gamifie* Checklist

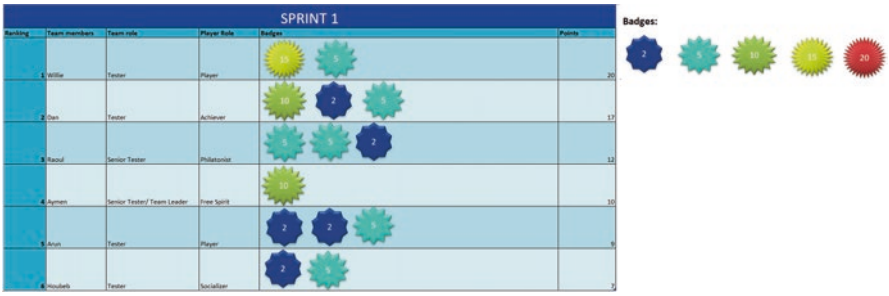

Fig. 7 Sprint 1

Figure 7 shows the how the different users collected badges after sprint 1. A similar sheet shows the badges earned in sprint 2.

Sheet 4—Dashboard

The last sheet is the dashboard. This is where the rankings, leaderboard, points, and rewards are displayed to everyone. Figure 8 illustrates the dashboard sheet where all the data has been presented based on each sprint.

6 Results and Discussion

This section evaluates the proposed framework *Gamifie* by analyzing the results of the post-test survey and comparing them with the pre-test results. As mentioned above, once the 2nd sprint was over, a post-test questionnaire was given to the participants and the analysis of the results are presented below. Moreover, this section answers the research question ***RQ4: Does gamification actually increase employees' motivation and engagement?***

6.1 Post-Test Results

The section A of the questionnaire concerns the demographics, and no comparison has been made since all the answers are the same.

6.2 Hypothesis Testing

Hypothesis testing uses inferential statistics to test assumptions and generate population findings from data collected. The paired samples T-Test was used to test how significant the mean difference of the motivation level (as shown in Figs. 9 and 10) between the two results is.

- H_0: The mean of the pre-test result is greater than the post-test result.
- H_1: The mean of the pre-test result is not greater than the post-test result.

Fig. 8 Dashboard sheet

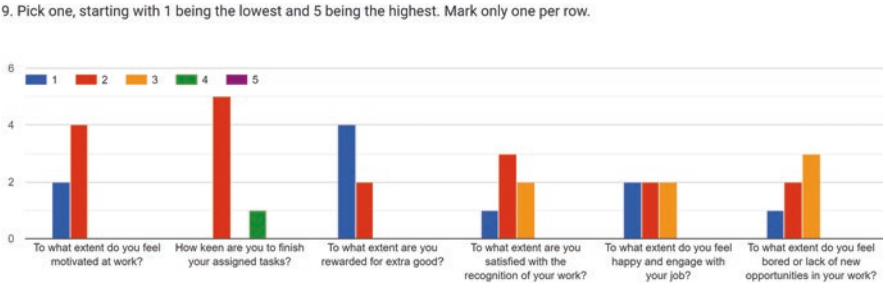

Fig. 9 Pre-test—Motivation level

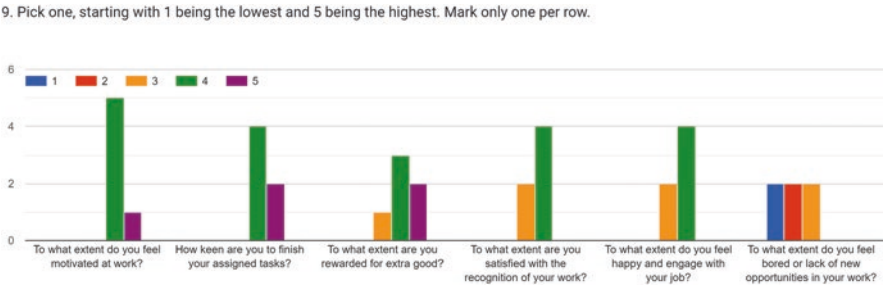

Fig. 10 Post-test—Motivation level

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-test	1.6667	6	.51640	.21082
	Post-test	4.1667	6	.40825	.16667

Fig. 11 Mean difference

Paired Samples Correlations

		N	Correlation	Significance One-Sided p	Significance Two-Sided p
Pair 1	Pre-test & Post-test	6	.316	.271	.541

Fig. 12 Correlation between both tests

Paired Samples Test

		Paired Differences					t	df	Significance One-Sided p	Significance Two-Sided p
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper				
Pair 1	Pre-test - Post-test	-2.50000	.54772	.22361	-3.07480	-1.92520	-11.180	5	<.001	<.001

Fig. 13 Paired sample t-test

The mean value for post-test was higher than the pre-test. The standard deviation for post-test was less, therefore data were more clustered around the mean, as shown in Fig. 11.

Figure 12 shows that the results of both groups were significantly positively correlated ($r = .316$).

The average difference between the paired pre-test and post-test ratings was −2.50, as shown in Fig. 13. Negative values reflect pre-test mean was lower than post-test. Since Sig. Value P (0.000049943162612) < 0.05, then H_0 was rejected and H_1 was accepted. Significantly, high ratings are better, and the results of the paired sample t-test reveal that post-test scores were considerably higher than pre-test values.

Based on the results and analysis done for both pre-test and post-test, it can be concluded that after applying *Gamifie,* motivation and engagement of employees have increased. Since H_1 has been accepted and post-test ratings are higher than pre-test ones, it can be deduced that overall motivation, satisfaction, and engagement has risen. In the same vein, ***RQ4: Does gamification actually increase employees' motivation and engagement?*** has hence been answered.

In this study, the primary aim was to propose a framework, using the concept of gamification, to increase the motivation and engagement among employees in IT companies. This was achieved by going through all the research questions set for the study with the proposal of a new gamified framework *Gamifie*. The research challenges that were encountered during this study include identifying the most effective gamification techniques for different types of employees, determining the ideal level of gamification to use, and finding ways to sustain the motivation and engagement over time. The findings of this study indicate that gamification can be an effective strategy for increasing motivation and engagement among employees in IT companies. Specifically, the use of leaderboards, badges, and rewards were found to be effective gamification techniques that helped to motivate and engage employees. Additionally, the level of gamification used should be customized for different employees, with more competitive employees requiring more challenging games and rewards.

Based on these findings, several recommendations can be made for IT companies looking to implement gamification as a motivation strategy in software project management. First, companies should consider customizing their gamification approach to suit different types of employees, considering their preferences, motivation, and engagement levels. Second, companies should be mindful of the level of gamification used, ensuring that it is neither too easy nor too challenging for employees. Finally, companies should explore ways to sustain the motivation and engagement of employees over time, such as by introducing new games or rewards periodically.

7 Conclusion

Managing software projects can be very challenging and keeping the employees motivated and engaged is also a big concern for the management in IT companies. As technology is evolving, the need for new concepts and ways of doing things is increasing and this is where gamification can help. The main aim of this research was to come up with a Gamified framework to help increase employees' motivation and engagement level in IT companies. A pre-test survey was conducted in an IT company to get the employees' opinions. According to the results, most of them were not very happy with their work and some were even willing to leave their jobs. One of the most significant findings from this research is that employees are not necessarily motivated by monetary value, rather things like recognition, satisfaction, and good working conditions. Different gamification frameworks were

compared, and a novel framework was developed, named *Gamifie* which included game components that aim at boosting job motivation and productivity. *Gamifie* was tested on a team of 6 persons for a duration of 1 month, i.e., 2 sprints of 2 weeks. A post-test survey was then conducted to get the feedback of the persons. Based on employees' evaluation and statistical analysis, *Gamifie* proved to be successful in increasing the motivation level of employees. The present work on Gamification and SPM ratifies earlier findings and contributes additional evidence that suggests that game components can positively affect the motivation level of workers in IT companies. It is recommended that companies introduce the framework in their workplace and look at possible means to reward the employees who earn the most marks on a regular basis. We anticipate that the adoption of such a gamified framework is in line with the UN Sustainable Development Goal 8 which is to promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. A highly motivated employee will be obviously more productive thereby help to attain a sustainable economic growth.

The work however does have some limitations. First, *Gamifie* was tested and applied to only one team of six people for a duration of 1 month. Moreover, Microsoft Excel was used as a tool to help the application of the framework. Therefore, as future works, a more prolonged application of *Gamifie* and on more team members would be planned. A web interface and its corresponding dashboard would be implemented. Adding more game mechanics in terms of levels and achievements can be envisaged. Finally, more ways to earn points to foster competition among different teams can be looked at.

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A Collaboration Process for Developing Business Process Improvement Implementation Plans

Komugisha Lilian

1 Introduction

Business process improvement aims to solve issues brought on by a lack of confidence in the current business procedures [16]. Based on Porter's Competitive Advantage paradigm, the BPI concept was first introduced in 1985 [5]. Developing a BPI implementation plan is critical to realizing BPI in any organization [14]. BPIIPD is a repetitive process that requires internal and external stakeholders to provide extensive knowledge and a variety of abilities [2]. Hence, there is a need for a way to facilitate stakeholder participation at a low cost within a limited time [1].

Chakravorty in 2009 created a Six Sigma implementation model and detailed how to create a complete implementation plan and boost stakeholder participation during BPIIPD [4]. To incorporate stakeholders during BPIIPD, the methodology stresses the utilization of unofficial gatherings and the creation of teams or groups. The model details the procedures needed to draft an implementation strategy. However, Chakravorty passes over detailing how the implementation plan's specifics are generated [4]. Page in 2010 outlines ten steps with elements that can assist the organization in developing a successful BPIIP [14]. To secure buy-in for the successful implementation of the improvement, the model promotes stakeholder involvement at every stage of the process [13] through teamwork, facilitated workshops, and meetings. Page recommended using conventional gatherings to foster stakeholder involvement [14]. However, they are expensive and require much time [12]. The model lacks the tools to promote greater stakeholder involvement within a constrained budget and time frame.

K. Lilian (✉)
Makerere University, Kampala, Uganda

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This research aimed at developing a "flexible, repeatable, predictable and transferable" BPIIPD Collaboration Process. The proposed artifact will enable non-skilled group members of the BPIIPD team to develop the plan efficiently within the limited time, ensure group buying in, and enhance effective communication without a professional facilitator, hence reducing the costs. The research followed the specific objectives to achieve the above main goal:

1. To investigate the current approaches of BPI implementation plan development and the current methods used to involve stakeholders and their strengths and weaknesses
2. To design an artifact that addresses the collaboration challenges identified in the methods used
3. To evaluate the designed artifact

2 Methods

Design science was adopted to address the lack of a means to promote greater stakeholder involvement within a constrained budget and time frame during BPIIPD. Design science has relevance, design, and rigor cycles [8]. In the relevance cycle of this research, case organizations of the Uganda Communications Commission (UCC), Kampala Capital City Authority (KCCA), and CMA-CGM shipping company were identified. UCC, a communications regulatory body in Uganda, focuses on digital transmission and interdependent systems to improve employee productivity. The organization is continuously improving business processes, including digital migration transmission, salary management, staff recruitment, and frequency licensing, to meet the needs of stakeholders. KCCA is a capital city governing body in Uganda that improves internal processes like customer care, license issuing, payment, revenue collection, and debt management, collaborating with external stakeholders. The organization maintains a business process improvement department and interacts with external stakeholders like the minister, parliament committee, customers, vendors, and local government leaders. CMA-CGM Shipping Company Uganda, a leading shipping company in Uganda, has enhanced customer care and information dissemination through an information portal and call centers, with some improvements requiring head office directives.

The approaches and tools used to involve stakeholders during the development of BPIIPD were investigated in an exploratory survey following the procedure in Table 1.

The exploratory survey in the relevance cycle used a literature review, questionnaire survey, and interview research techniques. The literature review enabled the researcher to investigate the existing BPIIPD approaches, stakeholder types involved in BPIIPD, and the challenges associated with stakeholder involvement during BPIIPD. Data sources used were publications, organization technical documents,

Table 1 Design for exploratory survey

Parameter of an exploratory survey	Details of how the parameter was addressed
The main objective of the study	To investigate the approaches of BPIIPD and methods used to involve stakeholders
Target respondents	Focal persons responsible for BPI projects, ICT manager, and heads of departments Organizations such as Uganda Communications Commission, Kampala Capital City Authority, and CMA-CGM Shipping Company Uganda
Sampling method	Purposive sampling enabled to identify respondents based on the following criteria: 1. Availability of the respondent active in BPI to respond in a face-to-face interview 2. Ability of respondents to answer a questionnaire 3. Existence of a BPI project in UCC (digital migration transmission, salary management, staff recruitment, and frequency licensing), KCCA (customer care, license issuing, payment, revenue collection, and debt management processes), and CMA-CGM Shipping Company Uganda (customer care and information dissemination)
Sample size	Using the Krejcie and Morgan [17] table, a sample size of 45 respondents was used
The instrument for data collection	Questionnaires were used to collect data from the BPIIPD team because they were many, busy, and not readily available An interview guide was used for the IT manager and focal persons responsible for BPI projects because they were few and available during the implementation of the BPI project
Average time	60 minutes for interview sessions
Interview procedure	A request for participation in the interview was delivered physically to the respondents Questionnaires were delivered to and collected from the respondents both online and physically The approaches and tools used to involve stakeholders during the development of BPIIPD were investigated
Data analysis	1. The researcher determined what to analyze based on the objectives 2. Getting acquainted with the collected data and analyzing responses from questionnaires and interviews 3. Organizing data according to themes derived from the objectives 4. Coding and entering data into the SPSS tool 5. Performing an analysis of descriptive responses for all the questions on the questionnaire according to frequency distributions and descriptive statistics to display results concerning each of the research questions 6. Reflection on analyzed data and evaluating the findings

government publications, and reports of BIP in case organizations. A questionnaire was utilized to collect data on attitudes, knowledge, beliefs, and feelings regarding the development and challenges of BPI implementation plans in organizations and the usability of the collaboration process. Interviews were conducted during the

initiation phase to gather data, understand the business environment, and assess the relevance of the research in real organization settings.

In the rigor cycle, the literature in the existing body of knowledge was reviewed and skillfully adopted to design BPIIPD-CP. The researcher used the existing knowledge base to acquire an in-depth understanding of the existing approaches to BPI, BPIIPD, methods of stakeholder involvement during BPIIP, their associated challenges, and how collaboration engineering could be adapted to address existing challenges.

The design cycle involved designing and evaluating the artifact of this research [8]. BPIIPD approaches, collaboration engineering, and methods used for stakeholder involvement in the rigor cycle together with requirements defined in the relevance cycle from the exploratory survey were input to the design of BPIIPD-CP. Evaluation of BPIIPD-CP was done using walk-through and pilot testing, and refining the artifact [8, 9]. The evaluation was conducted in the Uganda Communications Commission, Kampala Capital City Authority, and Uganda Investment Authority. Using the analytical and observational methods, the usefulness and usability of the artifact were evaluated. Usability was defined as the degree to which the BPIIPD-CP supports stakeholders involvement to develop BPIIP with the least possible effort. Key indicators that were used to measure usability included support for stakeholder shared understanding, appropriateness of the ThinkLet selected, and support for sharing of information among stakeholders [1, 2]. The criteria used to measure the usefulness included stakeholder satisfaction during the execution of BPIIPD-CP, stakeholder accommodation during BPI plan development, and tasks accomplishment in time. Table 2 shows the procedure for walk-through sessions and pilot testing.

3 Results

Current BPIIPD Approaches, Organization 1 As Kampala the capital city of Uganda strives for developement, KCCA has made significant strides in its internal processes. The BP that had benefited from these improvements include customer care, license issuing, revenue collection, and debt management. KCCA has been working closely with various external stakeholders, such as the Minister of Kampala, the public, equipment suppliers, counsellors, and expert consultants. As part of the implementation of these process improvements, KCCA presented the BPI idea to the Change Management Advisory Board (CMAB), which approved it. The CMAB then tasked a committee of affected stakeholders to develop a detailed BPIIP through a series of activities (Table 3).

Organization 2 UCC is a regulatory body that oversees communications operators in Uganda and functions in a high-tech environment that is constantly changing. UCC works with a variety of stakeholders, including workers, the public, the gov-

Table 2 Evaluation procedure for walk-throughs and pilot testing sessions

Aspect	Description
Walk-through sessions	
Goal	To acquire practice-based information on how the BPIIPD-CP process was executed and to identify and correct errors in the designed BPIIPD-CP
Inputs	The input for the first session in organization one was the designed BPIIPD-CP by the researcher. Input to organizations two and three was the refined BPIIPD-CP
Participants	Four participants: One researcher, one professional facilitator, and two members of the BPIIPD team
Time required	Time for each session kept changing
Evaluation setting	Natural setting
Approach used	Explain the role of research: By the researcher Explain the aim of the evaluation session: By the researcher Ask participants to review the process activities (patterns and ThinkLet used), tools, and procedure for executing activities for usability and usefulness: By the researcher Encourage participants to identify errors and suggest means of eliminating identified errors Based on participants' experience ask whether there are any ways the BPIIPD-CP could be improved
Output	Refined version of the BPIIPD-CP
Pilot testing session	
Goal	To determine if the designed BPIIPD-CP can be used to develop BPI implementation plan
Inputs	Refined version of the BPIIPD-CP
Participants	27 participants, 9 per organization: 1 professional facilitator, 3 heads of departments, and 5 operational junior staff
Time required	Time for each session was dynamic and kept on changing
Evaluation setting	Natural setting
Approach used	Participants executing each of the BPIIPD-CP tasks to achieve the expected deliverable Participants generated ideas, filtered the ideas, and agreed on what to include in the BPIIP At the end of piloting testing, a questionnaire was issued to collect information about the quality of the designed collaboration process
Output	BPI implementation plan

ernment, suppliers, Internet service providers, broadcasters, subject-matter experts from other nations, and development partners. Numerous organizational processes were being improved at the time of the survey, including frequency licensing and management, staff recruiting and management, wage management, and dispatching. The committee of affected stakeholders developed a detailed BPIIP through a series of activities given in Table 4.

Table 3 BPIIPD process at KCCA

Name of the activity	What was involved in executing the activity
Communication of the selected BPI alternative	Review of process map of the affected process by the committee stakeholders and business analyst
Communication of purpose of developing the BPIIP	Identification of the sponsors, affected departments, and their expectations by the improvement plan owner from whom the BPI idea originated
Scope definition for the BPIIP	Aspects that defined the scope of the BPIIP were identified, reviewed, and agreed upon by the committee members
Definition of the required activities to realize BPI	During facilitated workshops, members were tasked to identify the activities to operationalize the BPI and the expected activity deliverable(s)
Estimation of the required resources	The facilitator guided the discussion of resources in terms of time, budget, and human resources for each activity
Identification of required technology	A list of service providers for technology was generated based on expertise, cost, working relationship, and vender current projects Selected service providers were invited to give their views with respect to the required technology details
Determination of quality and performance indicators	Milestones were set and quality indicators were defined by the stakeholders
Assessment of risks and mitigation measures for improvement implementation	Risks associated with improvement changes were critically analyzed and evaluated, and mitigation measures were identified
Development of an implementation strategy for rolling out the changes for improvement	An impact analysis was developed and the best way to roll out the improvements was defined. The stakeholders were required to generate ideas on how change could be implemented
Discussion of the communication strategy	Details on how communication would be done among the improvement team and the rest of the organization were defined
Development of a testing plan for the improvements	Details of the testing procedure for the improvement were agreed upon by the stakeholders led by domain-specific experts
Development of a training plan for the affected stakeholders	A training expert guided the group discussion on defining how the training could be done, stakeholders' training needs, and training materials
Documentation	Using information generated in all activities, the owner of the BPI idea develops a comprehensive BPIIP and presents it to management

Organization 3 CMA-CGM Shipping Company Uganda has a branch in Uganda that oversees freight management. They have enhanced their customer service by implementing an information portal and call centers. However, their business processes have been affected by environmental issues, competition, and changes in technology. Decisions to make improvements in the organization are made at the head office. Workshops are organized and questionnaires are used to collect feedback from other sub-offices including the Uganda office about what to include in the

Table 4 BPIIPD process at UCC

Name of the activity	What was involved in executing the activity
Development of BPI teams	BPI implementation plan development started with top management (vary from the executive director, project manager, process manager, process owner) and middle management that constituted team one give an abstract view of the BPI plan Middle management, junior staff, vendors, testing and training experts constituted team two The role of middle managers was selling the BPI idea to other members, spearheading the development of the BPIIP, and verifying if the developed plan would achieve the desired goals set by top management Junior staff were responsible for the actual realization of the developed BPIIP
Team one (varied based on the nature, size of BPI) undergoes a number of activities to develop first draft of the BPIIP	
Communication of the BPI idea to the rest of the team members to get buy in and approval	The BPI idea was presented in a concept paper drafted by the head of department from where the BPI idea originated The scope of BPI, budget, sponsors, and time for BPI were explained The affected heads of department were informed about their roles and responsibilities in developing the improvement implementation plan
Estimation of the required resources	The overall time, budget, and constraints related to the BPI project I were suggested and agreed upon by the members
Team two (constituted middle management and junior staff from departments affected by BPI) activities to develop detailed BPIIP	
Definition of justification for BPII alternative selected	Stakeholders tasked to review documentation of selected BPI alternative
Communication of reason for developing the BPIIP to stakeholders	During this activity, information with regard to the overall time and budget required to implement the BPI alternative was explained. The constraints associated with the BPI project were also identified
Communication about the affected departments and stakeholders to team members	The departments to be involved in process improvement and expected roles and responsibilities were explained
Generation of the aspects that define the scope of the BPIIP	The team defined what was expected and not expected to be part of the developed implementation plan
Determination of the activities required to implement the improvements	Activities and their sequence of execution were defined by the stakeholders. Each activity was allocated time, human resources, deliverables, and budget to implement it during free brainstorming session The responsible human resource for each activity was also assigned

(continued)

Table 4 (continued)

Name of the activity	What was involved in executing the activity
Identification of technology required for execution of BPI	Vendors with whom the organization was working with were given priority. The terms of reference for the vendors were defined by the stakeholders
Development of a strategy for rolling out the changes that result from implementation of the developed plan	The stakeholders identified the changes likely to occur from the operationalization of the improvement plan Assessed the risks associated with each identified change and how it could be mitigated or controlled. During this session, a risk management plan on how to handle the risks was developed by the stakeholders An impact analysis was also performed and a change management plan developed through brainstorming session
Determination of the quality and performance indicators	The performance indicators and the quality checks for the improvement work were suggested. The quality management team was constituted
Development of a communication plan	Stakeholders defined how the process improvement team would communicate among themselves and with the rest of the organization In order to save time required for this activity, small subgroups were created to handle different aspects of the communication plan and merged into the communication plan
Development of the improvement test plan	The development procedure used for the communication plan formulation was adopted to develop the testing and training plans The training plan defined how affected stakeholders both internal and external were to be trained on the new technologies
Documentation of all the above information into an improvement implementation plan used to operationalize the BPI project by the plan owner	This was done using Microsoft project tools, reference charts for risk analysis and access database among other tools. On completion, a copy was submitted to top management for further refinement and approval
Further analysis of the BPIIP	In cases where the BPI was very critical to the organization, a subcommittee within top management consisting of two to three members was selected to further analyze the details of the BPIIP developed

BPIIP. However, this does not occur for every improvement. For some business process improvements, CMA-CGM Shipping Company Uganda is only put in the know of what to implement to realize the improvements and they are not involved in the BPIIP development process. The developed BPIIP by the head office is sent to CMA-CGM Shipping Company Uganda electronically to guide them on how to realize the improvements. CMA-CGM Shipping Company Uganda sees improving business processes as a directive from the CMA-CGM headquarters.

3.1 Summary of the BPI Implementation Plan Development Process

The implementation plan development process included activities listed in Table 5. It should be noted however that the plan development process steps provided in Table 5 might or might not be executed in a linear manner.

Stakeholders Involved in BPIIPD BPIIPD cuts across various departments in the organization. The BPIIPD teams in the organizations visited were found to have stakeholders with varying expertise, educational backgrounds, and different skills among other attributes as illustrated in Table 6.

Table 5 Summary of the BPI implementation plan development process

(i) Review of documentation and communication of details about the selected BPI alternative. Documentation might include selected BPI alternative and the high-level specifications, affected process and its process map, problem(s) that trigged BPI, affected stakeholders, sponsors of the BPI project, constraints associated with implementing the selected BPI alternative, assigned BPI implementation plan owner. This information is included in the concept or proposal for the BPI alternative presented to management
(ii) Definition of the scope of the BPI implementation plan; what was going to be realized
(iii) Identification of activities to be done to realize the selected BPI alternative and determine the sequence of activity execution
(iv) Allocation of time, budget, and human resource to implement each identified activity
(v) Identification of deliverables and performance indicators for each activity
(vi) Determination of how quality management would be implemented
(vii) Identification of technology required by the improved process
(viii) Analysis of the change management strategy for changes likely to occur as a result of operationalization of the developed implementation plan
(ix) Definition of the risk management strategy for risks associated with implementation of the plan
(x) Formulation of a testing plan for the improvements made
(xi) Development of training plan for affected stakeholders
(xii) Development of the communication strategy for the development team and the rest of the organization
(xiii) Reviewing of the developed implementation plan, incorporation of suggested changes, and approval of the plan for realization.

Table 6 Key types of stakeholders, levels of stakeholder involvement, and roles played by stakeholders during BPIIPD

Stakeholder type	Responsibility	Out of 3 organizations (UCC, KCCA, CMA-CGM) that involve stakeholders as part of BPIIPD team	Level of consultations
Executive director	Own the improvement idea and champion the BPIIPD Accept remitting of funds for activities involving stakeholders Approve the developed implementation plan for operationalization	3/3 (UCC, KCCA, CMA-CGM)	Very high
IT experts	Inform other stakeholders about technologies that need to be considered and incorporated in the plan for hiring, procurement, or improvements IT experts also recommend the best service providers	2/3(UCC, KCCA)	High
Human resource manager	Recommend the best human resources to be assigned specific tasks Provide information about needed expertise for the BPI	1/3(KCCA)	Medium–low
Improvement plan development leader	Document the BPIIP Oversee and ensure successful implementation of the improvements Oversee activities involving other stakeholders during BPIIPD	3/3(UCC, KCCA, CMA-CGM)	Very high
Business analyst	Communication of the relevance of BPI alternative and BPIIPD Explaining the current process and desired improved process to gain a shared understanding and get buy in to BPIIPD by stakeholders	3/3(UCC, KCCA, CMA-CGM)	Very high
Operational staff	Provide information on how BPI can be operationalized in a realistic manner	1/3(KCCA)	Low
Customers, suppliers, regulatory bodies	Inform the implementation plan being developed if it is worth and realistic to the environment outside the organization Present their needs to be incorporated in the BPIIPD	1/3(KCCA)	Low

(continued)

Table 6 (continued)

Stakeholder type	Responsibility	Out of 3 organizations (UCC, KCCA, CMA-CGM) that involve stakeholders as part of BPIIPD team	Level of consultations
	KEY: Level of consultations Very high: Always consulted before any critical decision regarding the BPI implementation plan development was taken. High: Frequently consulted but for some decisions, they might be left out. Medium: Might or might not be consulted during development of BPI plans and for some decisions they be left out. Low: Most of times were not consulted at all regarding decisions of BPI plan development		

Table 7 Methods used to involve stakeholders during the development of BPI implementation plans

Methods used for stakeholder involvement	Out of 3 organizations (UCC, KCCA, CMA-CGM) where the method is used	Remarks about method used
Facilitated workshops	3/3 (UCC, KCCA, CMA-CGM)	Used for information delivery and generation of details for BPIIPD among many stakeholders Expert document management systems (EDMS) and e-mail system were tools used in sharing and storing information facilitated workshops. E-mail system was found to be part of the expert document system. Used to enhance fast sending and receiving of messages about the details of the improvement implementation plan being developed
Traditional meetings with internal and external stakeholders	2/3 (UCC, KCCA)	Majorly used to exchange information about critical decisions in respect to BPI plan development. Normally involve few stakeholders
Other methods (questionnaires, interviews, open door system, and phone calls)	1/3 (UCC)	Questionnaires and interviews were used by UCC and KCCA to gather responses from a large group of external stakeholders (public). They were also used to gather requirements to incorporate in the BPI plan being developed. Open door and phone calls were used for quick information gathering among internal stakeholders

Commonly Used Methods for Involving Stakeholders During BPIIPD These included facilitated workshops, meetings, questionnaires, interviews, electronic document management system, and e-mails as shown in Table 7.

3.2 Challenges That Affect Stakeholder Involvement During BPIIPD

C1: Low Human Resource Willingness to Participate in BPIIPD Many people gave BPIIPD low attention because it did not contribute to the appraisal. For example, a respondent made a comment that "*it's not part of my job description to develop BPI plans. I just help in developing them.*" This statement validated that BPI implementation plan development (BPIIPD) was not part of the appraisal. The limited time given to analyze the plan details usually resulted in developing a BPIIP with gaps. This, therefore, caused many changes during plan implementation due to unforeseen circumstances. Limited human resource involvement and lack of commitment lead to less ownership of the developed implementation plan resulting in increased resistance during the plan operationalization.

C2: BPIIP Developed Were Department Specific Departments usually identified their achievements and deliverables independently from others. Specific departments from where the BPI idea originated developed the BPIIP in isolation to best suit their departmental needs. The interests of other departments that were indirectly affected by the BPIIP were left out. Consequently, the developed plan was rejected during implementation which resulted in many changes being made to it so as to suit the needs of other affected departments.

C3: Poor Composition of BPIIPD Teams Due to Competition for Human Resources by Departmental Heads A syndrome of "*keep the best as explained by the IT manager at KCCA*" was also identified among managers. Heads of the departments were required to identify personnel in their departments to be part of the BPIIPD team. Heads of departments who were indirectly affected by BPI kept the best performers for other tasks in their departments even if they were to offer the best resources to the BPIIPD team. This resulted in BPIIP being developed by a few individuals who even at times were not very knowledgeable about the improvement project at hand.

C4: Limited Budget for BPIIPD Managers worked on the assumption that stakeholder involvement during BPIIPD had to occur without a budget. For example, a project manager commented that "due *to the limited monetary resources assigned by the government to the organization, BPI implementation plans at departmental level are not given priority*." Lack of budget for stakeholder involvement activities resulted in BPIIPD being assigned to one or two individuals. It is for the same rea-

son that BPIIP for some BPI projects was not developed in organizations. A few individuals in the BPIIPD process resulted in a plan that was rejected during its implementation due to the non-representation of stakeholder needs and interests.

C5: Limited to No Shared Understanding and Harmonization of Concepts for the BPIIP Being Developed BPIIPD required multiple skills and was knowledge intensive involving different people in and outside the organization with varying skills, educational background, and expertise. The diverse backgrounds of various stakeholders resulted in the analysis of the same concepts of the BPIIP differently. Reaching a compromise and making everyone agree required a lot of time due to arguments. The plan was assigned to one or two people to develop and reduce the time required to gain a shared understanding with many stakeholders.

C6: Organizational Politics and Varying Stakeholder Interests During BPIIPD It was discovered that operational employees feared to talk freely to their superiors about the plan facts. One of the respondents stated that "*my boss is my boss, I do what am told*." Furthermore, some stakeholders had self-interests for personal gains leading to decisions that could affect the quality of the BPI plan. In addition, social conflicts and prejudices among stakeholders involved in the BPIIPD resulted from differences in age, gender, educational background, and position held in the organization. Key stakeholders with high interest and power had limited time to participate in plan development activities, thereby delegating their juniors. However, during the implementation of the plan, such stakeholders' absenteeism was manifested in drawing negative conclusions about the quality of the plan. Thereby subjecting it to many changes to suit their needs and interests.

C7: Limited Support for Collaboration Between the Organization and External Stakeholders External stakeholders were often left out during the development of such implementation plans. This might be attributed to limited collaboration methods between the organization and its external stakeholders. Failure to involve external stakeholders negatively affected the developed implementation plan as many of their needs were not catered for.

C8: Limited Time Assigned to the BPIIPD by Management Time to discuss the agreed changes from plan reviews was often nonexistent due to strict deadlines. Middle management committees preferred small-sized meetings to develop the BPI plans arguing that involving other stakeholders would be time-wasting. Leaving out the majority of stakeholders meant leaving out many interests and needs of implementers of the plan. Limited stakeholder involvement created a problem later during implementation.

4 Discussion

BPIIPD is a recurring task that requires multiple stakeholder involvement. This, therefore, calls for collaboration among key affected stakeholders [14] to accomplish such mission-critical activities [10]. In this research, stakeholder involvement was majorly found between middle and top management levels [15] who used meetings, Expert Document Management Systems, e-mail, and facilitated workshops to gain a shared understanding of BPIPD concepts. Operational staff and external stakeholders were only put in the know of what they were supposed to do to realize the plan. This resulted in many BPI projects failing during implementation due to a lack of alignment between the BPI-selected alternative and the implementation plan to realize it [14]. The high failure rates might also be attributed to resistance to the developed implementation plan by the implementers. This is in line with Amiyo's findings that there was a need to involve all types of affected stakeholders [2]. Lack of stakeholder involvement attributed to limited time, and strict deadlines resulted in the need to save time wasted during the involvement of affected stakeholders as [12] agrees. This was further worsened by a lack of budget allocation for BPIPD. This was attributed to the fact that managers thought that stakeholder involvement was supposed to occur naturally, hence allocating limited or no budget for the BPIIPD.

To address these needs (i.e., limited stakeholder involvement, use of assigned time optimally, incorporating varying stakeholders' interests into the BPI plan), organizations conducted facilitated workshops and meetings. However, workshops were found to suffer from unequal participation as a result of shy and dominant participants, lack of focus on the agenda, lack of a cheap and sustainable way of conducting workshops, and lack of a means of saving time required for conducting workshops [12]. To ensure facilitated workshop efficiency and effectiveness, organizations resorted to hiring professional facilitators with knowledge and expertise in group dynamics to ensure the set goal and objective were achieved [7]. However, professional facilitators were expensive to hire [6, 12]. In line with the above discussions, challenges and observations from reviewed literature revealed requirements for the BPIIPD. The identified requirements were categorized as stakeholder involvement requirements, cost requirements, and time requirements.

(a) *Stakeholder involvement requirements.* Stakeholder involvement was seen as a challenge as affirmed by the exploratory study findings. Hence, there is a need to provide a means of encouraging stakeholder involvement during BPIIPD. Therefore, the stakeholder involvement requirements include the following:

R1: Provide a means to increase stakeholder involvement in collaboration sessions. This can be achieved by ensuring that stakeholders have a shared understanding of BPIP concepts through effective communication and active participation in collaboration sessions [1, 6, 12]. This would enhance stakeholder willingness to interact more often during the BPIIPD. Interaction among stakeholders enables them to experience the BPIIPD, air out their

views when sharing information about the BPIIP, and encourage free participation to generate as many ideas as possible. During interactions, stakeholders should keep focused on the topic of discussion to avoid time wastage on irrelevant issues and ensure the expected results are achieved.

R2: Encourage affected departments to work together during the development of BPIIPs. This could be accomplished by encouraging BPIIPD goal sharing and addressing varying stakeholder interests among teams to help affected departments understand the importance of interaction and information sharing. Departmental heads should clearly articulate how the BPIIP for the selected BPI alternative contributes to the achievement of departmental and organizational vision, mission, and goals. This would enable tactical managers or departmental heads to be champions of stakeholder involvement across the different affected departments.

R3: Identify the right stakeholders for BPIIPD teams. Selecting the right stakeholders to participate in stakeholder involvement sessions for developing BPIIP is critical. Stakeholders with high power and interest in the BPI project should be included in the plan development team since they could influence other members to participate in the plan development process. Right stakeholder selection could ensure that members generated accurate information to incorporate into the BPIIP as described in Table 8.

R4: Provide a means to promote a shared understanding of concepts. When developing the BPIIP, accommodating varying stakeholders, active participation, and listening can help stakeholders reach consensus and promote a shared understanding of concepts. This would enhance a shared understanding among stakeholders.

R5: Increase and allow flexibility in accommodating generated ideas from stakeholders into BPIIPs. Establishing respect, active listening, and open communication are crucial for fostering an environment where all partici-

Table 8 Summary of key stakeholder types involved during BPIIPD

Stakeholders name	Role of stakeholder and level of influence
Executives	Provide the leadership and commit funds to improvement activities Influential and interested (most important)
Employees	Implement the BPIP Interested but non influential
Improvement champions	Sell the improvement ideas to get other people in the organization Influential and interested (most important)
IT technicians	Support the IT systems used in the improvement process Influential and interested (most important)
Customers and suppliers (external stakeholders)	Affected by business process improvements Interested but non influential
Business process analysts	Analyze the process for improvements and give informed decisions about contents in the BPI implementation Influential and interested (most important)

pants feel comfortable sharing ideas during stakeholder interaction sessions during BPI implementation plan development. This would reduce missing out on important information raised by stakeholders while increasing the sense of ownership of the implementation plan. In addition, building consensus so as to take care of the different needs and interests of stakeholders was critical. This would reduce disagreements caused by stakeholders with self or personal interests during the development of the plan.

R6: Improve existing collaboration methods between the organization and external stakeholders. The integration of stakeholder feedback and the use of online collaboration technologies can enhance the efficiency and involvement of more external stakeholders in the BPIIPD. This would reduce resistance from external stakeholders during the implementation of the improvement plan since most of their needs would be cared for.

(b) *Cost requirements.* The exploratory study findings showed that conducting facilitated workshops as the commonest stakeholder involvement method was expensive as affirmed by other scholars. Therefore, the need to conduct workshops at low or no cost was identified. Therefore, the cost requirements include:

*R7: Having a less expensive way for involving stakeholders during the development of BPIIPs. I*mplement facilitation processes and scripts to guide unskilled facilitators during collaboration sessions of BPIIPD [1, 7]. This would encourage organizations to conduct collaboration activities for BPIIPD since low costs are involved. More stakeholder participation during improvement plan development increases ownership of the developed plan. Increased ownership reduced resistance during plan implementation as stakeholder needs and interests are cared for. Allow flexibility in facilitation or provide a facilitation guide such that any member of the implementation plan development team can do facilitation easily and without any difficulty. Eliminating hired facilitators would lower the costs required for collaboration sessions during BPI implementation plan development.

(c) *Time requirements.* BPIIPD was assigned limited time as observed in the exploratory study finding and reviewed literature. Hence, the need to save time and use the limited time assigned optimally was identified.

R8: Provide a means to save the time required when involving stakeholders during BPIIPD. There was the need to adopt facilitation processes and scripts to guide unskilled facilitators manage group dynamics using the least required time possible during collaboration sessions of BPIIPD [7]. This would enable management to encourage such stakeholder involvement sessions as they leave time for operational employees to perform other tasks as required. Staying focused on the topic of discussion, quick means to build consensus, and avoiding the generation of irrelevant contributions from too many debates were some of the ways time could be saved during such stakeholder involvement sessions. Table 9 summarizes collaboration challenges of stakeholder involvement during BPI implementation plan development (C1–C8) and the requirements identified for each challenge (R1–R8).

Table 9 Summary of challenges that affect stakeholder involvement during BPIIPD and corresponding identified requirements

Challenges that affect stakeholder involvement during BPI implementation plan development	Identified corresponding requirements
C1: Low human resource willingness to participate in BPI implementation plan development	R1: Provide a means to increase stakeholder involvement in collaboration sessions
C2: BPI implementation plans developed being department specific	R2: Encourage affected departments to work together during the development of BPI implementation plans
C3: Poor composition of BPI implementation plan development teams due to competition for human resources by departmental heads	R3: Identify the right stakeholders for BPI Implementation Plan Development (BPIIPD) teams
C4: Limited budget for the development of BPI implementation plans	R7: Having a less expensive way of involving stakeholders during the development of BPI implementation plans
C5: Limited to no shared understanding and harmonization of concepts for the BPI implementation plan being developed	R4: Provide a means to promote a shared understanding of concepts
C6: Organizational politics and varying stakeholder interests during the development of BPI implementation plans	R5: Increase and allow flexibility in accommodating generated ideas from stakeholders into BPI implementation plans
C7: Limited support for collaboration between the organization and external stakeholders	R6: Improve existing collaboration methods between the organization and external stakeholders
C8: Limited time assigned to the development of the BPI implementation plans by management	R8: Provide a means to save time required when involving stakeholders during BPI implementation plan development

5 Presentation of the Model/Framework

The implication of this model on the UN Sustainable Development Goals in developing countries is to ensure the inclusivity of ideas, interests, and needs of all employees including women in the organizations during process improvements. Design science was used to guide the development of the model**.** Design science has seven guidelines that were adopted in this research as illustrated in Table 10 [8].

Design science has three cycles of relevance, rigor, and design that were adopted. The procedure followed in the relevance and rigor cycles is shown in Table 1. The design cycle involved designing and evaluating an artifact [8], using input from existing methods of the rigor cycle, and relevance requirements.

Evaluation was done using walkthroughs and pilot testing [8] as elaborated in Table 2. Organizations of: the Uganda Communications Commission a communications regulatory body, Kampala Capital City Authority and Uganda Investment Authority whose role is to attract investors were used. The results from evaluation confirmed that the artifact supported ***usability*** *through* (a) shared understanding of aspects to define the BPIIP among stakeholders; (b) ThinkLets selected were appropriate for the collaboration tasks and results were achieved in the shortest possible

Table 10: Adoption of design science guidelines

According to [8], *seven design science* guidelines emphasize that:	
Design science guideline	How it is addressed in this research
1. Design as an artifact	This research resulted in collaboration process to guide BPIIPD
2. Problem relevance	The problem was the lack of a means to involve stakeholders in BPIIPD at a low cost and within a limited time The process of interest is business process improvement People involved organizational employees and other stakeholders
3. Design evaluation	The collaboration process was evaluated using walkthrough and pilot study to assess its usability and usefulness
4. Research contribution of the artifact to the existing body of knowledge	Research contributed to existing knowledge of BPI
5. Research rigor	The existing body of knowledge was used in the design and evaluation of the artifact
6. Design as a search	Reviewing literature on BPIIP An exploratory study was used to define a list of high-level requirements A refined list of high-level BPIIP guidelines was created from requirements and used to design the collaboration process (end/ goal/solution)
7. Communication of research to audiences	Dissemination was done in academic journals and conferences to cater to academia and practitioners.

time; (c) the collaboration process supported information-sharing among stakeholders during the development of BPIIP. The artifact was ***usefulness*** because (a) stakeholders were satisfied with execution of the BPIIPD-CP; (b) varying stakeholder needs were accommodated in BPIIPD; and (c) process tasks were accomplished within allocated time. During the design of the artifact, the step-by-step approach [11] was adopted from the literature in the rigor cycle to develop the collaboration process as elaborated.

Step 1: Task Diagnosis *The problem was defined by performing task analysis, stakeholder analysis, resource analysis, and practitioner analysis.*

(a) Analysis of tasks. The goal of the collaboration process was to support stakeholder involvement at a low cost during BPIIPD process. The deliverable of the collaboration process was a detailed BPI implementation plan.
(b) Analysis of stakeholders**.** Among some of the characteristics to consider was age, sex, educational backgrounds, roles and responsibilities, previous team history, among others [10, 11].
(c) Analysis of available resources in terms of time, budget, knowledge, physical resources, and effort available. Composition of the stakeholder team involved in the development of BPI implementation plans was dynamic and not static.

(d) Analysis of practitioners. Practitioners for BPI implementation plan development were not specific. The experience and skills required were dependent on the affected departments and nature of BPI implementation plan being developed.

Step 2: Decomposition of Task Activities During the decomposition of the process, the patterns of thinking to guide the group when executing the activities required to perform a particular task were selected [3, 6, 7].

Decomposition of the BPI implementation plan development process

1. Communicate the purpose for the meeting session.
2. Communicate and review summaries of selected BPI alternative. Information reviewed includes the high-level specifications, affected process and its process map, problem(s) that trigged BPI, affected stakeholders, sponsors of the BPI project, constraints associated with implementing the selected BPI alternative, assigned BPI implementation plan owner.
3. Define the scope of the BPI implementation plan; what is going to be realized.
   - 3.1 Identify aspects to define the scope of the BPI implementation plan, constraints, and any associated assumptions.
   - 3.2 Select the most important aspects to define the scope of the BPI implementation plan.
   - 3.3 Evaluate aspects proposed to define the scope of the BPI implementation plan.
   - 3.4 Agree on the generated list of concepts to define the scope.
4. Identification of activities to realize the selected BPI alternative and determination of the sequence of activity execution.
   - 4.1 Define the list of activities to be included in the implementation plan and the sequence of activity execution.
   - 4.2 Filter and converge activities required to realize the selected BPI alternative.
   - 4.3 Categorize the listed activities by order of execution.
   - 4.4 Evaluate the categorized listed activities.
   - 4.5 Agree on suggested categorized activities and order of their execution.
5. Allocating time, budget, and human resource to implement each identified activity.
   - 5.1 Discuss and allocate time, budget, and responsible human resource to each of the agreed activities.
   - 5.2 Analyze generated list and determine the best estimates and human resource for each activity.
   - 5.3 Agree on estimates for each activity.
6. Identification of deliverables and performance indicators for each activity.
   - 6.1 Define deliverables and performance indicators for each of the activities.
   - 6.2 Filter activity deliverables to eliminate redundancy and poor wording.

6.3 Categorize activity deliverables in sequence for activity execution
6.4 Agree on activity deliverables by order of execution.

7. Determination of how quality management will be implemented.

7.1 Identify quality requirements and discuss how quality management for the deliverables would be done.
7.2 Filter and analyze the quality requirements and there implementation procedure.
7.3 Evaluate requirements, metrics, and items on the quality checklist.
7.4 Agree on quality requirements, metrics, and controls.

8. Identification of technology required by the improved process.

8.1 Converge and reflect on the technologies required to make the improved process work.
8.2 Evaluate the technologies selected and the identified service providers.
8.3 Agree on listed technologies and service providers required for the improvements.

9. Analysis of the change management strategy for changes likely to occur as a result of operationalization of the developed implementation plan.

9.1 Determine any changes likely to occur from operationalization of the BPI plan, affected stakeholders, impacts of change, and how they could be monitored and controlled.
9.2 Discuss and filter listed changes, affected stakeholders, change impacts, and procedure for monitoring and controlling the change.
9.3 Evaluate the listed changes, affected stakeholders, impacts, and control measures.
9.4 Agree on prioritized changes, affected stakeholders, impacts, and change monitoring and control procedure.

10. Defining the risk management strategy for risks associated with implementation of the plan.

Risk Identification. This activity is aimed at identifying likely risks associated with BPIIP operationalization.

10.1 Identify risks likely to occur during BPI implementation plan operationalization.
10.2 Analyze and filter the identified risks to identify the most important and key risks.
10.3 Categorize risks in relation to the activity deliverables.
10.4 Evaluate the categorized risks likely to occur during BPI implementation plan operationalization.

Risk Assignment.

10.5 Perform a risk analysis on the identified risks to determine the likelihood and impact of the risk occurring, i.e., define the risk factor for each risk.

10.6 Identify controls for the identified risks.
10.7 Evaluate the identified controls for identified risks during BPIIP operationalization.
10.8 Converge and filter the prioritized controls identified.

Risk Mitigation

10.9 Define the risk response strategy and identify the risk additional controls/mitigation strategies (define risk policy).
10.10 Evaluate and categorize identified risk controls in relation to identified risks and activities.
10.11 Define how risk monitoring should be enforced, i.e., identify risk triggers that have occurred, risk owners and define proper implementation of controls.
10.12 Define the contingency of fallback strategy for high risks.

11. Formulation of a testing plan for the improvements made.

11.1 Define the goal for testing and discuss details of the testing plan for implemented improvements (what to test, stakeholders to perform the testing, when testing was to take place, where testing would be done, cost of testing, and how testing results would be handled).
11.2 Analyze and filter the generated aspects to be considered during testing of the implemented improvements.
11.3 Evaluate generated lists of aspects defining the testing plan.
11.4 Agree on the testing plan details.

12. Development of training plan for affected stakeholders.

12.1 Identify and discuss the training needs required for the improvement to be realized (for both organizational and implementation team, i.e., information to be communicated, who would do the training, when would the training be done, where would the training take place and the required training materials).
12.2 Filter and converge aspects that define the training plan.
12.3 Evaluate filtered aspects required for training to be achieved.
12.4 Agree on the aspects to define the training plan.

13. Development of the communication strategy for the development team and the rest of the organization.

13.1 Define the information needs of stakeholders (what information was expected, when communication was to occur, how information would be distributed, which stakeholders were to receive the information).
13.2 Converge and organize the elements of the communication strategy.
13.3 Evaluate organized elements of the communication strategy.
13.4 Agree on details of the communication strategy.

14. Reviewing of the developed implementation plan, incorporation of suggested changes, and approval of the plan for realization.

Activities decomposed above follow five patterns of reasoning as explained earlier. Below is the classification of each decomposed activity in relation to the pattern of thinking.

Diverge: Tasks (3.1, 4.1, 5.1, 6.1, 7.1, 9.1, 11.1, 12.1, and 13.1)
Converge: Tasks (3.2, 4.2, 5.2, 6.2, 7.2, 8.1, 9.2, 11.2, 12.2, and 13.2)
Organize: Tasks (4.3 and 6.3)
Evaluate: Tasks (3.3, 4.4, 7.3, 8.2, 9.3, 11.3, and 12.3)
Build Consensuses: Tasks (3.4, 4.5, 5.3, 6.4, 7.4, 8.3, 9.4, 11.4, 12.4, and 13.3)
Completion of activity classification according to patterns of reasoning led into selection of ThinkLet to achieve these patterns.
Step 3: Choice of ThinkLet
(De Vreede & Briggs, 2005; De Vreede & Briggs, 2009; Nakakawa, 2012)
LeafHopper was used for activities 3.1, 5.1, 7.1, 9.1, 11.1, 12.1, and 13.1.
FreeBrainstorm was used for activities 4.1, 6.1.
FastFocus had activities 4.2, 6.2, and 8.1
FastHarvest. Activities 3.2, 5.2, 7.2, 9.2, 11.2, 12.2, and 13.2 required FastHarvest for exhaustive analysis by the subgroups.
RichRelations was used for activities 4.3 and 6.3.
StrawPoll was an Evaluate Pattern used in activities 3.3, 4.4, 7.3, 8.2, 9.3, and 12.3.
CrowBar ThinkLet was used to support Build Consensuses.
Step 4: Facilitation Process Model showing ThinkLet logical flow for activities involved in BPIIP-CP (Fig. 1).

Conclusion BPIIPD approaches exist in BPI literature, yet they lack the means to encourage increased stakeholder involvement at a low cost within a limited time frame. This research aimed at developing a "flexible, repeatable, predictable, and transferable" BPIIPD Collaboration Process (BPIIPD-CP) using design science. The proposed artifact would enable non-skilled group members of the BPIIPD team to develop the plan efficiently, accommodate varying stakeholder needs, ensure group buy-in, and enhance effective communication without a professional facilitator. This would in turn reduce the costs and time required to manage stakeholder involvement dynamics during BPIIPD. The research does not provide a new approach toward BPIIPD but seeks to strengthen the existing approaches with collaboration guidelines. Therefore, the research attempts to fill the gap of adoption of collaboration approaches into BPIIPD by designing a collaboration process. This research could further be strengthened by evaluating it using experimental evaluation and field evaluation methods to prove its usefulness and usability.

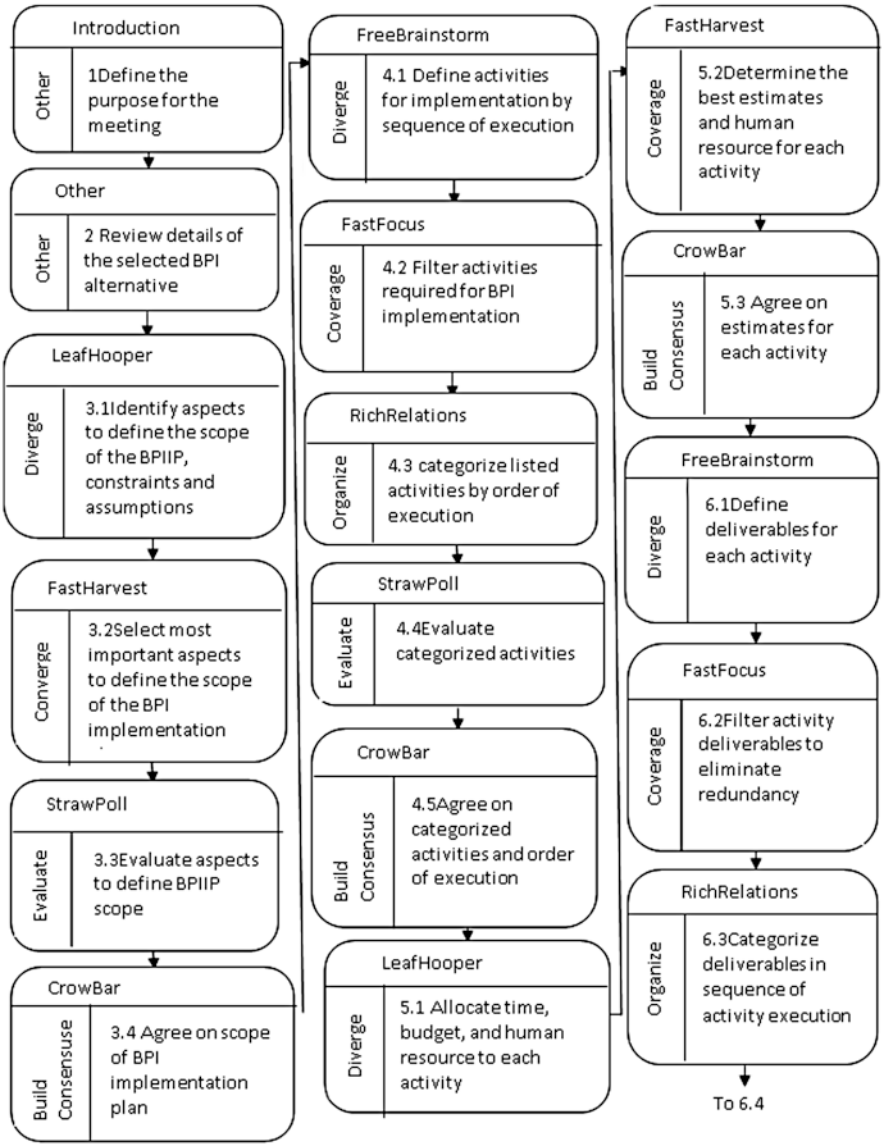

Fig. 1 Facilitation process model showing ThinkLet logical Flow for Activities Involved in BPIIPDP

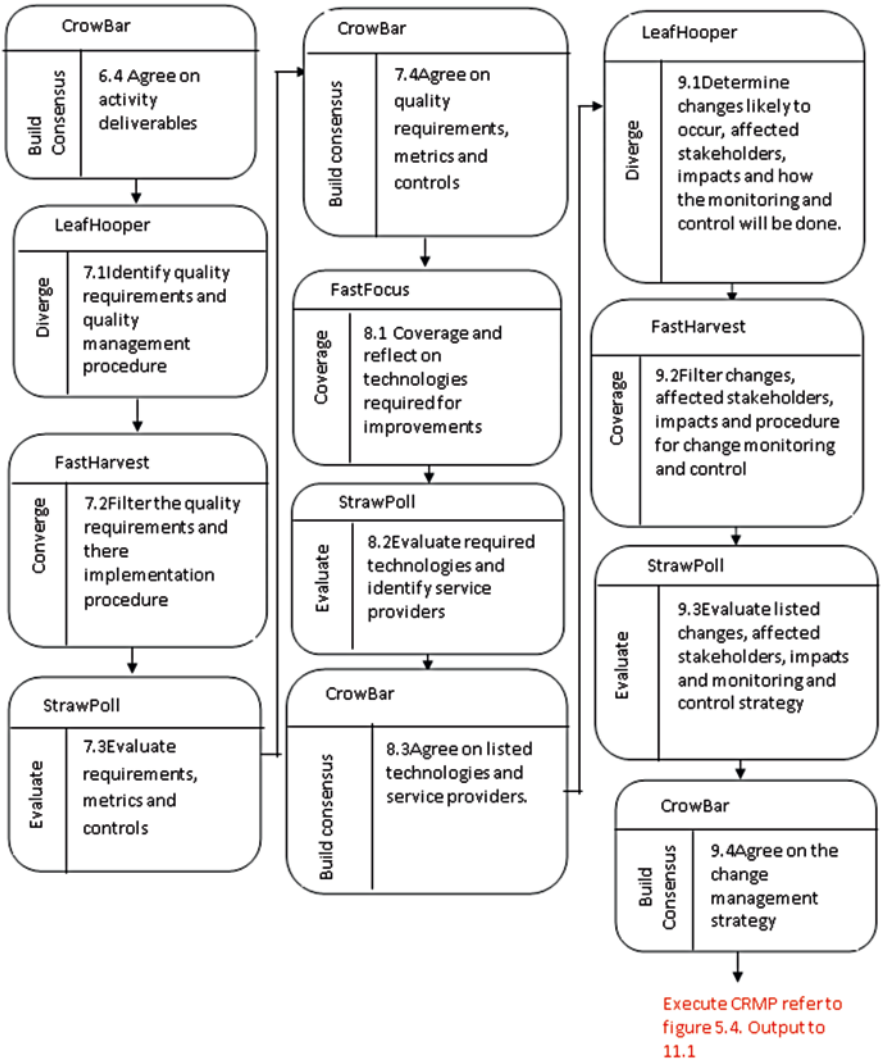

Fig. 1 (continued)

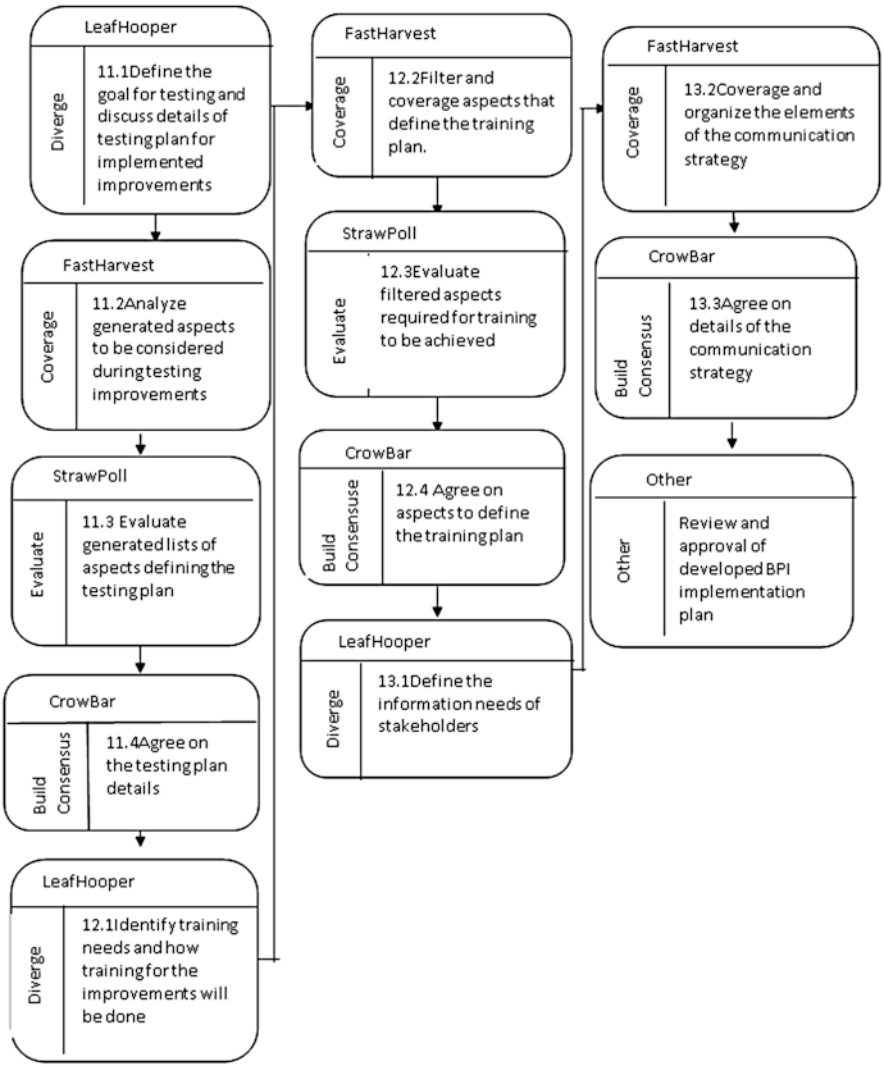

Fig. 1 (continued)

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A Framework for Adopting ICT-Based Services Among Coffee Farmers in Uganda: Case Study of Bugisu Subregion in Bugisu

Moses Obulei, Emmanuel Eilu, and Joseph Mutemere

1 Introduction

The most traded commodity in the world is coffee after oil. For stability and growth, the economies of many countries depend upon coffee production. New studies have found that *Coffee arabica*—the plant that almost all coffee is made from—may go extinct by the year 2080. Climate change already had and will continue to have a severe and negative effect on coffee production throughout the world [1].

The African economies remain predominantly agrarian, with the sector accounting for roughly 15% of the continent's GDP, employing 90% of the rural workforce and 60% of the total labor force in the urban and rural areas. The sector contributes about 40% of export earnings and provides over 50% of household needs and income [2, 3]. In Uganda, the greatest agricultural export earner is coffee. Uganda's Robusta production is the second largest in Africa, making it the seventh Robusta-producing country in the world. Uganda is also the third Arabica-producing country in Africa. On a national economic level, it accounts for the largest export revenue accounting for 20% of Uganda's GDP [4]. Coffee in Uganda is being grown by 1.7 million households, cultivating on average of less than 1 ha and contributes on average 70% to the incomes of these small-scale farmers [5]. Coffee exports for the 12 months (financial year 2020/2021) amounted to 6,078,638 60-kilo bags worth US$ 559.26 million [6]. Although Uganda grows both Robusta and Arabica, the Arabica is the major type of coffee grown in the country, accounting for about 80% of production.

Bugisu region in Eastern Uganda is the third most successful coffee-growing regions in Uganda after central and western regions. Bugisu region produced about 675,850 bags of Arabica coffee in 2018/2019 [6]. Coffee in Bugisu is majorly grown

M. Obulei (✉) · E. Eilu · J. Mutemere
Uganda Christian University, Mukono, Uganda

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in the higher, wetter slopes of Mount Elgon's foothills. However, while Bugisu region is the third most successful coffee growing region in Uganda, coffee farmers face numerous challenges that have significantly reduced the production of coffee. Coffee farmers in the region are grappling with pests which destroy large parts of farms leading to about 50% loss. There is also a challenge of diseases such as coffee wilt disease and coffee berry disease that lead to poor quality output. Limited land for coffee plantations due to the ever increasing population. Population density, for example, in Bugisu region especially on the coffee growing mountain slopes is very high. These areas are faced by land fragmentation due to the inheritance cultures of dividing land among siblings especially on Customary Land [7]. The region also experiences prolonged drought and landslides which destroy coffee trees leading to low output. For example, the 2010 landslide in Bududa District in Bugisu region destroyed over 60,000 coffee trees which meant a destruction of about 40.8 metric tons of freshly picked coffee [8]. Climate change, on the other hand, poses a significant threat to coffee farmers, with erratic rainfall and increases in temperature leading to reduced coffee yields and lower quality beans [9].

Therefore, there is a need to improve coffee production and one of the ways to improve coffee production is by using ICT innovations to curb some of these challenges. Information Communication Technologies (ICT) are defined as any application, device, or tool that enables the visualization, exchange, and collection of data through transmission or interaction. The use of ICT in agriculture involves the design, conceptualization, development, application, and evaluation of different innovative ways of using ICTs, with a primary focus on agriculture. The introduction of ICT into the agricultural sector has brought in a new modern paradigm that facilitates and improves the agricultural production. The ICT has rendered number of services that have boosted agricultural production over year—services such as online market access, online weather information systems, diseases and pests control systems, farm management systems, and many others. There is no doubt that ICT has demonstrated incredible potential of improving agriculture productivity in developing countries through innovations specifically that use ICT [10].

However, while ICT would help address most of the challenges faced by the coffee farmers in Bugisu region, there is a need to assess the farmer's readiness to adopt the use of ICT and also examine the necessary challenges that may hamper its adoption. This chapter explores the necessary factors for successful adoption of ICT among coffee farmers in Bugisu. In order to guide the study, technology–organization–environment (TOE) framework was used.

1.1 Technology–Organization–Environment (TOE) Framework

The process of adopting new innovations has been studied for over 30 years, and as a result, a number of technology adoption theories have been proposed. One of the most popular models adopted by many researchers is the technology–organization–environment (TOE) framework. This framework was first developed by Tornatzky

and Fleischer in 1990 [11]. The Technology-Organization-Environment (TOE) framework is a theoretical framework that explains how the use of a new technology is influenced by a number of factors. The TOE has proven over years to be a valuable tool for understanding the complex interplay between technology, organization, and environment.

- The technology in the TOE refers to the characteristics of the new technology that is being introduced. It considers aspects such as the functionality of the technology, how complex it is, how compatible the technology is with the legacy systems, and how user friendly the technology is.
- Organization, on the other hand, refers to the internal context in which the technology is used. It considers aspects such as the organization's size, managerial structure, the culture of the organisation, and resources.
- The environment considers the external context in which the organization operates, including factors such as market conditions, regulatory requirements, and social and cultural norms.

One of the reasons why the TOE framework was chosen was that it provides a holistic perspective on technology adoption and implementation. Rather than focusing solely on the technology itself or the organizational context, the framework recognizes that both internal and external factors are important in shaping technology adoption and use. This allows researchers to take a more nuanced approach to studying technology adoption, and it helps organizations to better understand the complex interplay of factors that influence their technology decisions (Fig. 1).

Using the TOE framework, the study identified the following three major objectives that were investigated.

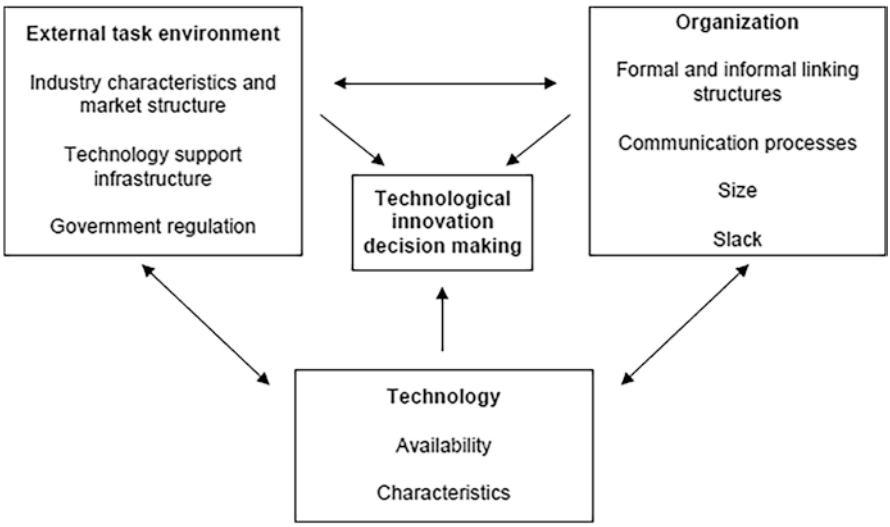

Fig. 1 Technology, organization, and environment framework [11]

2 Objectives

1. To assess the challenges associated with the adoption of ICT among coffee farmers in Bugisu sub region.
2. To establish the technology, organization, and environment factors that facilitate the successful adoption of ICT among coffee farmers in Bugisu subregion in Bugisu.
3. To develop TOE framework for successful adoption of ICT among coffee farmers in Bugisu subregion in Bugisu.

3 Methodology

Qualitative research was used since this study addresses the "what," "how," and "why" research questions and enables deeper understanding of experiences, phenomena, and context. Bugisu subregion, specifically Mbale and Sironko, was the study area where the sample selection was done from different coffee unions, extension workers, and the coffee farmers within the community. Purposive sampling technique was used to select the respondents. A total of 23 participants participated in the study. Interview and Focus group discussions were used data collection tools in the study with believe that the instruments will complement each other to enable validation of findings of this research. 3 Focus group discussions of 4 coffee farmers were convened and 11 participants' were interviewed including 3 ICT leaders, 6 Union leaders and 2 extension workers. The study used content analysis to determine the presence of certain words, themes, or concepts from the field data. These themes were later presented in the form of frequency tables and graphs for ease of presentation and discussion. The summary of the method used in the study is presented in Fig. 2.

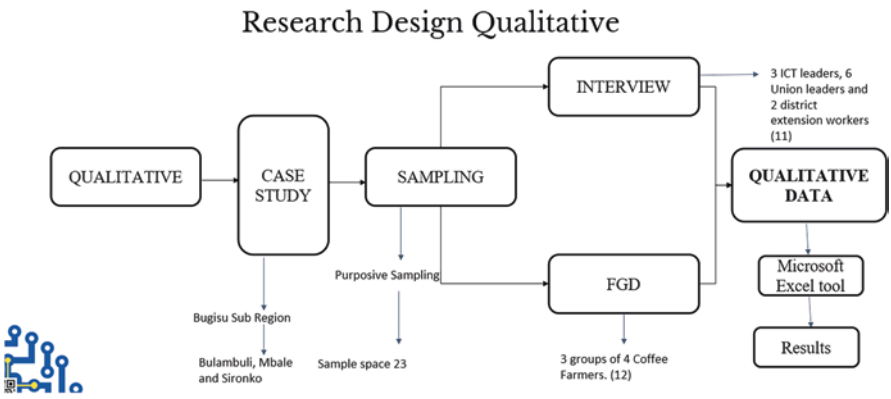

Fig. 2 The summary of the methodology

4 Presentation of the Findings and Discussions

This section presents the results and discussions concurrently. Different data collection instruments were used in the research because the researcher believed that the instruments would complement each other to enable validation of findings of this research. The instruments used were focus groups and interviews. About 23 participants were involved in both interviews (11 participants) and focus groups (12 participants). The purpose of the study was majorly to assess the challenges limiting the adoption of ICT by coffee farmers in Bugisu subregion and to define the necessary factors for increasing the adoption of ICT by coffee farmers. This section is organized as follows; demographic of respondents, ICT investments, challenges limiting the use of ICT by farmers, necessary factors for the increased adoption of ICT by coffee farmers. This chapter then presents a DOI model for adopting ICT among farmers in Bugisu region.

4.1 Types of Coffee Processed by the Unions (Table 1)

Table 1 Types of coffee processed by the unions

Coffee source	Type of coffee processed
Namatyo Falls	Honey
Budwale	Washed
Wanale	Honey and washed
Bukhanakwa	Washed and natural
Bududa	Natural
Sipi Falls	Washed and natural

4.2 Respondents

In total, 12 coffee farmers, 6 coffee union leaders, 3 ICT officers from the union head offices, and 2 extension workers participated in this study. Both focus groups and interview methods were utilized for gathering data from the respondents as seen in Table 2.

4.3 Demographic Profile

The respondents' demographic details are presented in this section. All the respondents were requested to share details of their age range, educational level, land ownership type, and their, which comprised the key characteristics of the study population.

4.3.1 Responses by Age

The age ranges of the correspondents are shown in Table 3. As shown in Table 3, three correspondents were between the age group of 20 and 30 years, eight respondents between 31 and 40 years, nine respondents between 41 and 50 years, two respondents between 51 and 60 years, and one respondent was above 60 years.

Table 2 Respondents

Respondents	No. of respondents	Tool utilized
Coffee farmers	12	Focus group discussions
Union leaders	6	Interview
ICT officers	3	Interview
Extension workers	2	Interview
Total	23	

Table 3 Age of the respondents

Age	Number of resopondents
20–30 years	3
31–40 years	8
41–50 years	9
51–60 years	2
Above 60 years	1
Total	23

Table 4 Level of education

Correspondent	Educational level			
	Primary	Secondary	College	Degree
Coffee farmers	7	3	2	
Union leaders			2	4
ICT officers				3
Extension workers				2
Total	7	3	4	9

4.3.2 Level of Education

Table 4 shows the level of education of the respondents. There were no registered masters and PhD holders. Degree holders were the highest to participate in this study with a total of 9 respondents, followed by 7 farmers whose level of education was primary education, 3 having secondary education, and 4 having college education.

4.4 Type of ICT Investments

During the focus group discussions and interviews, the farmers, extension workers, union leaders, and ICT officers were asked to indicate on the ICT type they own and its frequency of use. The results are presented in Table 6 and Fig. 1. Figure 1 shows that mobile phone is the most widely used ICT devices in the area with 83% usage. This result suggests that this device is the most reliable sources of innovation and any information about coffee. Similarly, 30%, 17%, 17% and 17% indicates that internet, Market information system, printers and computers respectively are also readily available for use, which as well shows that they are not readily available but, still serve as a medium of getting relevant coffee information. This could be attributed to the high cost of purchasing a computer and printers, which are relatively expensive. Also, the high cost of internet subscription or poor network coverage may prohibit the respondents from using the available market information system. TDRS (soil moisture tester), GPS, and external storage devices with 13%, 9% and 9%, respectively, are also not readily available and not much used. The results of the interviews and focus group discussions show that only coffee unions use these devices.

Least percentages of 4% and 4%, respectively, were observed for regulatory system and television, which confirms that they are the least available ICT devices through which smallholders' source relevant agricultural information in the study area. In summary, the results revealed that phone is the most readily available ICT device for the respondents in the area (Fig. 3).

During a face-to-face interview, one union leader stated, "*These featured type of phones are the most owned and used phones by our farmers to make calls and*

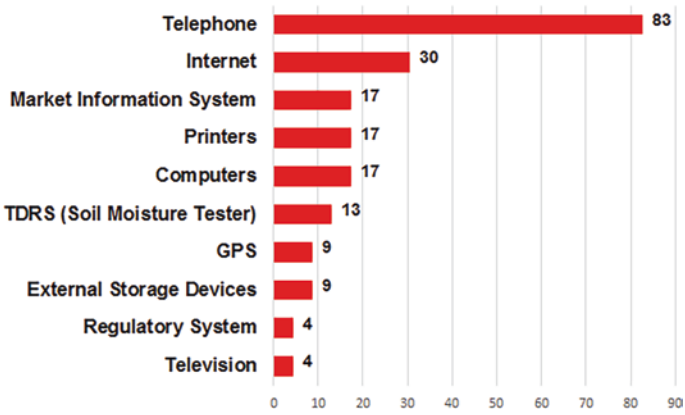

Fig. 3 ICT type ownership

receive any messages. We usually share knowledge and any kind of awareness through SMS with them."

4.5 Factors Limiting the Use of ICT by Coffee Farmers

The respondents were also asked to rate the possible factors limiting the use of ICT by farmers (Fig. 4).

Figure 4 clearly shows the factors that limit ICT usage by coffee farmers and are discussed below.

Lack of Electricity

It was realized that 100% of the respondents stated lack of electricity to be a major limiting factor for adopting ICT. The farmers who could access electricity reported that they face a big challenge of load shedding. The costs of electricity are also too high, which limits the usage of ICT devices as they need power. During one of the focus group discussions, one farmer stated, "*Electricity bills these days are too high to be afforded. If government could probably provide free power, then that would enable us to use those gadgets such as the smart phones*." It is well asserted and concurred by [12] that the likelihood of a decrease in use of ICT tools by farmers by 0.9 by a 1% increase in electricity outage. The state of dependence of smallholder farmers on solar systems and batteries restricts them from watching TV or using their phones any time during the day. A good percentage of farmers are normally reluctant to use ICTs due to constant electricity outages.

Lack of ICT Infrastructure

Figure 4 also shows that there was 100% lack of ICT infrastructure. One of the ICT officers at Zukuka bora coffee union said, "*I think ICT is not much in use because of the network challenges. You find that transactions are not completed in the*

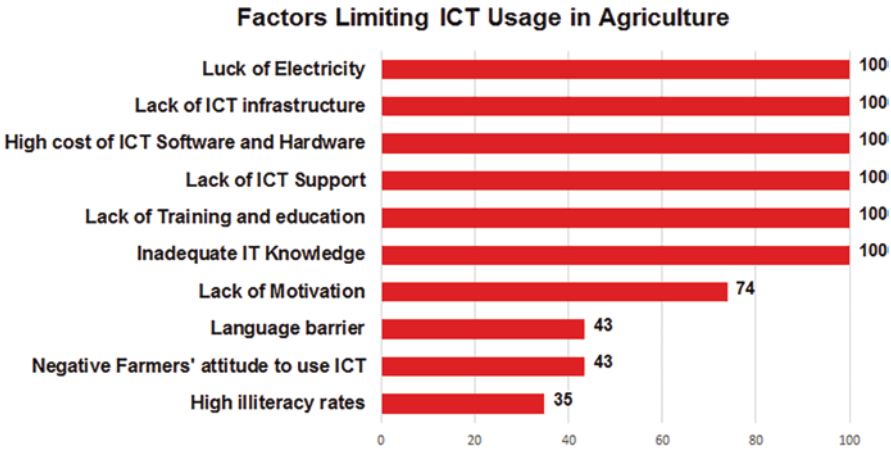

Fig. 4 Factors limiting ICT usage by coffee farmers

expected time frame. For example, sometimes it's so disappointing when I try communicating to some coffee buyers who are out of Uganda, my messages are sometimes seen after a day just because of weak network coverage. So as a result, we as a union sometimes miss out these buyers." One extension worker during the interview stated, "*Most of our farmers don't use electricity because it's expensive for them and us as extension workers, are faced with poor network coverage especially when we are in the field. This means that the farmers too have network challenge*." In most African countries, as concurred and asserted by [13], infrastructure development is still in its young stages. This is, however, common in most rural areas. Most African rural communities are characterized by poor network connectivity, poor road network, and no access to electricity. The absence of these technological infrastructures poses a barrier to ICT adoption as most of the farming population live in rural communities.

High Cost of ICT Software and Hardware

Figure 4 further shows that 100% of the respondents cited high coast of ICT software and hardware as a major limiting factor for the adoption of ICT. During the study, one of the ICT officers stated during a face-to-face interview, "*This hardware you see here are expensive for a low-income earner to purchase. These things require government to support with the purchase since at least am sure there is a budget for it as compared as here in these unions*."

It was realized by [14] that high cost of ICT service includes a barrier to its use on agricultural input information. For example, the cost of mobile services and mobile handsets excluded many poor rural farmers from accessing TigoKilimo in Tanzania. In Mali, 95% of SENEKELA users find that the cost is prohibitive. Yet, the cost was a barrier to the uptake of ICTs on agricultural input by farmers in Tanzania. [14] then concluded that the cost is a barrier to the use of ICTs on agricultural input information by farmers in developing countries. Similarly, the main

limiting factors of ICT adoption are the cost of technology and availability of software as reported by [15].

Lack of ICT Support

Figure 4 further shows that 100% of the respondents received no support from ICT. During one of the FGDs, one of the farmers stated that "*for us here we have not been introduced to ICT. We would wish to best understand what this is and what it does in our coffee*." In one of the interview sessions, one of the ICT officers also commented, "*The ICT devices are too expensive and surely if government and unions could team up to procure some of these devices then the adoption would be at a high rate*."

The financial levels of the farmers are not sufficient enough to enable them to purchase the gadgets to be used, such as smart phones and internet. One of the district extension workers stated that "*one thing that I noticed is that our farmers' income cannot sustain them at the same time enable them to purchase ICT equipment such as GPS and remote sensors*." The extension worker continued and suggested, "*Government should come in and support with financing to procure these devices*." Another extension worker officer said that "*equipment such as Printers, Servers and computers are costly to maintain when it comes to repair*." On interviewing one extension worker, he said that "*government has done very little to bring technology to our farmers. Even the taxes attached to subscription of data to access the internet has scared many from engaging with technology.*"

This is concurred by [12] that lack of financial support to farmers results in many farmers not using ICTs to improve their farm productivity. In addition, a large percentage of farmers in developing countries can't afford the cost of paying for extension advisory services rendered by ICT innovators and servicing mobile phones because of their low standard of living [13].

Inadequate IT Knowledge and Lack of Training and Education

According to Fig. 4, 100% of the respondents had either inadequate IT knowledge or had never undergone any form of ICT training or education. One farmer during the focus group discussion hinted that "*I can't even operate this smart phone. With only this problem, am sure when a law is passed out that ICT is a must in our coffee business, then I might require some serious training*." Most farmers during the focus discussion groups stated that using ICT in agriculture is completely a new concept that they had never thought of adopting. One farmer continued, "Am *actually just hearing for the first time from you that it's possible to look for coffee market using my smart phone*."

One identified important aspect in the studies is the illiteracy rate among farmers. According to a study by [13], the rates of illiteracy are normally very high among smallholder rural farmers, which affects their ability to effectively manage and understand the use of ICT tools [13]. There is need to have a diverse range of agricultural skills by making more investment in life-long learning, education, and skills development [16]. Higher education and advanced skills in this knowledge revolution play a complementary role in technological advances. Without sufficient education and trained workforce, new technologies cannot be adopted in

agricultural production. The smallholder farmers should be equipped with the necessary skills and knowledge for them to be able to impart the acquired knowledge and skills to the masses especially if it involves the less educated in the rural areas.

Lack of Motivation

From the findings as shown in Fig. 4, lack of motivation was also identified as a limiting factor, with 74% lacking motivation. These farmers attitude was negative and, as a result, they didn't know the importance of using ICT.

One farmer reported, "*I have never been exposed to these things because in my area, I rarely see this technology you are talking about, and I don't see any reason as to why I would I use it because right now am able to grow my coffee and take to the coffee union without this technology*." On interviewing one of the extension workers, she clearly stated, "*the type of farmers we are dealing with are those primitive farmers who are never and easily persuaded to adopt and use ICT because they are more contented to their ways of operation. Most of them even can't use the electronic system that was introduced mainly to help them redeem their inputs*, *yet they received training*."

It has been stressed by [17] that frequent exposure to ICT and usage must be considered if someone wants to form a positive attitude toward ICT. When people frequently get exposed to ICT and use it, they will realize that ICT is helpful and beneficial to them, which creates a positive attitude toward ICT usage.

Language Barrier and High Illiteracy Rates

It is also revealed in Fig. 2 that 35% and 43% had a problem of language barrier and high illiteracy rates, which means that they would not be able to read and write. One of the farmers during the focus group discussions stated, "*honestly, I didn't go far with books. That's why you see me not using those big phones because it needs someone who knows English to read the things in it*." While at BCU, one farmer said that "*technology needs to be used by those people who went to school. In fact, I fear those things because I can't read or even write.*" One of the extension workers noted, "*The farmers who have attained education are so few and most of these few are school dropouts who are half baked, causing a delay in the adoption of ICT usage.*" To adopt ICT usage, reading and writing were required. According to [18], the farmers' lack of ICT knowledge limits them from using ICT frequently. The leading languages of the internet are generally not those used in the rural areas by the smallholder farmers rather English which requires a literate to use.

Farmer's Negative Attitude Toward ICT Usage

From the finding as shown in Fig. 5, 43% of the sampled respondents showed a negative attitude toward the employment of M-Agric. One said, "*honestly, am not in support of the use of the existing tech in Agriculture because one thing I know is that our sales are effected by Technology.*" Similar to the finding of Dhaka (2010), a positive significant relationship was found between the level of education of farmers and their attitude on ICT-based farming. This may be due to the fact that education changes the human behavior, and using different ICT tools is difficult for illiterate people. Finally, a significant positive relationship was found between farmers'

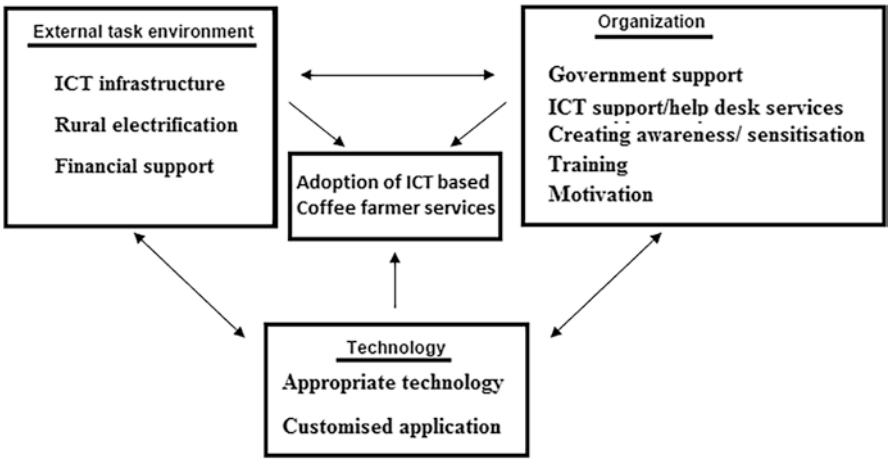

Fig. 5 A TOE framework for successful adoption of ICT among coffee farmers in Bugisu subregion in Bugisu

knowledge on ICT and their attitude on ICT-based farming. Ajayi (2013) also found the same result in his study. This is to say that farmers attitude on ICT-based farming is most likely to be positive if their level of knowledge is found satisfactory and relevant to their need.

4.6 Factors for Increasing the Adoption of ICT by Coffee Farmers and Extension

Training Farmers on How to Use ICT

One of the most identified challenges in adopting ICT was lack of skills among the farmers. Farmers need to be trained and be followed up with different refresher trainings specifically on how to use ICT.

One farmer during the focus group discussion said, "*We would have tried using this ICT that you are talking about but the only problem we have is that we even don't know how to operate it.*"

One farmer further asked, "*How soon could the education program for the elderly be introduced in our villages to equip us with the skills of using ICT without any fear?*"

There is need for the government to demystify ICT training at all levels of education to improve local content development. In the current scenario of a rapidly changing world and agriculture extension, has been recognized as an essential mechanism for delivering advice and information or knowledge as an input for modern farming [19]

Sensitizing Coffee Farmers About the Importance of Using ICT

This sensitization is needed not only for bringing up awareness but also for creating a trust for using ICT among the farmers and different coffee unions and between the farmers and the extension workers.

One of the farmers stated, "*I really don't see the reason of me using ICT because first, I am able to bring my coffee here at the union and even receive my payments. To me, it's risky to use ICT because am not sure where my details will be taken and who will use it*." Government should popularize technological changes to the coffee farmers, coffee unions, and the extension workers such that all parties are moving at the same pace of adoption.

Agriculture is an information-intensive industry which generally draws upon infinite sources of a wide considerable body of research materials and locally contextualized knowledge. It relies upon continuous flow of information from world, local, and regional markets [20]. To optimize production, coffee farmers need information. Different kinds of information are being made available to those interested, particularly on how to start farming, what to do when one is at a cross road, and management of coffee farming.

Government Support

On interviewing a union leader, she proposed that government together with the existing coffee unions should come up with a proper strategy of ICT adoption. The extension worker suggests that government should be top of the game by accelerating ICT usage through refresher trainings and follow-ups. One of the extension workers noted, "*we have been having an electronic reporting system which was actively used for 3 months and later most people stopped reporting through the system. After the first training we had, no follow-ups were made. I for one would suggest that our government should be on top of the game by accelerating ICT usage through refresher trainings and follow-ups to be sure that the system is used as expected*."

A study conducted in Malaysia by [21] established that supposed benefits of ICT and conducive government policies positively influence decisions on adoption and use of ICT. Lack of stakeholders' support such as support from government as a key stakeholder to usage and adoption of ICT will lead to inadequate planning. Stakeholders' support plays a crucial role in accelerating usage and adoption of ICT. This relates to what [22] found out in his study that customers and sellers of the firm exert pressure on it to use ICT in its transactions with them; that in my study, the Stakeholders' support motivates farmers towards adoption and usage of ICT and vital in creating awareness and need for training program, focused on adoption and usage of ICT.

Financial Support for Farmers

"*Some of us do not have that capital to finance all of our coffee project activities until harvest time arrives. One of our main sources of capital is the yield of last year's harvest*," one of the farmers during the focus group discussion stated.

On interviewing one union leader, he stated, "*In most cases to earn cash, our farmers have to sell the crops as soon as possible. So often the coffee must be sold*

at a low price." Furthermore, enough money is not earned by farmers for increasing either the amount of agriculture production or household consumption [23]. Government together with banks facilitates farmers in producing various agricultural products in order to maintain national food security. Banks should be encouraged by the government to provide special financing products for agricultural entrepreneurs and farmers. It has been proven that lending to farmers can increase farmers' living standards and income [23].

Improvement and Maintenance of the Existing Infrastructure
One of the ICT officers when interviewed said, "*According to me, I think improving on the adoption of ICT calls for development and maintenance of infrastructures that will support network communication system*." Farmers during the focus group discussions suggested that electricity has to be accessible and affordable for them. This is because the ICT devices use electricity and therefore government should play an upper hand in this. Government should think of providing free internet for the farmers. An example was given by a union leader that *Soroti market was given free internet by their Member of Parliament.* From this fact, he suggested that government is in capacity of providing free internet to the coffee farmers.

Among the modern modes of ICT, mobile telephony has been the most widely and recently accepted mode of delivering information not only in India but also in other African and south Asian countries. Increasing mobile phone–based services enhances the availability of information and knowledge and will further help in improving education, better health and efficiency, awareness, better adoption of technology, better market efficiency, reduced transaction costs, etc. The economic growth and development of the rural sector will in turn be catalyzed. It was emphasized by [24] that ICT has great potential and should be offered the same importance as biotechnology revolution.

4.7 TOE Framework for Successful Adoption of ICT Among Coffee Farmers in Bugisu Subregion in Bugisu

Technological Factors
As stated earlier, technology refers to the characteristics of the technology itself, including the appropriate type of technology, its functionality, complexity, compatibility with existing systems, and ease of use. The following forms of technology would greatly facilitate the activities of the coffee union and coffee farmers in Bugisu subregion:

- *Appropriate technology*. This is the introduction of efficient and effective technology that can best be used by the farmers and unions to facilitate their day to day coffee farming activities such as market information system, GPS technology, mobile phone–based farmer applications, and TDRS (soil moisture tester).

- *Customised application*. Most illiterate group of farmers would easily embrace and use technology if only the available systems had features that would be enabled to translate in the local languages.

Organisational Factors

Organization refers to the internal context in which the technology is used, including factors such as the organization's size, organizational structure, support, culture, and resources, etc.

- *Government support*. There is a need for government to extent ICT-based services to the rural coffee farmer and provide all the necessary support needed for a successful adoption and use of ICT base services.
- *ICT support/help desk services*. This helps the farmers to call whenever they encounter a challenge with any of the technologies provided.
- *Sensitisation and creating awareness*. Technology is not well embraced by some cultures who believe that their property would indirectly be grabbed as a result of using it. Different communities need to be educated about the advantages of using technology. Transforming the mindset of farmers one at a time in preparation for the introduction of ICT to them is really needed.
- *Training farmers, extension workers, and cooperative leaders*. Basic skills especially on how to navigate different ICT devices such as phones, tablets, and computers should be offered to both farmers and cooperative leaders. Also they should be trained on how to use the available coffee farming applications.
- *Motivation to use ICTs*. This is a form of lowering the prices of ICT devices to enable farmers buy them. Also provide free internet for applications used by farmers. Cooperative unions should motivate farmers by gifting those who consistently use ICT to access different services such as loan requests, communication, and awareness.

Environmental Factors

Environment refers to the external context in which the organization operates, including factors such as market conditions, technology support infrastructure, regulatory requirements, and social and cultural norms.

- *Provision of the necessary ICT infrastructure*. There is a need to provide or improve on the necessary ICT infrastructure such as extending telephone masks to the rural areas.
- *Rural electrification*. Government needs to strategize to prioritize electrification of these areas that farmers come from. This will enable the low income earner access electricity that will enable them to charge their phones.
- *Financial support to farmers*. The cooperative unions can offer some credits to farmers purchase different ICTs and software.

5 Conclusion

Bugisu region in Eastern Uganda is the third most successful coffee-growing regions in Uganda after central and western regions. Bugisu region produces about 675,850 bags of Arabica coffee. However, while Bugisu region is the third most successful coffee-growing region in Uganda, coffee farmer face numerous challenges that have significantly reduced the production of coffee. Coffee farmers in the region are grappling with pests which destroy large parts of farms leading to about 50% loss. Therefore, there is a need to improve coffee production in the region, and one of the ways to improve coffee production is by using ICT innovations to curb some of these challenges. ICT provides services such as online market access, online weather information systems, diseases and pests control systems, farm management systems, and many others. ICT has demonstrated incredible potential for improving agriculture productivity in developing countries through innovations specifically that use ICT. However, while ICT would help address most of the challenges faced by the coffee farmers in Bugisu region, there is a need to provide a framework for ICT adoption. This chapter, therefore, presents a TOE framework for successful adoption of ICT among coffee farmers in Bugisu subregion in Bugisu.

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Assistive Technologies for the Visually Impaired Learners: Are Teachers Adequately Trained to Use Assistive Technologies?

Peles L. Biswalo

1 Introduction

The major aims of this chapter are to explore how visually impaired learners are catered for in using assistive technologies (ATs) to access tuition and educational materials. Furthermore, the chapter will look at how teachers are trained in catering for the VILs. The main objectives are (1) to explore how visually impaired learners are catered for in using assistive technologies and (2) to examine how teachers are trained to cater for the visually impaired learners. In relation to the theoretical framework, technology-enhanced learning environments (TELE) will be interrogated based on its characteristics [67]. TELEs are presented in the theoretical framework. The discussion begins with what disability covers according to the World Health Organization.

According to the World Health Organization, disability covers impairments, activity limitations, and participation restrictions. An impairment is a problem in body function or structure; an activity limitation is a difficulty encountered by an individual in executing a task or action; on the other hand, a participation restriction is a problem experienced by an individual in involvement in life situations [68]. The above being true, individuals with disabilities have equal access to education, a key issue of the 2030 Agenda for Sustainable Development. Both are directly connected to the 17 goals of the agenda and at the core of Sustainable Development Goal 4 (SDG4). Goal 4 aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all [64]. One target of the SDG4 is equity, which is defined by its goal which says thus:

P. L. Biswalo (✉)
University of Eswatini, Kwaluseni, Eswatini

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> By 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations [64, p.17].

In relation to this chapter, and in terms of key legislations and policies [61–63], learners with visual impairments (LWVIs) have a right to access education with other able-bodied learners. To expand on LWVIs, generally there are two categories of people with visual disabilities: the blind category and the partially sighted category [6]. From an educational point of view, students with visual disabilities, whether they are blind or visually impaired, need modifications in teaching methods, curricula, and teaching aids that meet their individual needs in various fields such as reading and writing, identification and mobility, and the development of different senses [11, 28]. This in turn can make it possible or easier for them to access teaching and learning materials. On the other hand, information technology or commonly referred to as ICT has increased opportunities for the visually impaired to learn. They are able to access teaching and learning materials using different ICTs. This makes a great deal of their suffering a part of history [29]. In particular, the use of assistive technologies (ATs) may play a key role in supporting learner access to equitable education [3, 26]. Consequently, some institutions working in the field of serving the visually impaired were able to find and employ means to serve the visually impaired through assistive technologies [53].

1.1 Assistive Technologies

Assistive technology refers to any facility or technology, specifically made or commonly available, that is used by people with disabilities (PWDs) for participation, to guard, support, train, measure, or substitute for body functions, structures, and activities, or to prevent shortages, activity limitations, or participation barriers. It comprises hardware (devices, equipment, instruments) and software [48, 68]. defines assistive technology (AT) as specialist equipment designed to promote computer access for people with disabilities. Assistive technology can provide equality between visually impaired individuals and their sighted peers within the emerging information society. With the aid of appropriate technological devices, visually impaired persons can independently access, process, store, and transmit the same information handled by sighted people [58]. A related supporting agent to the use of ATs by visually impaired learners (VILs) is the use of mobile devices that work well with the mobile learning (M-learning) platform.

Some authors have described M-learning as an ability to provide/receive educational learning contents in mobile devices such as tablets, smartphones, and PDAs [1, 44, 60] at anytime and from anywhere. Hence, they create a flexible learning environment. While the above is possible, challenges may exist for VILs to use the devices since visual content is prevalent on educational platforms, which is not surprising given that out of the five traditional senses, sight is most valued [22]. For

example, cognitive multimedia learning theories advocate for the instructional implementation of visuals [42, 49], claiming that using visuals typically yields more effective learning outcomes [2]. Moreover, most learners indicate preferences of learning with visuals [35]. Because of the imbalanced focus on visual learning materials, students with visual impairments are often at a disadvantage [55]. reveals that in opinion of teachers, most of the special schools in their study were not providing training in regard to assistive technology for their teachers. Some, however, were giving Braille training [33]. showed concern on lack of training both for preservice teachers and ongoing professional development of teachers to address the technology needs of special education students.

Teacher knowledge of, and comfort with, assistive technology (AT) is key for student use of ATs [26]. This is the key question to ask in this chapter: are teachers adequately trained to use assistive technologies?

1.2 Teacher Training on the Use of Assistive Technologies

Generally speaking, teacher training is capacitating prospective teachers to acquire knowledge and skill so as to be able to instruct and assess learners effectively. To effectively conduct their duties, instructional media, technologies, and ICTs are used to support the teaching and learning process. In supporting VILs and other students who may have other disabilities, teachers may lack knowledge and skill in accommodating them through ICTs and ATs. For example, in a study to assess the relevance of assistive technology (AT) used by persons with disabilities enrolled in higher learning institutions (HLIs) in Tanzania [45], the authors identified challenges related to the shortages of AT experts and AT courses for training, caretakers, and other professionals. In addition, in a study that investigated teachers' perception and factors limiting the use of high-tech assistive technologies resources in special education schools in North-West Nigeria [16], it was revealed that teachers do not use high-tech assistive devices regularly to teach students with physical disabilities. The researchers recommended that both government and other stakeholders should organize workshops, seminars, and other capacity building training regularly for teachers as means of updating their knowledge and skills in the use of assistive devices considering the dynamic nature of special education technology.

Researchers [19] reported that assistive technology is applied to the education of students with visual impairment; however, authorities, teachers, experts, and users indicated the need for technology infrastructure and pedagogical support. In other settings, researchers have tried to develop ways of training teachers to be better equipped in assisting VILs. [40] developed a training model to impart information technology (IT) knowledge and skills to visually impaired students in India. Orca (an open screen reader) was used to collect information from the end-users. The researchers concluded that, although there is a significant amount of research available to impart knowledge and skills in other subjects like science, mathematics,

history, geography, and languages, there is very little research being done to impart knowledge related to teaching IT skills to visually impaired students. It was observed that teachers follow more of a "trial and error" method and not a standard researched training model. They do not consciously take into consideration the learning styles and cognition process of a visually impaired student while imparting IT knowledge and skills to them.

This chapter therefore reviews the literature on how visually impaired learners are catered for in using assistive technologies (ATs) to access tuition and educational materials. Furthermore, it will look at how teachers are trained or prepared in using ATs when catering for the VILs.

2 Literature Review

Selected reviews on the use of ATs for the VILs are presented in this chapter. In addition, it is to determine whether teachers are adequately trained to use ATs for VILs. According to [41], preparation of teachers to face the challenges of an ICT-enriched teaching and learning environment is crucial. Teachers need to be equipped with the fundamentals of ICT tools and sufficient understanding on the integration of these tools in teaching and learning. In addition, efforts must be exerted toward changing mindset and developing positive attitudes toward ICT application in teaching and learning. Research, for example, shows that familiarity and level of comfort in using AT can result in positive teacher attitudes and effectiveness in integrating AT into their curriculum [20, 65]. According to [3, p. 130], a participant said, "I need more education in the use of AT devices that my students should be using." Furthermore, "I should recognize the importance of AT devices and their availability to students with visual impairments" [3, p. 131].

Al-Zboon [7] reported on perceptions expressed by teachers of students with VILs in Jordan on the use of ATs. Highlights included challenges that teachers perceive in using ATs with their students, in particular, computer use, willingness of learners to use particular devices, and the lack of such technologies in schools and at home [16]. investigated teachers' perception and factors limiting the use of high-tech assistive technology in special education schools in North-West Nigeria. Findings revealed that teachers do not use high-tech assistive devices regularly to teach students with physical disabilities. On a positive note, teachers felt that there are great benefits to the use of ATs.

In a systematic review study on digital learning in mathematics for students with severe visual impairment, [32] concluded that interactive eLearning with audio and tactile learning programs may be a useful resource for students with VI to enhance their mathematical skills. In Meghalaya, India, [38] looked at teachers training for differently abled students in higher education. One college in Shillong for example had differently abled students including the hearing impaired, visually impaired, and physically handicapped. Teachers in this college were facing many problems in dealing with the students since they had not undergone or experienced any kind of

training [45]. assessed the relevance of ATs used by persons with disabilities enrolled in higher learning institutions (HLIs) in Tanzania. It was revealed that AT was provided conforming to the kind of a disability and that training was conducted for new AT users. The training covered topics related to simple maintenance and repair of ATs. The challenge was related to the shortages of AT experts and AT courses for training, caretakers, and other professionals. The authors recommended the establishment of AT courses for developing a cadre of AT specialists for conducting rehabilitation services.

3 Theoretical Framework

One of the objectives of this chapter is to explore how or whether teachers are trained in using ATs, more specifically for VILs. One of the critical tasks confronting teachers is how to integrate technology in their classroom to facilitate learning in order to enhance student achievement. Teachers are therefore compelled to develop a technology-enhanced learning environment (TELE) for their students. While this may be easily achieved in many settings, appropriate training at the pre-service and in-service levels for teachers of students with visual impairments regarding TELEs and in particular the use of assistive technology instruction is necessary.

Technology-enhanced learning environment (TELE) was chosen to interrogate the raised issues (teacher training and use of assistive technologies). TELE refers to learning environments where ICT tools are used to support and facilitate learning. In addition, a TELE is any technology that enhances the learning experience of participants. TELEs are environments where ICT tools are used to support and facilitate learning [30]. TELEs are based on constructivist pedagogy, whereby learners explore their own interests and undertake instruction in a flexible manner using different technologies [5]. In this regard, learning is viewed as a procedure of effectively developing information by coordinating encounters into the learners' earlier information; the learner assumes a dynamic part in building his/her knowledge.

TELE is used to describe both analog and digital technologies. Recently, however, digital TELEs are widely used in education. From the author's perspective, a key digital TELE is the concept of smart learning environments (SLEs). In this regard, digitized learning environments are made "smart" using artificial intelligence. The use of smart gadgets (e.g., wrist watches, seeing eye glasses, and smart walking canes) for the VILs are good examples of facilitating TELEs for VILs. Teachers and facilitators however need not focus more on the technology being used, but rather the learning process, and whether learning outcomes are achieved.

A TELE enjoys the following characteristics: (1) using technology to motivate people, (2) using technology to enrich learning resources, (3) using technology to implement learning and instructional strategies, and (4) using technology to assess and evaluate learning goals. These four uses of technology make a learning environment technology enhanced [67, p. 4].

In a study conducted to gather views of practicing and prospective teachers undertaking a course at a higher learning institution in Eswatini, participants were asked to indicate technologies they preferred to use in their classrooms. To explain the data, technology-enhanced learning environments (TELE) framework was used.

4 Methodology

The study reported in this chapter used a qualitative approach which draws from interpretivist and constructivist paradigms; the two seek to deeply understand a research subject rather than predict outcomes [21]. In addition, interpretivism seeks to build knowledge from understanding individuals' unique viewpoints and the meaning attached to those viewpoints [18]. Furthermore, the interpretive approach involves narrative data collection and analysis in order to gain deeper insights on the understudied phenomenon [4, 15, 18]. Interpretivists tend to research issues from a personal experience perspective [70]. On the other hand, constructivists view knowledge as constructed since people work to make sense of their experience [18].

The researcher used a case study to gather information from the participants [69]. outlined case studies' critical features. First, case studies investigate "a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident" [69, p. 18]. Thirteen participants were purposefully selected from a class comprising 35 students. The criteria used were based on the participant having had experience as a part-time teacher, a diploma in teaching but seeking a degree or currently teaching in a school.

Ethical issues are considered as one of the most vital parts of any research [54]. In this study, the researcher attended to key ethical issues such as confidentiality, anonymity, and informed consent.

Participants responded to a questionnaire with two open-ended questions. The idea was to collect opinions, personal insights, or firsthand experiences and narratives from the participants. Data were analyzed and grouped thematically [4, 15, 18] using thematic analysis (TA). TA is a method for identifying and analyzing patterns in qualitative data. In this chapter, narrations by the participants are in quotes in order to describe their preferences in using particular instructional media and technologies.

5 Findings

Thirteen students undertaking a course titled Technology and Skills in Education at a higher learning institution in Eswatini were asked to respond to two questions: (1) Which technologies do they prefer to use in the classroom? (2) Any reason or justification to use such technologies? Based on the TELE environments described in

the theoretical framework, the following themes emerged which were categorized in terms of the technologies preferred by the participants. They were:

1. Visual media and materials (whiteboard, projected materials, and classroom books)
2. Audio visual materials (audio recordings, video clips—YouTube videos)
3. The internet (social media, conducting research)
4. Digital tools/digital libraries
5. Virtual classrooms (e.g., Zoom)
6. Digital classroom (e.g., Google class)

The findings indicated an inclination toward visual-oriented materials (which cannot be seen by VILs or struggle to see them for low vision learners). This is supported by [22], whereby sight is most valued over other senses. In addition, the combination of audio and visual was preferred plus digitized tools, virtual classrooms, and digital classrooms which can be easily accessed via mobile devices [1, 44, 60] through mobile learning or commonly referred to as M-learning. The findings clearly indicate that characteristics two and three of TELE supported participants' responses. The two TELE characteristics are the use of technology to enrich learning resources and using technology to implement learning and instructional strategies [67, p. 4]. Below are the participants' individual responses.

Participant 1

> I prefer whiteboard as one of the technologies to use in a classroom, reason being that marking on a whiteboard requires less effort and pressure than marking on a chalkboard. Pens are easier to hold and write compared to a chalk.
>
> I also prefer to use the overhead projector as it allows me to face the students most of the time. It is better than having my back on them when having to write notes on the board as it may give learners a chance to play. Overhead projectors also save time since notes are already written before a class commences.

The above participant demonstrated understanding of a current technology (whiteboard), while at the same time embracing an older technology (overhead projector). Both preferred technologies are visually oriented which means they are appropriate for students with no handicaps. Teachers therefore should be trained to be cognizant of other populations such as VILs in their classrooms where inclusive education is practiced. In order to improve a TELE, [43] suggests strategies for handling learners with visual impairment in the classroom:

- Using large writing on the chalkboard or visual aids. The use of colored chalk is recommended. Let the children come close to the board or teaching aids so that they can see more easily.
- Read aloud what is written on the chalkboard.
- Prepare teaching aids that learners can read more easily such as large print materials. Other learners in the class could help prepare these or they can be produced by enlarging font sizes on computer printout. This can also help learners who have difficulties in reading.

- Learners may have difficulties seeing the lines on writing papers. They can be given papers with thicker lines drawn on it.
- Some learners will benefit from using magnifying aids. Two types are available. One type that enlarges the whole page and another type which magnify lines. These are useful aids to reading for VILs [43, p. 114].

The above suggestions support the four characteristics of TELE (motivation of learners, enriching learning resources, implementing learning and instructional strategies, and using technology to assess and evaluate learning goals). Participant 2 had this to say:

Participant 2

> I prefer exercise books for note taking and test writing. I believe it is also a technology since a learner could later use it to recall what had been taught to him or her earlier or even decades later.

Preference of exercise books revealed less understanding of other instructional technologies used in teaching and learning. It may suggest some teachers not being innovative enough to use or create other teaching and learning materials. Nevertheless, the use of textbooks and other visual materials needs to be adapted to accommodate VILs. In order to have a conducive TELE, teaching and learning processes would need to be modified. Teachers should identify textbooks they plan to use in class prior to the start of the school year so they can be ordered in Braille, large-print, or audio formats [43, p. 115]. For visual clarity as an example, a teacher might need to use a whiteboard with a black felt tipped marker instead of a traditional chalkboard or to provide the student with papers that have heavy black lines instead of the traditional light blue ones [43, p. 115]. Below are views of participants 3 and 9.

Participants 3 and 9

> (3) I prefer the Modern Classroom Technology; for example, Google Classroom. It aims to make it possible for all school district to streamline their learning experience because it is easy to use and accessible for all devices. Google classroom makes it really easy for teachers to add as many learners as they like. It is also effective in communication and sharing, so when teachers create an assignment using google doc, the leaners can access it immediately through their google drive. It also speeds up the assignment process, teachers can easily check who has submitted their assignment and who is still working on it, as well as offer them feedback immediately.

> (9) I prefer digital classrooms—These increase learners' participation and their level of efficiency and productivity. In addition to engaging students, learners may actively discuss and deliberate on practical situations to sharpen their critical thinking skills, which are the basis for the development of analytic reasoning.

The above participants chose a social learning network platform or *digital classroom* to show preference of technologies to use in the classroom. Google class embraces different tools as well as processes in conducting a class. These platforms are used to reach students and learners at all levels. The above platforms are used for

online learning. The question is how are VILs accommodated? Below are views from some authors on VILs and online courses.

The inclusion of visually impaired students in online learning in Africa is uncertain [12]. In Ghana, for example, it is estimated that disability prevalence hovers around three per cent (roughly 800,000 people) of the country's total population [24], with a third of this group suffering from visual impairment [57]. However, there is no record of how visually impaired students (VIS) have been or are being included in online learning [12, 46]. In addition, while it is claimed that massive open online courses (MOOCs) can democratize educational opportunities, [50] suggests that current MOOC platforms are not designed to be accessible and inclusive for learners with visual impairments. Participant 4 below had this to say:

Participant 4

> Zoom is my preferred technology as it has become the new normal for teachers and students. It rose to the top during the COVID-19 pandemic. Teachers can now connect synchronously with their students over a video call. Teachers can also record voice-over presentations and share it with their students.
>
> I also prefer using YouTube. YouTube is full of creative videos that can help learners grasp concepts so easily. Teachers can create their own personal instructional videos for their students.

Participant 4 preferred Zoom and YouTube videos. This is a good combination as there is a face-to-face element or synchronous participation. Zoom and YouTube educational videos and other video-sharing platforms make a good technology-enhanced learning environment (TELE) if appropriately utilized. For VILs, they can benefit with the audio aspect of Zoom. With YouTube videos, teachers should be trained to use Apps such as TalkBack which offers accessibility support for blind and low vision users through audio descriptions [37, 52]. Audio descriptions are supplementary description (voice over) tracks that provide visual information for blind viewers [10].

YouDescribe is another way for people with blindness and low vision to watch YouTube videos without missing out on important visual information. Once they are on the YouDescribe website or app, users can browse featured videos or search for videos to watch that have audio description [59, 66]. Some of these tools should be included as part of the learning in the preparation or training of teachers. In addition, and when using Zoom, teachers should encourage VILs to participate in discussions. This can be done by asking them questions, calling on them by name, and providing them with opportunities to share their ideas. Teachers should be patient and understanding when working with VILs. It may take VILs longer to complete tasks or participate in discussions. Participants 5, 2, and 11 had this to say on their preferred technologies.

Participants 5, 2, and 11

> (5) The internet is the most useful technology which helps us in our daily lives. Everybody needs internet to search for information related to exams, curriculum, and results.

(2) The internet is another technology I prefer to use. Learners can browse the net for more information and a teacher can as well continue lessons online using Google classroom to cover lost time during face-to-face session or polish up what was earlier taught to learners.

(11) The internet has been the best invention for the twenty-first-century teacher. First of all, I use it to search for information in preparation for my classes so that I don't rely only on the pupil's text book and teacher's guide. I use search engines like Google as well as browsers like Chrome. This has been very helpful in my teaching as I then have much information that I give to my learners and practice exercises that I also get from the internet.

Using the internet and Google Class indicated understanding of current technologies used in teaching and learning. Inclination however is for "able-bodied" learners. For VILs, assistive technologies such as screen readers, braille displays (device that converts text into braille), and the use of Zoom text magnifier and voice recognition software can be used. These can assist VILs access teaching and learning materials [58, 68]. In addition, the above technologies can be used by VILs when taking tests or exams (characteristic 4 of TELE) [25]. looked at inadequacies in learning environments and services for visually impaired students using ICT in an educational context with the aim of identifying problems and raise issues concerning visually challenged students in the course of their post-secondary education through eLearning. Challenges included affordability of E-systems, availability of online facilities, accessibility of websites, availability of books in all formats, description of pictures along with images, and good screen readers.

While the internet is used extensively in education settings, accessibility to online materials should ensure that the opportunities are guaranteed to everyone, including people with disabilities [56]. described the issue of accessibility in relation to technology-enhanced training by ensuring that learners are not prevented from accessing technology-supported resources, services, and experiences in general due to their disability. Participants 6 and 7 had this to say:

Participants 6 and 7

(6) I would prefer to use digital tools like laptops and smartphones in my classroom. They come in handy and are useful in learning because they enable learners to access the internet, which makes it possible for them to manipulate various applications that may be used to tackle quite a vast number of problems in any given situation.

(7) I prefer using digital libraries, more especially online libraries. Books can be checked out by multiple learners at the same time. Digital copies' new editions can be checked out by numerous people at once without queueing. Learners can also access information anytime and any day at the comfort of their homes in case they are given assignments.

The two participants above demonstrated understanding the importance of digital tools as well as digital libraries. A concern could be whether teachers are well informed or have enough training to use digital tools and libraries for VILs. In addition, are the libraries equipped to cater for the VILs? In a study where one of the objectives was to identify the accessibility of mobile devices to learners with visual impairment at the University of Eswatini, [51] reported where a participant lamented thus:

> I also think that effective online learning must include the needs of the learners with disabilities by equipping facilities such as the library and the computer labs with disability friendly corners well equipped with technology and human capital to accommodate visual impairment learning needs [51, p. 208].

The above suggestion by the participant indicates challenges faced by VILs when accessing teaching and learning materials in digitized environments. An improved TELE to cater for all learners including VILs should be developed. This is in line with [29] where TELEs are described as environments where ICT tools are used to support and facilitate learning. In addition, one of the characteristics of TELE is using technology to enrich learning resources [67]. This can enhance the participation of VILs in teaching and learning environments. Furthermore, the use of technology motivates learners including VILs [23, 31, 47]. To continue, participant 8 had the following to say:

Participant 8

> I like using PowerPoint. This facility enables teachers to present and demonstrate their ideas clearly.

Participant 8 preferred the use of PPT presentation when teaching. This tool is widely used in educational settings. Since it is a "visual"-oriented tool, teachers should be capacitated to adapt and modify the presentations to accommodate VILs. As suggested earlier, applications such as YouDescribe and TalkBack can be used to provide audio information for VILs [10, 37, 52, 59, 66]. To proceed with the presentation, participants 10 and 12 below give first-hand experience in using different tools.

Participant 10

> I am a teacher of English Language, Religious Education, and Literature in English. I have been teaching for the past twelve years, and my teaching is limited to a High School, thus I will talk about what I have done and do where I am stationed. Before we had electricity in the school, I would use my cell phone to record my voice and that of other teachers reading passages from magazines, newspapers, and interviews on the television. I would then play the audio recording for my English Language class as an exercise for the listening aspect of the syllabus. When I finally bought myself a laptop, I would then bring it to class with some speakers and play the discs and flash drives containing recordings that come from the exam's council for past exam papers and any other listening exercises that I find on the internet.

Participant 12

> I have found that I do my best work via online teaching than with face to face. I post slides for my students on their WhatsApp groups, I make voice notes for my presentation, which I also post to the groups. This method caters for both visual and auditory learners. Learners also get a chance to ask questions, clarity, and help.

The above participants (10 and 12) have given their experiences in using different tools and resources (cell phone, audio recordings, slides, and WhatsApp) to enhance their teaching. The descriptions seem to only address able-bodied students. There is

no indication of having worked with VILs or other differently abled learners. In contexts where teachers work with VILs, for example, VILs can supplement their reading of Braille or printed text with aural outputs from screen readers or digital talking books [13]. Tools such as DAISY (digital accessible information system) books have been developed to assist people with VI in the learning process [8, 39]. Parsee Smart Glasses (reading and navigation) is another tool to assist VILs. It is a pair of 3D high-tech smart glasses that help visually impaired and totally blind people perceive and explore their world as sighted people [8]. Three characteristics of TELE (motivation, enriching learning resources, and using technology to implement learning and instructional strategies) show the importance of using technologies in teaching and learning. In this chapter, the author recommends that courses in the use of technologies and adapting them (where applicable) to suite VILs should be included in teacher training programs. Participant 13 had this to say on preferred technology in the classroom:

Participant 13

> I am lucky that my school is one of the few schools in the rural areas that was sponsored with a computer lab by the Chinese government. This donation has brought with it among others, Wi-Fi, computers, and a digital projector. The IT teacher sometimes gives us permission to use the laboratory; I recently posted a video clip which I got from YouTube about the Last Supper. Learners watched the video using the school computers and Wi-Fi. My form 5 Literature class got to watch William Shakespeare's play Macbeth using the projector.

This participant has described experience in using technologies in rural-based schools. While the participant is happy with the current setup, [14] reported that teachers in more rural, remote areas such as Canada's eastern Atlantic province (Newfoundland and Labrador (NL)), resources for AT implementation may be more challenging to obtain. In addition, a lack of AT training within initial teacher education programs in general results in lack of knowledge around AT [9, 36]. The above shortcomings can be even more challenging in developing countries. Awareness and utilization of TELE principles [30] and constructivist pedagogy [5] can assist in training teachers to embrace the use of ATs to assist VILs.

In terms of teacher training and awareness of ATs, [34] reported on Indian educators' awareness and attitude toward assistive technology. Teachers of urban schools exhibited slightly better awareness and attitude toward ATs than those of rural schools. For example, [26] concluded in their study on training pre-service general educators in assistive technology competencies for students with visual impairments that a teacher who is aware of and understands the functionality of ATs is more able, and therefore more likely, to implement it in a meaningful way. This is supported by previous studies with views that this type of training can potentially impact the lives of students with VI in a significant way because an increase in teacher competency with AT translates to benefits for students using ATs [17, 27].

6 Conclusions

The chapter sought to explore whether teachers are adequately trained to use assistive technologies when teaching VILs. In addition, it was to gather views of practicing and prospective teachers at a higher learning institution in Eswatini on technologies preferred to use in their classrooms. The conducted study was guided by the TELE framework that refers to the use of technology to enhance learning. In particular, technology is expected to support constructivist learning principles by providing learners with opportunities to explore, collaborate, and problem-solve.

Based on the literature [16, 26, 33, 45, 55] and the results of the study, the researcher concluded that many teachers are not adequately trained to use ATs when teaching VILs. In addition, such ATs are inadequate or not appropriate for the VILs. The researcher further concluded that while the prospective teachers were exposed to numerous technologies, considerations were not made for assistive technologies. All the 13 participants in the study did not mention technologies that can be used to assist VILs nor did they mention working with VILs or how they can assist them in the teaching and learning environment.

7 Recommendations

The researcher recommends that training in the use of assistive technologies (ATs) and smart technologies (STs) should be part of the syllabus for teacher trainees. ATs and STs are devices or systems that use sensors, connectivity, and data analytics to collect and process information about their environment. ATs and STs can be used to automate tasks, improve efficiency, or provide insights that can be used to make better decisions. This is more especially for VILs.

The researcher further recommends that STs that are artificial intelligence–enabled should form part of the curriculum in equipping teacher trainees with skills in using instructional media technologies and ICTs in general when teaching. In addition:

- Inclusive education should form part of the teacher training curriculum.
- Special attention should be given on how to work with VILs.
- Personalized learning should be adopted, whereby a learner might use a learning management system, for example, to access a variety of resources and activities that are tailored to the individual needs.
- Prospective teachers should be equipped with knowledge and skill on how to integrate ATs in their lessons when working with VILs.
- Teachers should collaborate with other professionals who can help in the use of technology to support visually impaired learners. These include assistive technology specialists, teachers of the visually impaired learners, and orientation and mobility specialists.

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Perceptions of Health-Care Workers on Technology Adoption in Health-Care Facilities in Eswatini

Selloane Pitikoe and Dlalsile Dlamini

1 Introduction

What are the perceptions of the Health-Care Workers on adoption of electronic health records system (EHRS) in the Kingdom of Eswatini? What are the available support systems for Health-Care Workers to effectively use the electronic data management system in the Kingdom of Eswatini in Southern Africa? These are the questions that will be answered by the findings of this study. [1] highlights the importance of exploring perception when understudying Health-Care Workers with particular emphasis on the nurses. Coming from the nursing context herself, she points out that nurses are "privy to [their] own perceptions" (p. 3) and the challenge that comes with this norm in situations where nurses are confronted with different perceptions.

Over the past decades, health-care delivery underwent significant changes [2]. Progress in medicine as well as in information and communication technologies (ICTs) evoked new methods and new opportunities that support new initiatives in the provision of health-care services [2].

These new developments include the use of new information and communication technologies that improve services to patients, speed up waiting times, and address structural problems in the health service. In response to poor record management in

S. Pitikoe (✉)
University of Eswatini, Kwaluseni, Eswatini

Faculty of Education, Department of Adult Education, University of Eswatini, Kwaluseni, Eswatini

D. Dlamini
University of Eswatini, Kwaluseni, Eswatini

Institute of Post Graduate Studies, University of Eswatini, Kwaluseni, Eswatini

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health facilities, most governments, including that of Eswatini, opted for EHRS in place of the traditional paper-based [3]. These authors further underscored the potential loss of patients' medical records while using the paper-based system. In their view, while paper filing can only use one indexing system at a time, EHRS enables Health-Care Workers to index patients' data in multiple ways; which is economic and time-saving. However, the paucity of literature on the Health-Care Workers' perception on adoption of EHRS in Eswatini leaves a lot to be desired and hence this study.

[4, 5] observed a worldwide significant rise in the implementation of EHRS in a number of hospitals, for instance, in the USA, UK, and Denmark, where EHRS implementation initiatives are driven by a number of factors such as (a) the promise of enhanced integration and availability of patient data, (b) the need to improve efficiency and cost-effectiveness, and (c) a changing doctor-patient relationship toward one where care is shared by a team of health-care professionals. These findings imply a need to explore the local experiences from Eswatini context on what motivated the local health-care provision to migrate from the paper-based methods to e-records.

The literature further provides common position on the generally poor adoption of the electronic record system in health facilities. [6] in a study conducted in America on user acceptance of health records reported failed clinical system implementations due to lack of adoption by users. The writer further indicated that Health-Care Workers will not use a product that interferes with their workflow, changes the way they care for their patients, or places limitations on the way they practice medicine [7]. Predicting the reasons why physicians accept or reject a new information system will allow an organization to proactively take corrective action to increase acceptability. While these studies provide a rich background on the global response toward effective adoption of EHRS, the dearth of literature on Eswatini's response triggered this study.

1.1 Context of the Study

For a long time, Eswatini has been facing Health Management Information System (HMIS) constraints. The country relied heavily on paper-based tools for recording patient information when providing services and when filling in health facilities. This paper-based record-keeping system led to inadequacies in the tracking of: (a) drug consumption, (b) drug procurement and supply management (PSM), (c) equipment procurement and supplies. It was on this basis on these missing records that a new system in the form of EHRS was implemented.

Eswatini policy-makers and health administrators therefore decided to change from the current paper-based health records system to an electronic health records system (EHRS). This change is being undertaken to harmonize healthcare data and improve patient care. The country's client management information system (CMIS) is an EHRS that improves patient care by improving data quality and access,

reducing duplicated cases within the system, and improving patient flow and wait time within the health facility [7].

What remains unknown though are the perceptions of the Health-Care Workers regarding the adoption of EHRS in the national health care facilities which the study seeks to explore. This chapter is organized as follows: The chapter begins with the introduction followed by the theoretical framework and the methods. The results and discussions, and finally the conclusions and recommendations.

2 Theoretical Framework

This study is based on two interrelated theories: Technology Acceptance Model (TAM) by Davis (1989) and Awareness Desire Knowledge Ability and Reinforcement (ADKAR) model of change of 2006.

2.1 Technological Acceptance Model (TAM)

Technology Acceptance Model (TAM) was derived from the theory of reasoned action (TRA) by Davis in 1989; TAM was chosen as the ideal model for this study since it has been widely used in studies related to technology acceptance. The model offers a powerful explanation for user acceptance and usage behavior of information technology. TAM model is more applicable in predicting intention to use (adoption) and usage for users than non-users of a technological innovation. This model assisted the researchers in understanding the important elements that determine the acceptance of Information Technology (IT) and helps in effective planning since benefits of IT are hidden and intangible [8–10].

Davis et al.'s TAM model was used to describe two key attributes: perceived usefulness (PU) and perceived ease of use (PEOU) of the technology to the health-care practitioners. These attributes influence the behavioral intentions of accepting and adopting a technology system. Perceived usefulness is the degree to which an individual believes that by using a particular system they would enhance their productivity, while perceived ease of use is the degree an individual believes that using a particular system would be free of effort [8]. Between these two, perceived ease of use has a direct effect on both perceived usefulness and technology usage [10, 11]. [11] also found a relationship between the beliefs that users have about a technology's usefulness and the attitude and the intention to use the technology.

[10, 11] further found perceived usefulness to exhibit a stronger and more consistent relationship with usage than other variables. Furthermore, [11, 12] reported that if an individual perceives a technology to be convenient and useful, they may adopt it, even though they do not enjoy using the technology. Thus, there might be a possibility of a direct relationship between beliefs and intentions.

By contrast, a research by [11] refined the TAM suggesting that the mediating effect of attitude could be excluded as empirical evidence found that the attitude element did not fully mediate the effect of perceived usefulness on intention to use.

In their study using the TAM model, [11] explained that the characteristics of the technology and the difference in the personality traits influenced PEOU. Resistance to change is a constraint in the acceptance of an innovation and it had a significant influence on PEOU in the acceptance of a system. The magnitude of change-significant alteration of tasks drives the behavior of an individual. [11] concludes that domain-specific resistance to change was a determinant of PEOU of a technology.

There are other factors that may be attributed to organizational influences and system characteristics. [13] explained that in the medical practices, the acceptance models need to explain PU and PEOU within the context of the work practice of the Health-Care Practitioners in order to make the clinical information system more effective.

In Malaysia, the refined TAM model was used by [14] to study the various factors influencing personal computer acceptance by small and medium-sized companies. [15, 16] investigated the effects of different personal traits between Health-Care Practitioners and other knowledge workers in information technology acceptance. These authors reported that specialized training, autonomous practices, professional work arrangements, and the perceived threat to the professional autonomy of information technology had a significant negative effect on perceived usefulness. Functionality of the system alone does not relate to PU; other attributes such as personal traits, characteristics of the system, and resistance to change also contribute to PU. In this chapter, we used TAM to predict the intention to use EHRS among current users and future users.

Earlier on in this chapter, we indicated the paradigm shift from the paper-based records to the electronic records. While change is inevitable, management of such change in order to harvest the desired goals is crucial.

2.2 The ADKAR Model of Change

The ADKAR model was developed by Jeff Hiatt, CEO of Prosci Change Management, and first published in 2003 and reviewed in 2006. ADKAR emphasizes that successful organizational change occurs only when each person is able to transition successfully. *ADKAR* is an acronym that represents the five outcomes an individual must achieve for change to be successful: *awareness*, *desire*, *knowledge*, *ability*, *reinforcement*.

[17, 18] refer to each of these five actions as the building blocks for successful individual change and therefore successful organizational change. The process is sequential; each step must be completed before moving on to the next. Hiatt emphasizes that it is not possible to achieve success in one area unless the previous action has been addressed.

The five steps of the model

1. *Awareness of the need for change*: Understanding why change is necessary is the first key aspect of successful change. This step explains the reasoning and thought that underlies a required change. Planned communication is essential. When this step is successfully completed, the individual (employee) will fully understand why change is necessary.
2. *Desire to participate in and support the change*: In this step, the individual can reach a point where they make a personal decision to support the change and participate in the change. Naturally a desire to support and be part of a change can only happen after full awareness of the need for change is established. Building desire is partly achieved by addressing incentives for the individual and creating a desire to be a part of the change.
3. *Knowledge on how to change*: This step is about providing knowledge about the change, which can be achieved through normal training and education methods. Other methods of transferring knowledge, such as coaching, forums, and mentoring, are equally useful.
4. *Ability to implement the required skills and behaviors*: In this model, ability is understood to be the difference between theory and practice. Once knowledge on how to change is in place (theory), the practice, or actual performance of the individual, needs to be supported. This can take some time and can be achieved through practice, coaching, and feedback.
5. *Reinforcement to sustain the change*: Sustainable change requires positive feedback, reinforcement, rewards, recognition and consistent performance management protocols. Putting in place corrective measures also ensures proper monitoring and evaluation of new outcomes.

2.2.1 Why Use the ADKAR Model of Change?

The primary reason the writers favor this model is its focus on individual change and ensuring each person makes the transition. Most importantly, when focusing on the individual, it is possible to measure where they are in the change process and what is required to assist them. It does not simply rely on running a certain number of training programs, or communicating a message, and expecting everyone to follow. The section that follows presents the research methodology that was used in this study.

3 Methods

This interpretivist study adopted a phenomenological research design to explore perceptions of the Health-Care Workers in adopting EHMS in the health-care facilities of Eswatini. Interpretivism allows researchers to view the world through the

perceptions and experiences of the participants [19]. Through this paradigm, the researchers establish a better understanding of how the Health-Care Workers perceived the EHMS in their local context.

Along the same lines, the phenomenological design provides an opportunity to explore the deepest considerations of the lived experiences of the participants [20] in more detail. The design further allows for deep understanding of commonality of lived experiences within a group and develops bonding relationships of participants to their environment [21]. The rationale behind the phenomenological design in this study was twofold. First, the design was appropriate because it creates an opportunity for multiple socially constructed world views [21]. Secondly, the phenomenological design also enabled the researchers to gain insights on the views and experiences of Health-Care Workers on the usage of Electronic Healthcare Records Systems.

A purposively sampled group of 12 Health-Care Workers—5 doctors, 2 administrators, and 5 nurses—participated in this study. All the participants work in the two health-care facilities selected for this study in the Manzini region. [22] points out that in purposive sampling, the researchers choose the sample with an objective or purpose in mind. Purposive sampling is useful for situations where there is need to acquire a focused sample in a limited time lapse and where sampling for symmetry is not the main concern.

The study employed semi-structured interview guides for data collection. While the study lauds interviews for their ability to permit freedom for both the interviewer and interviewee in case of changing directions and exploring additional points when required, there are some disadvantages as well. For instance, [23] observes that conducting, transcribing, and analyzing the results of the interviews are time-consuming. These activities require the interviewer to possess adequate interview technique and proper time management skills without compromising the data quality. In the era of COVID-19, interviews posed an added risk of spreading the infection through contact. Henceforth, social distancing was observed. The researchers also wore a recommended facemask and carried a hand sanitizer to eliminate the chances of contracting the virus during interactions. Participants who did not feel comfortable with a face-to-face interview were awarded a choice for a telephone interview.

3.1 Data Collection Process

Data collection involved a well-planned exercise [24] where the researchers drew a timetable for each activity and sought for permissions from all relevant authorities including the Ministry of Health and the management of the facilities that were involved. Thereafter, the researchers identified the participants and then explained the research procedures and what was expected from them. The date and times for the interviews together with the venue were confirmed. Upon arrival on the data collection date, after the formalities and the introductions, the researchers explained

to the participants that participation was voluntary; the consent form was read and signed by the participants.

3.2 Data Analysis Process

Data were analyzed thematically to identify the generic themes or patterns within the collected data [25]. Naturally, the method "is not tied to any epistemological perspective" (p. 3352), which makes it more flexible and relevant to the study. In this study, the data analysis process was concurrent with the data collection process. The literature states that thematic analysis involves several steps, and the researchers observed the steps applicable to their study [26] as outlined in Fig. 1.

Figure 1 outlines the thematic analysis process. In this section, we outline how these steps were followed in this study. First, the researchers familiarized themselves with the data. Daily reading and rereading of the data were done coupled with listening to the daily recordings. This approach helped us to gain a comprehensive understanding of the data that were collected each day. The data were then transcribed verbatim—using MS Word followed by saving the transcripts on a Google Drive.

In the second step, we initially coded the data and developed a codebook for ease of reference. We also reviewed the previously generated codes and updated as necessary. We further identified meaningful patterns, concepts, or ideas derived from the collected data. The codes that we generated in step two were then collated into potential themes in the third step, where we examined the relationships between the different codes and explored overarching patterns.

In the fourth step, we reviewed and refined the themes by checking their coherence and relevance to the data. This process entailed organizing and reorganizing the data excerpts, ensuring that each theme captures a distinct aspect of the data set.

In the fifth step, we further developed and defined the themes, creating clear and concise descriptions that encapsulate the essence of each theme. Finally, the sixth

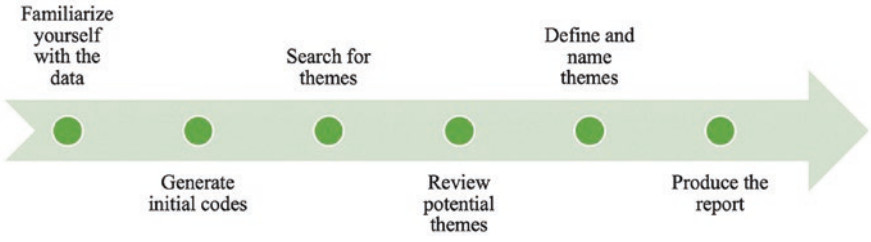

Fig. 1 Thematic analysis process. (Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.maxqda.com%2Fblogpost%2Fthematic-analysis-with-maxqda-step-by-step-guide&psig=AOvVaw0eA4PHV75QzrLm-D1yorVr&ust=1705823893708000&source=images&cd=vfe&ved=0CBMQjRxqFwoTCNiF-YDA64MDFQAAAAAdAAAAABAJ)

step involved production of a comprehensive analysis report, utilizing illustrative quotes and examples to support each theme which provided a rich understanding of the data.

The initial data analysis was presented to the research participants as the key stakeholders in the study and also to verify the contents of the report before dissemination of the findings. The following session presents the findings from this study.

4 Results

4.1 Demographics

Information presented in Table 1 below therefore illustrates the characteristics of participants according to age, gender, occupation, work experience, and level of education so that their lived experiences may be understood within their contexts.

The findings in Table 1 show that the youngest health professionals were at least 26 years old, while the eldest was above 50 years of age. This illustrates that most of the professionals were in their middle ages. Furthermore, 51% were Nurses by profession, 33% were Doctors, and 16% were Administrators. Regarding the

Table 1 Demographics of the participants

	Frequency		Percentage		
Characteristics	Male	Female	Male	Female	Grand total
Gender:	6	6	50	50	
Total	6	6	50	50	12 (100%)
Age:					
26–30	1	1	8	8	
31–35	2	1	18	8	
36–40	0	0	0	0	
41–45	1	1	8	8	
46–50	1	1	8	8	
Above 50	1	2	8	18	
Total	6	6	50	50	12 (100%)
Professional occupation					
Nurse	2	4	17	34	
Doctor	3	1	25	8	
Administrator	1	1	8	8	
Total	6	6	50	50	12 (100%)
Experience with EHRS					
1–5 years	5	4	42	33	
6–10 years	1	1	8	8	
Above 10 years	–	1	–	8	
Total	6	6	50	50	12 (100%)

experience that the participants had in using EHRS, 75% had between 1 and 5 years of experience in using the system. This signifies that the participants were relatively new in using EHRS, making their experiences very valuable to the study.

4.2 Themes

The key themes presented in this chapter included the perceptions of Health-Care Workers in the use EHRS; difficulties encountered by the Health-Care Workers; and strategies to improve the effective usage of EHRS as presented in Table 2.

Perceptions of Health-Care Workers on the Use of EHRS
The general perception of the Health-Care Workers was positive. In their view, EHRS improved the way they do business as they spent less time to search for the medical records. In the process, more patients are served within a reasonable waiting period. The two main themes generated under this theme are perceived usefulness and up-to-date record keeping.

Perceived Usefulness
The findings revealed that EHRS improves access to health records, making the Health-Care Workers more efficient. The participants concurred that the EHRS made access to stored record very easy. Similar sentiments were echoed by the five doctors that the system did not only improve access to records but it also shortened the patients' consultation time. Henceforth, they were able to see more patients at a given time. Administrator #1 shared his views on the usefulness of the system as follows:

> The system is very useful and improves efficiency, especially when it comes to access of patient data. We are new in using the system because we have been using paper files for many years; however, in my opinion this system is better than the traditional system. (Administrator #1)

Table 2 Summary of themes that emerged in the study

Themes	Sub-themes
Perceptions of Health-Care Workers in the use EHRS	Perceived usefulness (PU)
	Perceived ease of use (PEOU)
	Resistance to change
	Age factor in adoption of EHRS
Difficulties encountered by the Health-Care Workers	Lack of computer skills by users
	System is affected by network delays
	Challenges with editing wrongly captured data
Available support systems for effective use of EHRS	Irregular capacity building
	Lack of user-training
	Lack of communication between the supplier and the health provider

Similar sentiments were also shared by the doctors:

> Electronic Health Records Systems are designed to improve access and increase efficiency. Simply put, in bigger institutions with many patients, it means we spent more time serving clients and less time hunting for their physical files in the card room. Therefore, the more patients we serve the more lives we save or assist. (Doctor #1)

The findings from both participants highlight a positive perception toward EHRS and its contribution to work efficiency of both the doctors and the administrators. Notably, a significant improvement in accessing the health records and better health service provision was central. The main usefulness of EHRS was time efficiency, which in turn increased the time spent serving the patients within a reasonable waiting time.

Up-to-Date Record Keeping

The nurses indicated that EHRS made client record keeping more updated and accessible. In this regard, some of the nurses had this to say:

> Time is scarce in our daily routine, using this system saves a lot of time lost in search for records. In the past a patient could even be turned back because the record is missing, and a great deal of time would be spent looking for records especially when patients are not frequent users of the institution. But now it is very effective. (Nurse #2)

Similar sentiments were shared by Nurse #4:

> The electronic system is very effective as it enables easy retrieval of patient information and clinical history. This can be done in seconds. Additionally, it enables easy communication between nurses and facilities as the system can retrieve what service was previously offered to a patient and it specifies the facility the service was given. In short, the system has made work very efficient, thanks to the effective retrieval system; service delivery is improved service. (Nurse #4)

The views of the nurses regarding efficiency were echoed by the doctors as one of them stated thus:

> There is no doubt that electronic health record systems improve efficiency of service through improved access and convenient reach of records. It is also highly possible for me as a doctor to use my passcodes to access the necessary documents and serve my patients. In the past I would not be able to do so without the help of another designated person. (Doctor #3)

The findings revealed that while in the past some patients would be turned back due to either loss of or non-location of patients' records, the usefulness of EHRS is applauded for its effectiveness in timely file retrieval and efficient record keeping. Also, noted was effective communication between facilities that comes with EHRS, whereby passcodes are used to access the online client's medical history. While the section recommended EHRS for its usefulness to the health facilities, not much is known on the ease of use or accessibility of EHRS to the Health-Care Workers.

Perceived Ease of Use (PEOU)

The Health-Care Professionals identified age as one of the challenges that affect the uptake of technology in the health-care provision. For instance, the younger

professionals seemed more motivated to use the EHRS as opposed to the older generation. Some of the older professionals lamented that in the past they did not have to use computer that much, while for some, the issue was more on the computer illiteracy skills.

Younger health-care workers use it more often than older workers.

It was the perception of the institution Administrators that EHRS was more frequently used by the younger Health-Care Workers who were also readily computer literate. In this regard, one of the two Administrators had this to say:

> My experience is that younger nurses are very active users of the system. The older staff members are very slow in using it and often avoid using it. This is problematic because you find out that there is no consistence in the use of the system. You find that a patient comes to refill their prescription, but the previous visit does not appear in the system. (Administrator #2)

The views of the Administrators were supported by some of the doctors who had this to say:

> There is also resistance to change among staff members, and it is more especially complicated by the fact that the institution still supports a dual form of record keeping which includes both electronic and physical health records. In my experience old Health-Care Officers prefer the traditional system while younger professionals seem to prefer the electronic system. I believe if the institution drops the traditional methods, all staff will be compelled to utilize one system. (Doctor #3)

Evidence notes inconsistent data entry as well as a sluggish transition process in the uptake of EHRS. For instance, the findings reveal a substantive wealth of information that while the younger Health-Care Workers were keen to use EHRS, the older colleagues were resistant to the new change. In the interim, some of the patient's data would not appear in the system. Of importance was the dual system—use of both the print and the e-records in some health-care facilities and how it opened a window of opportunity for the Health-Care Workers on whether or not to use EHRS. The lack of reinforcement for a complete migration from the conventional record-keeping methods to EHRS was problematic. Was age the only underlying cause for no-adoption of EHRS by the older Health-Care Workers?

Computers Illiteracy

It was found that computer illiteracy also contributed to resistance to change and adoption of the new technology. For instance, the younger generation was more exposed to technology than the older generation. This limitation was affirmed by one of the nurses who had this to say:

> It's not that we do not enjoy using the system, we hardly received adequate training on it and often it delays the process because mistakes are made and the systems does not allow one an opportunity to update a record. This becomes time-consuming and affects future users. (Nurse #2)

Similar sentiments:

> Some of us are new at computers, in fact until recently, I did not need to use the computer extensively for any work related unlike our younger colleagues, and we find it hard to adjust because we aren't that good with computers. (Nurse #5)

The same view was also pointed out by the doctors who specifically identified limited ICT skills among the older generation of Health-Care Professionals:

> Quite frankly, in many institutions I worked where this system is introduced, it faces resistance because Health-Care Workers in developing countries are generally short of basic computer skills. In particular older Health-Care Workers who have never before needed ICT in their work roles will be more challenged. With time they will improve though. (Doctor #1)

The general consensus here is on computer illiteracy among the older Health-Care Workers and how it affects their pace when entering the data in the system and the data entry mistakes thereon. Given the limited computer skills, the older generation of Health-Care Workers finds it difficult to adjust. Computer illiteracy also brought about resistance to adopt the new change.

It was also found that the introduction of the new technology has also created some divisions among staff members which could also affect the adoption of the new technologies. Doctor #1 stated that:

> The real challenge is that in some of the institutions there is some division among the staff members in the same facility. Some prefer it while others do not. Obviously, those who do not prefer it will be quick to point out challenges. (Doctor #1)

In his view, Doctor #1 observes the factions that exist among staff where there are those in favor of the new technology and those who are not. The doctor also laments that the naysayers are always quick to judge and speak ill about the technology which makes the implementation process even more challenging.

The findings indicate that the younger health-care professionals were more comfortable using EHRS, while some older Health-Care Workers preferred to use more traditional methods of keeping records due to the limited computer literacy skills as well as lack of training in the use of EHRS. Most importantly, the differences in terms of preferences and the attitudes toward the new technology among staff members also had a significant bearing on the transition from paper-based records to electronic ones.

System Has Loopholes

There were some notable technicalities that made the system inaccessible to the Health-Care Workers. At the same time, the health professionals were of the view that EHRS was not fit for the purpose of the health-care provision in Eswatini. For instance, it was found that the system makes it difficult to edit any work that has been entered in EHRS and this discouraged the Health-Care Professionals to use the system. In this regard, one Nurse had this to say:

> The system does not allow any form of editing to be done to the file once made. This is very important because when errors are made (and they are often made) the system does not give you the option to edit and this essentially means an erroneous record has been saved in the system. Comparatively with physical records we can cancel or fill again meaning an accurate record is kept despite original error. (Nurse #3)

The same point was also raised by one of the Administrators who indicated that editing records are prohibited to ensure that source data is preserved as captured.

The Administrators however lamented that this function promoted the entry of incorrect data in the system.

The administrators also highlighted the imperfections of the system as reflected by one of the Administrators who had this to say;

> The system is not tailor made for our needs, so you find that it has a lot of features we do not need and lacks those features that are required in our field. This emanates from the fact that there was no liaison between the systems provider and the institution. Ours is the only mental health facility in the country and we need a system that talks to our needs and indicators. Unfortunately, the majority of the systems' components are generic making them almost unusable in our situation. (Administrator #2)

Over and above the limited computer literacy skills among the Health-Care Workers, participants also emphasized the unfriendliness of the system. Noted was also the technical limitation that some of the system's features are irrelevant to their context and those that their facilities need are missing in the system. This alludes to a mismatch between what the system offers and what is needed in the ideal world of health care in Eswatini. The involvement of and active participation of the relevant stakeholders prior and during the implementation of EHRS in Eswatini leave a lot to be desired.

A lot has been said regarding the usefulness and the ease of use of EHRS thus far. The question of institutional support for effective implementation of the platform remains unexplored.

Institutional Support

Institutional support plays an important role in mobilization and motivation for adoption of any change. Presumably, Eswatini Health-Care Providers also took the necessary precautions that ensure effective strategies in place to support the effective implementation of EHRS. In this study, the Health-Care Workers especially the nurses lamented on limited institutional and technical support. The findings also revealed the uneven cohesion between the EHRS service providers and the national health-care providers and how this affects health-care productivity.

Limited User-Training

According to the nurses, the initial training that they received in the early stages of the implementation process was inadequate. One of the nurses had this to say:

> Training was provided once and this is not nearly enough, in my opinion EHRS training is required after every three months to ensure that personnel has mastered the concept. Additionally, there is the issue of frequent updates which are also not very helpful for new users of the system. (Nurse #4)

The Doctors concerted to the concern on lack of training among the Health-Care Workers and how this limitation affects the quality of the work done by the health professional as follows:

> Training is important for this particular system because without the thorough knowledge of the system, it will be difficult to get the most out of the system. The challenge however is there is not enough training provided for users in the institution. This creates an inherent inefficiency in the institution which betrays the objectives of quality and efficient service provision by the health institution. (Doctor #3)

Some of the Doctors also weighed in on the lack of cohesion between the institution and the providers of the system:

> There is definitely inadequate support from the system developers, for instance the system has regular updates which are automatic with no prior warning. This is counterproductive because we often must wait for long hours while updates are taking place, and when the updates are done we must spend more time trying to figure out the new updates mean. Sometimes the updates change the positions of files and this often leads to queues and delays. (Doctor #1)

The findings underscore the repercussions of limited user-training on the mastery of the operation of the system. In addition, the dynamic nature of technology requires regular refresher trainings that update the user on the trends in EHRS, lack of which defeats the sole purpose of using the system. It also appeared that there were system random updates that the users were not aware of and the devastating effects that those updates had on the overall staff productivity as well as the filing system in general.

In summary, the findings highlighted a positive perception of EHRS in terms of accessibility, reliability, and the time saved in searching for the patients' information.

5 Discussions

The research questions that the study sought to address are recited as follows: (a) what are the perceptions of Health-Care Workers on the use of Electronic Health Record System in health facilities within the Manzini region in Eswatini? (b) What support is given to the Health-Care Workers to effectively use the electronic data management system?

5.1 What Are the Perceptions of Health-Care Workers on the Use of EHRS in Health Facilities Within the Manzini Region in Eswatini?

Perceived Usefulness

Earlier in this chapter, the literature observed that the traditional print filling system posed a danger of losing and/or misplacing patients' data, a notion which was affirmed by Nurse #2: "*In the past a patient could even be turned back because the record is missing*." The missing records perpetuated Eswatini health care to migrate from the print filing system as stated by [7]. The author highlights the infrastructure limitations such as limited storage capacity, unbalanced and missing records as some of the threats that propelled the paradigm shift.

The current findings evidenced the effectiveness of EHRS in record keeping while also minimizing the time taken to search for physical copies of the patients'

records; hence maximum consultation time. The findings were congruent with [13], who explored the impact of the electronic health record on an academic pediatric primary care center. Their study reveals efficiency and improvement in service delivery when EHRS is used which also concurs with the findings of [14].

Perceived Ease of Use

It was the perception of the institution administrators that the EHRS was more frequently used by the younger health-care workers who have adequate computer knowledge. Such findings may be linked to the findings of [5], who asserted that in order to be able to work with EHRS, users must be capable of using information technology such as computers and have adequate typing skills.

Computer illiteracy, resistance to change as well as anxiety that came with the e-recording system were among the factors that perpetuated the dual system (print and electronic recording). For instance, the options that were provided by the dual system further reinforced the negativity around EHRS and sticking with the tried and tested hard-copy filing system. These findings affirm the observations by [8], who argued that user acceptance of health systems plays a major role in the adoption of such clinical systems.

There were also some loopholes discovered in the system, which also affect the effectives of both the Health-Care Workers and the EHRS. One such loophole is that by default, the system does not allow editing of the data entries. This technical limitation opens door for incorrect data capturing. At the same time, there were no scheduled times for system updates which resulted in random system updates which slows down both the data entry and the effectiveness of EHRS "…*This is counter-productive because we often must wait for long hours while updates are taking place…*" (Doctor #1). The Doctor further laments on the distortions that come with the updates: "…*Sometimes the updates change the positions of files and this often leads to queues and delays…*" On the other hand, the findings further revealed incompatibility of EHRS with the needs of Eswatini health-care provision: "*The system is* ***not tailor made for our needs*** *so you find that it has a lot of features we do not need (Administrator #2).* Such interferences play a significant role in the adoption of EHRS as affirmed by [10], who discovered that Health-Care Workers would not use any product such as EHRS if it interferes with the workflow, changes how they care for their patients, or even creates limitations on their routine practice.

5.2 What Support Is Given to the Health-Care Workers to Effectively Use the Electronic Data Management System?

The findings also highlighted inadequate initial and subsequent training that prepares staff for a smooth sailing into the new system. The training of Health-Care Wokers in the two focal facilities was found inadequate to meet the needs of

Health-Care Workers which limited the Health-Care Workers' effectiveness in using the EHRS. In line with these findings, [10] found tremendous logistical challenges in virtual training of all hospital staff and many community clinicians on the use of the EHRS.

Furthermore, it was found that the institution offered little local support to meet the needs of users of EHRS. On the issue of staff training, the institution relied on centralized trainings that were offered by the Ministry of Health for which they had to submit their request and await the Ministry's response. This is quite a sharp departure from [11], who argued that organizations need to provide facilitating conditions, which include the extent and type of support provided to individuals that would influence their use of innovation.

The unanimous cry over inadequate training and how it affected staff's effectiveness in implementing EHRS resonated the findings of [12], that the adoption of electronic health records by physicians is slow despite the perceived benefits of their use. The top barriers that physicians list are the training methodologies used and the post-training support and mentorship provided to them after the rollout of the system in their facilities.

6 Presentation of the Framework

The chapter is grounded on two theories: Technology Acceptance Model and ADKAR model of change of 2006. However, this section dwells more on TAM, interrogating how the Health-Care Workers from the health-care facilities of Eswatini perceive the EHRS through TAM.

Perception is subjective in nature which means individual users' perception is a crucial determinant on whether or not the new technology will add value toward achievement of their individual goals. Coupled with this will be their subjective perception of accessibility or simplicity of the new technology to use.

Figure 2 presents a visual representation of TAM, developed by Fred Davis in the 1980s which describes the factors that influence users to accept new technologies. In this model, user acceptance is based on two main elements of perceived usefulness (PU) and perceived ease of use (PEOU). Perceived usefulness has to do with the level at which users believe that is they adopted the new technology and how such technology will enhance their job performance. If users perceive a positive input that the technology will bring to their work, then the likelihood that they would adopt such technology becomes high. PEOU refers to the extent to which users believe that using the technology will be effortless and require minimal mental and physical effort. If a technology is perceived as easy to use, users are more likely to adopt it.

Literature identifies five factors that may affect the perception or intend whether or not to use technology. These are: (a) the subjective norm, (b) image, (c) job relevance, (d) output quality, and (e) result demonstrability. Figure 2 also presents the role that experience and voluntariness can play in the choice-making process.

[1] alludes to the importance of perception especially in research studies that concern nurses and the potential of such to conflict with any new information. In this study, the views of the Health-Care Workers which included nurses portrayed the usefulness of TAM in terms of data capturing and storage. The findings further revealed how EHRS has improved the quality of health provision. Patients were given adequate consultation time while also spending lesser time in the line. While in the past, patients' data would go amiss, the usefulness of EHRS was seen in the updated records that were easily accessible through individual passcodes. This meant that patients did not have to narrate their medical history each time they consulted a physician. Similarly, physicians were also able to remotely access previously prescribed treatment by the click of a computer mouse.

Nonetheless, the perceived ease of use was not celebrated much. This was mainly because of the limitations in technology skills. Most of the older professionals did not have the required computer literacy to efficiently access and maneuver EHRS as it were with the younger ones. As a result, the older professionals resorted and held on to the traditional paper-based health records. As a result, there were some patients' data would not be captured in the system. The implication here is that computer literacy has a significant role in determining the level of motivation to adopt and use the new technology.

In summary, Technology Acceptance Model (TAM) posits that user acceptance of a technology depends on their perception of its usefulness and ease of use, which in turn influence the users' attitude toward using the technology, affecting their decision or intention to use the technology.

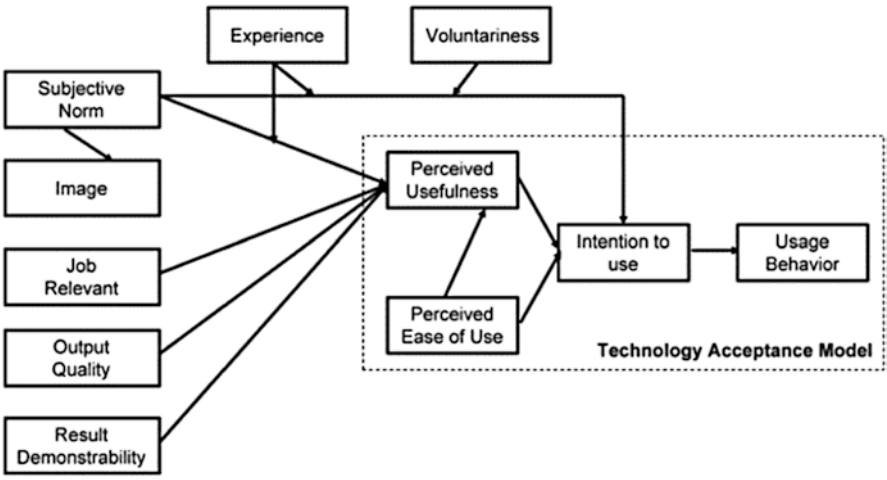

Fig. 2 Technology acceptance model. (Source: https://www.smartinsights.com/wp-content/uploads/2020/11/Venkatest-Bala-TAM-700x382.png)

7 Conclusion and Recommendations

The study concludes that, Health-Care Workers' positive perception on the use of EHRS in their institutions added value to storage and retrieval of patients' health data. Nonetheless, limited computer literacy and institutional support could adversely affect a smooth implementation of the EHRS. Therefore, the chapter makes the following recommendations.

1. Regular and consistent training and development for the Health-Care Workers that is supported by regular mentoring. In their view, training would make Health-Care Workers competent to efficiently use the EHRS.
2. Thorough research and needs assessment to inform the design of new electronic systems in order to tailor such systems to the needs of the intended consumers.
3. Decentralization of technical support to enable prompt trouble shooting while on duty.
4. A need for additional computers that will serve as access points to accommodate efficient data capturing.
5. EHRS is a networked system that captures large volumes intended to be accessed under minimum disruptions. Therefore, the need to improve the capacity of the current bandwidth is recommended.

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Digital Preservation of Cultural Heritage in Uganda: Case of Bugisu Sub Region

Seth Soita, Emmanuel Eilu, and Joseph Mutemere

1 Introduction

Africa is globally rich in resources of cultural and natural value. The entirety of 'the people's cherished arts, customs, festivals, sacred or worship sites, norms, values, ideologies, dress and dress-patterns, traditional monuments and architectures, which are cherished and conserved for their historical, political, educational, recreational and religious significance among others' is known as cultural heritage [1]. Akullo [2] states that Traditional Knowledge, for example, in Africa has obtained force as a strategic asset for socio-economic development, and consequently, there is a need for efficient management. Digitization is considered as an instrument that can be utilized to give long-term conservation and global approach to Traditional Knowledge. In the 1980s, interest in application of digitization and image processing started to appear amongst cultural institutions [3].

Digitization of cultural heritage has taken a popular turn in Uganda as elsewhere in the world as a means of conservation and preservation of cultural heritage for posterity. Uganda has a very strong cultural heritage. Many of its regions have kingdoms, including Buganda, Toro, Busoga, Bugisu, Teso and Bunyoro, among others. The Ugandan culture encompasses more than 50 African ethnic groups, as well as a small population of Europeans, Asians and Arabs [11]. Uganda's, digital preservation of cultural heritage is under the Ministry of Tourism, Trade and Industry under the sector of Tourism, Wildlife conservation and Museums. However, while digitization is viewed as a tool that can be used to provide long-term preservation and global access to indigenous knowledge, there have been serious challenges

S. Soita (✉) · E. Eilu · J. Mutemere
Uganda Christian University, Mukono, Uganda

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associated with digitizing cultural heritage material. Challenges such as limited knowledge on the importance of digitizing cultural heritage, lack of adequate skill in the use of information technologies, limited financial muscle to acquire the appropriate digitization tools and inadequate institutional digital preservation guidelines, policies and strategies have been reported. For example, a study conducted by Alinaitwe [12] on the existing relevant Information technologies available for adoption to safeguard Intangible Cultural Heritage by Cultural Institutions in western Uganda established that while 95% of the respondents recognized the role of information technology as Vital and crucial for preserving cultural heritage, only 29% had exposure to information technologies and about 58% lacked the relevant skills to use information technologies. Around 82% were challenged by limited financial resource envelopes allocated to information technologies. De la Porte and Higgs [13] state that the challenges observed during the digitization of cultural heritage in Western Cape presented that 76% of the respondents admitted there were limited technical skills and absence of training as a provocation. While 70% showed that limitation of knowledge presented an impact on the digitization of activities, 82% of the replies further spotted low numbers of personnel dedicated to digitization activities as a challenge. Lastly, 70% of the respondents showed lack of funding and 58% limited availability of skills. Inconsistent application of standards and the lack of institutional guidelines and policies were identified by 53% of the respondents. These examples give a picture on the challenges to digitization of cultural heritage material experienced in Africa. Magara [14] explains that in Uganda, there is hardly any system of recording, documenting and preserving indigenous information, let alone a mechanism for capturing indigenous knowledge to cope with dynamic world needs. This, therefore, has made it difficult to use ICT to provide long-term preservation and global access to indigenous knowledge in Africa and particularly in Uganda.

2 Problem Statement

Digitization of cultural heritage has taken a popular turn in Uganda as elsewhere in the world as a means of conservation and preservation of cultural heritage for posterity. However, whereas digitization of cultural heritage is viewed as a tool that can be used to provide long-term preservation and global access to indigenous knowledge, there have been serious challenges associated with digitizing cultural heritage material. Challenges such as limited knowledge on the importance of digitizing cultural heritage, lack of adequate skill in the use of information technologies, limited financial muscle to acquire the appropriate digitization tools and inadequate institutional digital preservation guidelines, policies and strategies have been reported. This, therefore, has made it difficult to use digital technologies to provide long-term preservation and global access to indigenous knowledge in Uganda.

Fig. 1 Three-legged stool for digital preservation

2.1 Theoretical Model: Three-Legged Stool

This entire study was guided by the Anne Kenney and Nancy McGovern model [24] for the Digital Preservation Management Workshops in 2003–2006; this stool represents the three aspects of a successful and sustainable digital preservation programme:

1. Organization
2. Resources
3. Technology

What the model demonstrates is that without considering and maintaining each of these components (or "legs"), a digital preservation programme will ultimately collapse. These three components need to be considered together in order to sustain digital preservation activity. This study focused on studying the three legs of the model and how they influence digital preservation (Fig. 1).

3 This Chapter

This chapter, therefore, assesses the underlying challenges of cultural heritage preservation in Uganda and establishes ways for using digital technology to provide long-term preservation and global access to cultural heritage in Uganda.

4 Research Questions

1. *What are the underlying challenges of preserving cultural heritage in Uganda?*
2. *What factors are necessary for successful adoption of digital technology to provide long-term preservation to cultural heritage?*

5 Methodology

Research Question One: *What are the underlying challenges of preserving cultural heritage in Uganda?*

In order to answer research question one, this study considered the Bugisu region in Eastern Uganda as a case study. This region has one of the richest cultural heritages in Uganda. TheBugisu sub-region is a region in Eastern Uganda consists of the following districts: Bududa District, Bulambuli District, Manafwa District, Mbale District, Namisindwa District and Sironko District. The sub-region is home mainly to the Gisu people, also called Bagisu. The Bagisu speak Lugisu, a dialect of Lumasaba, a Bantu language. Lugisu is very similar to the Bukusu language, spoken by the Bukusu people of Kenya. According to the 2002 national census, the Bugisu sub-region was home to an estimated 1 million people at that time. Random sampling was used to select three districts for the study, namely Manafwa District, Mbale District and Bududa District. Three districts were considered representative. Then purposive sampling was used to identify and select clans that had old cultural artifacts that needed urgent preservation. The clans that were selected include: Baata-BaweeleManyi Clan, BasongolaBasano Clan and Banametsi clan.

5.1 Cultural Heritage Under Study: Clan Records

Clan records were selected as the major cultural heritage for study. Clan records were selected because they were readily available and easily accessible compared to other cultural heritage, such as the Bagisu ‘‘Imbalu’ dance, historical pottery, tools and clothing. Interviews were conducted with the respective clan leaders of the different clans that were identified, and observation was used to observe different cultural heritage and record books. The study used content analysis to determine the presence of certain words, themes, or concepts from the field data.

Research Question Two: *What factors are necessary for successful adoption of digital technology to provide long-term preservation of cultural heritage in Uganda?*

5.2 Systematic Review

This study opted to use systematic review to answer question two of this study because of the following reason. Access to digital preservation experts in the region to provide information on ways in which digital preservation of cultural heritage can be made a success was futile. Questionnaires were e-mailed to digital preservation experts outside of the region; however, no feedback was received. Systematic review was, therefore, considered the best method in the absence of digital preservation experts.

Systematic review is a laborious method used to plot out secondary data and lets the evidence emerge automatically [4]. It aims at identifying, evaluating and summarizing the already published findings of all relevant individual studies, thereby making the available evidence more accessible to the researcher. The strength of systematic review method lies in evidence to establish what works and how it works [5]. The systematic review method has been extensively used in medical research and the natural sciences. It is commonly used by international agencies such as the Australian Agency for International Development (AusAID), the UK's Department for International Development (DFID) and many others directly or indirectly by individuals or organizations contracted to do research on their behalf with the sole aim of finding what works and how it worked in generating development outcomes [5].

The purpose of the systematic review carried out in this article was to review the factors necessary for successful adoption of digital technology to provide long-term preservation to cultural heritage presented by different studies. The systematic review method statistically combined data from a series of well-conducted primary studies and therefore provided a better and bigger picture on the factors necessary for successful adoption of digital technology to provide long-term preservation and global access to cultural heritage. The systematic review followed a four-stage systematic review process, namely;

- Framing questions for a review.
- Data collection—an unbiased literature search.
- Data evaluation—assessing the studies for inclusion in the review.
- Data analysis—determining the heterogeneity of data.

5.2.1 Framing Questions for a Review

The problems to be addressed by the review should be specified in the form of clear, unambiguous and structured questions before beginning the review work. Research question two particularly guided the systematic review process as stated earlier (*What factors are necessary for successful adoption of digital technology to provide long-term preservation to cultural heritage in Uganda*):

5.2.2 Data Collection

An extensive and unbiased literature search was conducted on the *factors necessary for successful adoption of* digital technology *to provide long-term preservation to cultural heritage*. Keywords were identified from the research questions. The keywords that were identified and searched included success factors digital preservation, cultural heritage, indigenous knowledge and cultural records. The review covered reports, journals, conference proceedings, books and websites. Google Scholar was of much help for this review. The selection of papers was based on how each paper comprehensively addressed the research questions, particularly the

keywords. From the review, About 46 journal/conference/book chapters/articles/thesis on keywords were reviewed. From the review of 46 studies, 22 studies were found to have addressed some aspects of the keywords. A more refined evaluation was made on the 22 studies, and the review found that only eight publications comprehensively covered the keywords and 14 did not extensively address the keywords and they were excluded. Therefore, the eight studies were used in this chapter to derive general factors for successful adoption of digital technology to provide long-term preservation to cultural heritage.

There are a number of arguments concerning the number of studies appropriate for a systematic review. Slavin [6] observes that large sample studies are desirable for external validity, especially if the design features are optimal, though large studies do not necessarily guarantee internal or external validity. Nevertheless, a number of researchers also agree that studies with small sample sizes tend to have much larger, positive effects than larger sample sizes [7]. A number of scholars have set a sample size criterion for a systematic review that provides strong evidence of effectiveness, and moderate evidence of effectiveness. Both require at least two studies with sample sizes of 250 [6]. This, therefore, means that the eight studies reviewed in this paper is adequate in providing a strong evidence of adoption of digital technology to provide long-term preservation to cultural heritage.

5.2.3 Data Evaluation

Selected papers for a systematic review must be subjected to a more refined quality assessment procedure. This can be done through general critical appraisal guides and design-based quality checklists. This chapter uses a simple data extraction table to organize the information extracted from each of the eight reviews that provided comprehensive literature on the keywords of the search (e.g. authors, country, publication year, study design/number of participants, the technology used and the outcomes of these study). Data evaluation was then followed by data analysis.

5.2.4 Data Analysis/A Meta-Analysis

An exploration for heterogeneity was conducted to determine whether there were major differences between studies in terms of *factors necessary for successful adoption of* digital technology to provide long-term preservation to indigenous knowledge. This was achieved by summarizing the different factors using tables and a graph; however, the findings were also summarized narratively.

6 Presentation and Discussion of Results

In this section, the presentation of findings and the discussions are done concurrently.

Table 1 Clans

Districts	Name of clan	No. of respondents
Manafwa	Baata-BaweeleManyi	2
Mbale	BasongolaBasano	1
Bududa	Banametsi	1

6.1 Clans Studied (Table 1)

Baata-BaweeleManyi is a Bamasaba-speaking clan that originally came from Manafwa district, which was formally South Mbale. It spread to different locations, including Bulambuli district, Tororo and outside Uganda, that is Kimiliyi in Kenya. The Baata-Baweele are estimated to be an approximate number of 2500. And this number is the total of those in Bulambuli, Tororo, Kenya and Manafwa. This clan belongs to Babuya because they originate from the South.

Basongola Basano is a clan neighbouring Mount Wanale to the East of Mbale district. They belong to Wanale because they are in the centre of Bugisu land. They currently live in Busano Sub County, located in Mbale district, with an approximate number of 4200 people, with the biggest population involved in agriculture.

Banametsi neighbour the Baata-Baweele Manyi and are, therefore, referred to as the Babuya. They are presently located in Bududa district, mostly covering the hilly areas of the district. This clan is approximated to have five thousand clan members scattered in the different parts of Bududa district.

During the study, a number of historical clan records were presented by the different clan leaders, some dating back to 1975. These included records that contained land conflict meetings, land division meetings, marriage meetings and many others (Fig. 2).

7 Importance of Clan Records

One of the questions that was asked during the interview session with the clan leaders was: *What is the relevance of clan records to the society?*

7.1 Distinctive Parts of Identity

The clan records have special features that make them easily recognizable and different from other clans. This is true in that, a number of them are written purely in Lumasaba which makes them very different from other clans. Banametsi clansman said, ‘these records are of importance because they uniquely distinguish us from

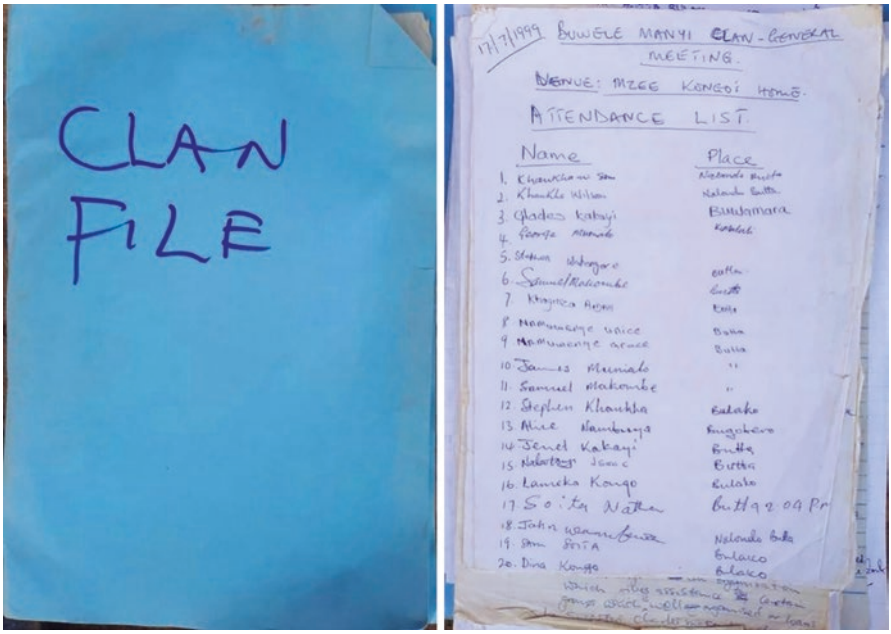


Fig. 2 Some of the clan files

other clans and in the whole world, there are no other cultures with writings and pronunciations like in Lumasaba worldwide'.

Giesecke [8] observes that the difference in clan records defines the end of the system creating identity through shared language and the language itself providing an opportunity to create a particular identity in the system which clearly denies borders.

7.2 Learning Purposes

These clan records are kept for the future generations to help aid them learn what transpired during the initial stages of their great-grandparents and parents. This helps learners to be prepared for the future and reach their fullest potential as life-long learners. One of the clan leaders during the interview stated, 'Am very sure at a certain point in time, there will be a moment when these clan records are a necessity in schools for the students to know what happened those long times ago'.

According to OECD [9], enhancing learning is recognized widely as an important and key route to improving the outcomes of a student and therefore contributing to the country's economic competitiveness.

7.3 Preservation of Our Roots/Identity

Clan records make our roots or origin remain in place. Even when our forefathers pass on, when records are written and are in place, they will show and sketch back where the clan originated from. "*When I pass on, am very sure when it comes tracing back when we came to existence, there will be no hassle as it will have been recorded already*". Preservation is core to protecting identity in the conservation of the past for the future generations to come [10].

7.4 Future Reference

It's an important item that can be used in future to refer to something that had happened many years ago. When these records are in place, there will be speaking with authority without guess work. "*you can refer your children to the clan records that we had and they may learn what sort of discipline we used, how long our clan meetings took place, the order of writing minutes and so on and so forth*". It is known by a variety of societies that lack written records do the preservation of their traditions and cultural heritage in forms of folklore, myths and oral histories handed down from generation to generation in sorts of epics and legends. Therefore, a careful refining of these legends and folklore will provide very important evidence about the people in the past.

8 Challenges Faced in Preserving Clan Records

The different clan leaders were also asked to explain how challenging it is to preserve these clan records.

8.1 Storage Challenges

8.1.1 Books Being Eaten by Rats

Clan record books are being destroyed by rats that hover around the houses looking for food. These rats find their way inside the house with the motive of finding food items but instead land on very important documents we have kept and hence destroy them through different punches in them and hence disorganizing the whole record process. One of the clan leaders cited, 'As an assistant chairperson to the BaataBaweeleManyi clan, I have for sure evidenced this habit happen exactly in my house and hence lost very paramount information'.

8.1.2 Lack of Storage Space

A specific place where only records can be placed without interference from any persons. They are kept but exposed to where everyone can access, hence rendering these very important records at risk. Actually, we haven't put this into consideration as a clan. 'As a clan leader of BaataBaweele, many of our clan records are exposed to public with no one attending to them as the administrator'. The biographical data, clan records, unpublished records and other documents that relate to the work of individual projects, institutions, field schools and organizations in private and public sectors are being preserved for materials that document the intellectual history of archaeology. Different scholars involved in research on the history of archaeology have for a long time been aware of the conditions in which these records are found and stored. These records are found in individual and institutional possession being degraded and become scattered because of lack of proper storage facilities that come from the individuals who are not sure of what to do with the records and paper [37].

8.1.3 Fire Outbreaks

Fire outbreak is yet another challenge that has affected the preservation of cultural records. This has been possible through young children who accidentally play around with matchboxes by testing one match stick on the carelessly placed records and hence all being lost, including property worth large amounts of money. 'We once experienced this scenario as a family where the fire caught our very important records we had placed in a corner of the house. They were burnt to ashes'. The fire is becoming a nearly annual occurrence in several regions globally as fires keep on occurring due to high temperatures and shifting precipitation. These fires are caused by careless handling by different stakeholders, and accidentally, documents are destroyed [38].

8.1.4 Lack of Community/Ngos/Traditional Support

Due to lack of proper establishment as clans in the Bugisu sub-region, there has been no hand by the government of Uganda, other Ngos and the community at large. These clans are only known by the clansmen and the members of the clans alone but not known by the government as a governing body of the country. So without this in place, it poses a great challenge to the clan records because their involvement would add great value to the way records would be preserved.

'We as a clan of Baata BaweeleManyi haven't taken any initiative to involve the government/NGOs/community in the preservation of clan records. This has greatly pulled us back because involvement of partners would have moved us to a great step ahead'.

Governments no longer provide the vision and the strategy to incorporate sustainability in public policy, and yet governments and NGOs would need to develop strategies for transitioning to an economy which is based on sustainable principles. Bell [16], in addition, states that the government needs to play a strategic role in advanced innovation of all sectors of the society since the advancement of sustainability will call for changes and hence a strong call for technological and policy innovations.

9 Factors for Successful Adoption of Digital Technology to Provide Long-Term Preservation of Cultural Heritage in Uganda

Using the systematic review method, the factors necessary for successful adoption of digital technology to provide long-term preservation of cultural heritage in Uganda were identified. These factors were identified through a systematic review of different models and frameworks for digital preservation of records. A combination of models and frameworks was reviewed to give grounded coherence to the study and to understand the factors that constitute a framework for the preservation of digital records.

9.1 Model and Frameworks for Digital Preservation of Records

The digital preservation framework formalizes digital resources and associated information used to effectively manage these kinds of resources and more so digital content that resides uniquely under libraries stewardship. Here the preservation resources may include actions necessary for preservation, ensuring authenticity and mitigating the effects of technology. Leijonhufvud [17] observes that models are partial representations of theories and do cover aspects of theories. In addition, models convey a mental image of a phenomenon or a real world and often lead to formulation of theories [18]. Below are eight theories studied and presented in the various tables.

9.1.1 Study One: Davies [19]

The PSR troika model was forwarded to assist in the understanding of strategy development for the running of organizations. The model comprises three major aspects, which are Policy, Strategy and Resources (PSR), as illustrated in Table 2

Table 2 Success factors [19]

Success factors
Policy related
Resource related
Management related

Table 3 Success factors [20]

Success factors
Management-related activities
Policies
Resources
Technology-related activities
Content Mamagement

below. These three elements of the PSR troika model are reviewed in this study as they are considered as enabling factors for successful implementation of digital preservation of cultural records in the Bugisu sub-region.

9.1.2 Study Two: Corrado and Moulaison [20]

Preservation triad was developed by Corrado and Moulaison [20]. This model looks at a variety of needs by several communities. This model (Triad), therefore, focuses on technology, polices, resource management and content management ways, therefore providing enabling factors for successful implementation of digital preservation of cultural records in the Bugisu sub-region, as illustrated in Table 3 below.

9.1.3 Study Three: Carnegie Mellon University [35]

The Digital preservation capability maturity (DPCM) model was developed by Carnegie Mellon University in 1999. This model is based on the functional specifications of ISO 14721, the auditing criteria of TRAC and ISO16363. The objective of the model is to provide a process and performance framework (benchmark) against best practice standards and foundational principles of records management, information governance and archival science. This model identifies seven essential elements, as illustrated in Table 4 below. All these elements listed below were essential for understanding ways of enabling digital preservation of cultural records in the Bugisu region.

Table 4 Shows success factors [35]

Success factors
Strategies
Governance
Policies
Collaboration
Designated communities
Technical expertise
Digital preservation services

Table 5 Shows success factors [21]

Success factors
Policies and procedures
Collaboration and partnership
Human resources
Funding
Education and training
Technological infrastructure
Strategies metadata systems
Technical expertise
Copyrights and intellectual property rights
Trustworthy repositories

9.1.4 Study Four: Masenya [21]

Masenya [21], in the study titled 'A Framework for Preservation of Digital Resources in Academic Libraries in South Africa" examined the implementation of digital preservation practices in academic libraries in South Africa in the light of the rapidly changing information environment and came up with 10 digital preservation practices that were very useful for enabling digital preservation of cultural records in Bugisu region, as illustration below in Table 5.

9.1.5 Study Five: Boamah [22]

Boamah [22] studies show the effective management and preservation of digital cultural heritage resources Boamah 2014: an exploration of contextual factors in Ghana and came up with eight factors for effective management and preservation of digital cultural heritage resources, as illustrated in Table 6. The elements listed below played an important role in understanding enabling factors for digital preservation of cultural records in Bugisu region.

9.1.6 Study Six: Eschenfelder et al. [15]

Eschenfelder et al. [15] presented a nine-dimensional framework for digital cultural heritage organizational sustainability, and the framework identified nine important factors for digital preservation practices that were useful for enabling digital preservation of cultural records in the Bugisu region, as shown in Table 7 below.

9.1.7 Study Seven: Council of Canadian Academies [23]

The Council of Canadian Academies [23] came up with enabling factors that help realize digital preservation of cultural heritage in Canada. These factors also provide useful insights and enablers for digital preservation of cultural records in the Bugisu region, as shown in Table 8 below.

Table 6 Shows success factors [22]

Success factors
National cultural heritage resources (physical content)
Stakeholders' attitudes
Policies and strategies
Infrastructure and other resources
Collaboration
Effective management and preservation of the content.
Digital content
National Digital Heritage Repository (memory)

Table 7 Shows success factors [15]

Success factors
Technology
Management
Relationships
Revenue
Cost
Valued product service
Disaster planning
Legal/policy
Metrics/assessment

Table 8 Shows success factors [23]

Success factors
Participatory
Collaborative opportunities
Business models
Infrastructure
Human resources
Funding

9.1.8 Study Eight: Kenney and McGovern [24]

Kenney and McGovern [24] developed what they termed a 'three-legged stool model' comprising three elements: organizational leg, technological leg and resources leg; they are interrelated and influence one another. It was used as a guide to understand the various elements contributing to the digital preservation framework in academic libraries. This model was helpful in understanding enablers for digital preservation of cultural records in the Bugisu region, as illustrated in Tables 9 and 10 below.

Table 11 below presents a summary of the success factors and their frequencies and percentage.

The outcomes, as indicated in Table 10 above, show the most frequent factors suggested by all the eight (8) studies marked (100%) as Technology infrastructure and Management Related. The second most frequent factor, as suggested by seven out of eight (87.5%), was Resource Allocation/Funding. The third most frequent factor was Proper Implementation of Strategies and Policies, as suggested by six out of eight (75%) studies. The fourth most frequent factors were business models and stakeholders, suggested by three out of eight (37.5%). The factors that only appeared once were content management; participatory; education and training; copyrights and intellectual property rights; valued product service; metrics/assessment; and collaborations & relationships (Fig. 3).

9.2 Factors for Successful Implementation of Digital Preservation of Cultural Records in the Bugisu Sub-region

The assumption here is that cultural records in the Bugisu region like, in any other regions of Uganda, are facing difficulty in preserving on both paper and electronically; therefore, there is a great need to understand the level of preserving such records for assured access for the generations to come. A few organizations are digitizing materials that are in danger of being lost in the future, such as old clan books, old photos, and other pieces of history. To ensure that there is permanent storage of these digitized resources, the study found it vital to investige the factors that lead to successful implementation of digital preservation of cultural records in the Bugisu

Table 9 Shows success factors [24]

Success factors
Organizational
Technological
Resources

Table 10 Factors: Frequency of citation across the eight studies

Factors	[19]	[20]	[35]	[21]	[22]	[15]	[23]	[24]
Proper implementation of strategies & policies	X	X	X	X	X	X		
Resource/Funding	X	X		X	X	X	X	X
Management Related	X	X	X	X	X	X	X	X
Technology Infrastructure	X	X	X	X	X	X	X	X
Copyrights & Intellectual Property Rights				X				
Stakeholders			X	X	X			
Business Models						X	X	X
Collaborations & Relationships						X		

Table 11 Factors: Frequency and percentage table across the eight studies

Factors	Frequency	Percentages
Technology Infrastructure	8	100
Management Related	8	100
Resource Allocation/Funding	7	87.5
Proper implementation of strategies & policies	6	75
Business Models	3	37.5
Stakeholders	3	37.5
Copyrights & Intellectual Property Rights	1	12.5
Collaborations& Relationships	1	12.5

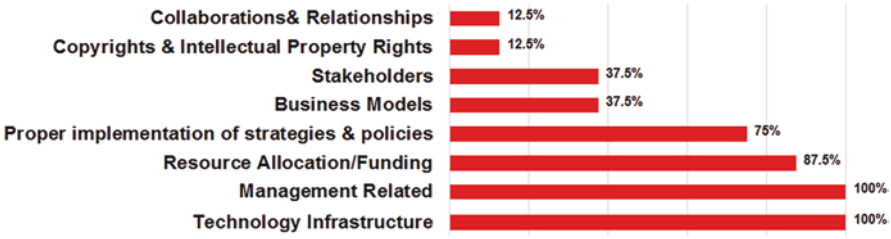


Fig. 3 Shows the percentage across the eight studies

sub-region. The systematic review here, therefore, presents very paramount factors for successful preservation of clan records in the Bugisu region using technology. These factors include Technology infrastructure, proper implementation of strategies &policies, Resource Allocation/Funding, organizational support, collaborations & relationships and Copyrights & Intellectual Property Rights [20, 21, 24].

9.3 Technology Infrastructure

According to Table 10 above, technology infrastructure was cited by all the eight authors, and this represented 100%. This means that it is one of the most important factors that is needed for digital preservation of cultural records in Bugisu. There are a number of technologies that were identified during the review which included digital repositories, metadata systems, technological, technical expertise, digital preservation services, technological infrastructure, technical expertise, infrastructure and other resources, digital content, National Digital Heritage Repository (Memory).

For these clan records to be well managed, there is a need for appropriate digital infrastructure. Digital infrastructure includes the ability to run it, define policies and standards for digitization, manage your staff, cost plan, train users and use the acquired skills to do a backup of digital content. Nevertheless, people with competence, appropriate skills and attitudes are not visibly available in various clans of Uganda to do the initiation, implementation and sustainability of digitized records/projects. African archivists do lack the necessary experience and are poorly equipped to train others in the electronic digitization and preservation of clan records [25]. Furthermore, a number of clansmen are totally not comfortable with this technology world in which they are living; they are, therefore, technophobic and struggle a lot to be stewards of digital information and print. For success to be registered in the digital preservation of clan records in the Bugisu region, there is a need to invest in the different kinds of technologies and capacity development.

9.4 Management/Government Support

Management support is yet another important factor towards digital preservation of cultural records in Bugisu. Table 10 above shows that 8 out of 8 (100%) authors cited management as an important factor. For one to fully sustain digital preservation initiatives, it's very vital to align these initiatives with the organizational goals and mission. There are a number of management-related factors that were identified by different authors during the review, which included adequate leadership, organizational support, procedures and appropriate strategies, good governance, managing content describing the same factor management. Currently, there is very little effort by the clans or Bugisu cultural union or even the government to preserve clan

artifacts for future generations. The clan management must acknowledge the importance and benefits of digital preservation of cultural records. Then clan management and other enthusiasts should convince the Bugisu cultural union and government to support the digitization of cultural artifacts including clan records for future generations. Corrado and Moulaison [20] state that the preservation team needs to convince the management and other decision-makers that digital preservation is important to the overall mission of the organization. There is a need to have a communication plan that clearly describes the various benefits of digital preservation to the management and other stakeholders of Bugisu clans. A number of clans in the Bugisu region haven't made digital preservation a priority and even funded projects may be unsuccessful if digital preservation is not a fundamental concern. Therefore, proper management-related factors need to be put in place to better the digital preservation processes of clan records in the Bugisu sub-region in Uganda, and these factors may include references to organizational support, procedures and appropriate strategies, good governance and managing content, among others.

9.5 Resource Allocation/Funding

Funding is very primary in the sustainability of digital preservation. As seen in Table 10 above, seven out of eight authors (87.5%) pointed out resources as a significant factor in digital preservation of clan records in the Bugisu region. Digital preservation projects and activities require considerable resources to implement and maintain over a long period of time [26]. To be successful, there needs to be commitment by various institutions to financially support the project [20]. Financial support is one of the key factors for any commitment to any project; it ensures sustainable preservation of digital resources. However, Masenya [21] observes that clans do not have the necessary funds readily available to develop and sustain their digital preservation programmes, making it a challenge to fund such initiatives. There is a need to secure adequate funding from the government or stakeholders for the successful preservation of clan records in Bugisu.

9.6 Proper Implementation of Strategies & Policies

For long-term access to digital preservation of clan records for future generations to benefit, there has to be heavy dependence on digital preservation strategies being in place which are labeled by relevant policies and procedures [27]. As Table 10 shows, 75% of the authors pointed out strategies and policies as a vital factor in digital preservation of records. During the study, it was discovered that there were no policies put in place to ensure long-term preservation of digital services, clan leadership cannot be said to be undertaking digital preservation. A number of clans in the Bugisu region do not have policies to control the execution of such activities. So a

clear and realistic preservation policy will help to achieve long-term access to digital content and reap future benefits of digital preservation.

There is a need for policies that can provide a framework and practical guidelines for the development of an institutional digital preservation procedure. This may include a digital preservation policy model with two phases, that is a policy level and implementation level and a Joint Information System Committee Digital Preservation Policies Study that designs a model for helping institutions develop appropriate digital preservation policies [28].

Therefore, digital preservation policies need to be designed to guide in the digital preservation processes of clan records in the Bugisu sub-region in Uganda and such policies should include references to copyright and metadata policies, digital resources, storage, security and collection disaster plans, among others.

9.7 Business Models

Table 10 above shows that three out of eight (37.5%) authors cited Business Models as an important factor. A well-designed business model is extremely important for generating alternative revenue for sustaining digital preservation of clan records projects in the Bugisu region. The success of preservation of digital records requires maintenance, proactive stewardship and continuity of service [23]. Heritage institutions like clans may provide informal support to do a preservation of digital assets and have digitization outputs, commitment to the progressing maintenance of the resources is always not exactly spelt out or even guaranteed, and therefore, alternative funding model is of paramount value. Different scholars argue that lack of ongoing endowment and the investment of capital in digital preservation is a reflection of a tradition of digital heritage projects that rely on commercial revenues models and project-based philanthropic funding.

9.8 Stakeholders

Freeman [29] defines stakeholders as managers and employees as internal stakeholders, and suppliers, society, government or clients as external stakeholders. While McCabe et al. [30] define a stakeholder as an individual or a group having legitimate interest in an organization or its activities. Table 10 above shows that three out of eight (37.5%) authors cited Stakeholders as an important factor. Stakeholder collaboration becomes an important aspect in digitizing clan records. McCabe et al. [30] distinguish between collaboration for planning and development processes and collaboration for marketing purposes. Raju [33] observes that stakeholders contribute to the achievement of the clan's objectives. Stakeholders are needed to manage and maximize a vision shared, representation, achievement of objectives good working relationship and communication. Stakeholders

conclusively contribute a lot towards the digital preservation of cultural records and therefore without them, there wouldn't be records that many scholars have researched about.

9.9 Collaborations & Relationships

There is a need for a well-maintained collaboration with many stakeholders with the mandate to preserve electronic records [31]. Table 10 above shows that 1 out of 8 (12.5%) authors cited Collaborations & Relationships as one of the most important factors for successful digital preservation of records. Ryan [32] observes that Uganda encounters several challenges when it comes to the collaboration of digital preservation projects and includes the complicated customs process, limited control over the environment and lack of accessing high-end equipment. This DPWG did propose a five-point plan for creating digital preservation partnerships: cultivate a foundation of knowledge and identify a shared vision; assess the current digital preservation landscape at each institution; advocate for the value of digital preservation activities; implement shared digital preservation services; and sustain group activities and establish structures for ongoing support [34]. In a nutshell, great collaborations and relationships are vital for a successful digital preservation of clan records initiative in the Bugisu region in Uganda.

9.10 Copyrights & Intellectual Property Rights

As Table 10 shows, only 12% of the authors pointed out Copyrights & Intellectual Property Rights as a vital factor in digital preservation of records. Well-stipulated copyrights and intellectual property rights will steer the process of digitizing cultural records and put it at a greater height, hence putting the preservation of clan records in the Bugisu sub-region in Uganda at a stance. Various institutions may fail to preserve these collective works because the identification of copyright owners, obtaining license agreements, locating them and keeping records of each agreement are unquestionably a resource-intensive process [23].

9.11 The Three-Legged Stool Model for Digital Preservation of Cultural

9.11.1 Heritage in Uganda

Having established the successful factors for implementing digital preservation of cultural records in Bugisu. This study used the three-legged stool model forwarded by Kenney and McGovern [24] to provide a taxonomy for classifying the different

factors for successful adoption of digital technology to provide long-term preservation to cultural heritage.

9.12 The Three-Legged Stool (Extended)

Created by Kenney and Nancy McGovern for the Digital Preservation Management Workshops in 2003–2006, this stool represents the three aspects of a successful and sustainable digital preservation programme:

1. Organization
2. Resources
3. Technology

What the model demonstrates is that without considering and maintaining each of these components (or 'legs'), a digital preservation programme will ultimately collapse. These three components need to be considered together in order to sustain digital preservation activity.

10 Organization

The organization or management leg of the stool looks at the elements required to address the organizational needs and practices of a digital preservation programme. This leg not only maps the parameters of a programme but helps drive the organizational change required for a successful digital preservation programme.

Given the eight factors identified through the systematic review process conducted in this chapter, the organizational or management components include:

- Management
- Proper implementation of strategies and policies
- Copyrights and intellectual property rights
- Business model

11 Resources

The resources leg looks at the time, money and people requirements of a digital preservation programme. These are the resources required to create and maintain a sustainable programme. The resources required include:

- Resource/Funding.

12 Technology

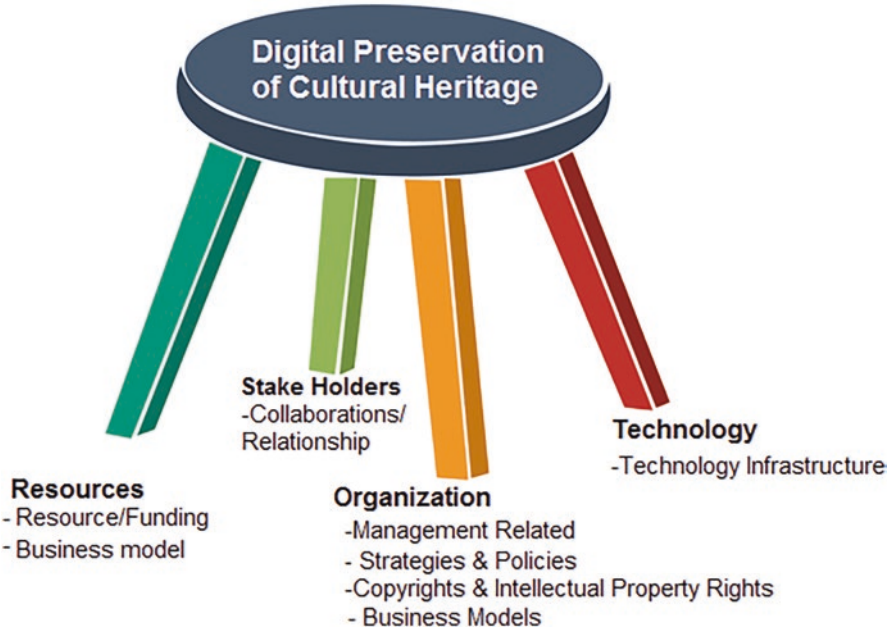
The technology leg represents the necessary hardware, software and secure environments required to sustain a digital preservation programme. The technology leg also acknowledges changing technology and is prepared to respond accordingly. The areas the technology leg covers in digital preservation include:

- Technology Infrastructure

13 Stake Holders

McCabe et al. [30] state that a stakeholder is an individual or group that has legitimate interest in the activities of the organization. Here there is a need to maximize a shared vision, the achievement of objectives, representation, good working relationships and communication. The stakeholder's leg is where collaborative partnerships of planning and development are established [30]. The various stakeholders include resource allocators, content creators, external collaborators, internal collaborators and the end users.

- Collaborations & Relationships



14 Model Summary

The organization leg ('the what'), the technological leg ('the how'), the resource leg ('the as is') and the stakeholders of digital preservation stool need to be coordinated to develop compliant and feasible digital preservation strategies. A number of clans make efforts to preserve their records by digitizing and implementing them but such efforts are being obstructed by limited human resource, lack of policies and planning, technological and financial resources on the side of the organizational with statutory responsibility of digital preservation. In a nutshell, for the sustainability of digital preservation of cultural records, there must be key factors to the three-legged stool model, which include organizational, technological, resource and stakeholder factors.

15 General Conclusion

This study investigated an investigation on digital preservation of cultural records in Uganda, especially in the Bugisu sub-region, with the intention to propose a framework necessary to the clans. There was a revelation of little growth of awareness of digital preservation of cultural records in the Bugisu region whereby the clan leaders had some ideas of making various efforts to make an implementation. There were some efforts to create digital preservation programmes, but challenges such as funding, technical expertise, copyright/ legal issues and management support, among others, hindered the progress of preservation of cultural records digitally [36].

These preservation methods were hindered by several challenges, such as lack of human resources, lack of funding, lack of technological knowledge by the clan leadership who have the responsibility of preservation and alleviation of these challenges.

Lack of knowledge about digitization of clan records was highlighted as a major issue and as this, clans were to put strategies in place such backups and risk management to keep the digital materials. Based on the findings above, Technology Infrastructure, Management/Government Support, Resource Allocation/Funding, Proper Implementation of Strategies & Policies, Business Models, Stakeholders, Collaborations & Relationships, Copyrights & Intellectual Property Rights are the factors that will enable smooth digital preservation of cultural records in the Bugisu region.

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Fostering Higher Education Engagement with the United Nations' Sustainable Development Goals: A Transformative Pedagogical Approach

Sneha Thombre, Harshad Wadkar, and Makarand Velankar

1 Introduction

Following the unveiling of the United Nations' Agenda 2030 in 2016, there has been a notable increase in worldwide recognition of sustainability, propelling it to a position of paramount global significance. For example, the study conducted by Smith et al. [1] highlighted how the UN's Sustainable Development Goals (SDGs) framework has become a central pillar in guiding global sustainability initiatives, prompting institutions worldwide to reevaluate their role in this transformative agenda and the goals are interlinked [2].

This heightened awareness has prompted a growing recognition of the imperative to incorporate sustainability into the core curricula of higher education institutions (HEI). Colleges are emerging as pivotal agents in the pursuit of the SDGs. The Sustainable Development Solutions Network (O'Riordan et al. SDSN [3]) underscores the indispensable role of colleges, asserting that the comprehensive attainment of the SDGs hinges significantly upon their contributions in education, research, innovation, and leadership. For example, the work of Brown et al. [4] offers empirical evidence of how colleges and universities have assumed a central role in advancing sustainability through curricular reforms and sustainability initiatives.

Colleges, as vital hubs of knowledge creation and dissemination, play a crucial role in molding societies with a strong sustainability ethos. They hold a mandate to foster growth through research and education, imparting contemporary knowledge to students while enhancing their competencies. This mandate goes beyond merely

S. Thombre (✉) · H. Wadkar · M. Velankar
MKSSS's Cummins College of Engineering for Women, Pune, India
e-mail: sneha.thombre@cumminscollege.in; harshad.wadkar@cumminscollege.in; makarand.velankar@cumminscollege.in

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transmitting knowledge; it entails equipping every individual with the values, qualifications, skills, and insights essential to nurture a sustainable society. Research by Johnson et al. [5] demonstrates the significant impact of sustainability education on students' values and attitudes, highlighting the transformative potential of higher education.

To fulfill this mandate, it is essential to adapt the curriculum to address both local and global challenges. It necessitates the adoption of teaching strategies that nurture collaborative decision-making; active participation in sustainable development initiatives at local, national, and international levels; and engagement in interdisciplinary thinking and integrated planning [6]. The case study conducted by García-Martínez et al. [7] exemplifies how pedagogical innovations that encourage interdisciplinary collaboration enhance students' capacity to address complex sustainability challenges effectively.

However, this transformation is not without its complexities. The landscape is replete with accreditation and rating organizations, each with distinct criteria for evaluating the success of colleges. As they evolve, so too must the institutions they assess. Both novice and experienced educators grapple with the uncertainties and challenges of continuous learning in this dynamic context García-Rico et al. [8]. Recent research by Philipsborn et al. [9] highlights the shifting landscape of higher education accreditation and the imperative for institutions to adapt their pedagogical approaches accordingly.

The advent of ICTs, especially in the aftermath of the pandemic (COVID-19), has revolutionized teaching and learning, profoundly altering the educational landscape Di-Marco et al. [10]. This study delves into the "Green Computing" course as a case study, where students actively engage with the UN's 17 SDGs and explore their intricate relationships with the environment, society, and the economy. Adopted unanimously by 193 nations in 2015, the SDGs serve as the focal point of our research. Within this investigation, we analyze the application of constructivist teaching techniques, particularly the utilization of whiteboard animations. These animations incorporate hand-drawn visuals accompanied by audio commentary to convey the essence and importance of the SDGs [11].

Additionally, we employ the K-W-L (Know-Want to Know-Learn) chart as an assessment tool to assess the efficiency of this pedagogical method. The findings of this research are promising, with students reporting significant benefits. Specifically, the integration of whiteboard animation videos has been found to heighten students' classroom engagement (83%), sustain their attention throughout lessons (89%), improve their knowledge retention (72%), and enhance the overall clarity of the course content (79%). Moreover, students offer valuable insights into optimizing the utilization of video clips, recommending shorter durations, alignment with course objectives, and controlled quantities as best practices. This study underscores the potential of ICT in knowledge dissemination and raising awareness among the newer generation about vital SDG-related matters. It serves as a testament to the effectiveness of a participatory pedagogical approach within the context of HEIs.

In summary, the thoughtful utilization of information and communication technology, as illustrated by whiteboard animations, presents itself as a viable tactic for instructing students in HEIs about the SDGs. This method aligns harmoniously with a participatory teaching approach, facilitating the smooth conveyance of information and the cultivation of greater awareness among the rising generation.

2 Literature Review

The Sustainable Development Goals (SDGs) represent a global initiative aimed at tackling urgent environmental, social, and economic challenges [12]. Educational institutions play a pivotal role in fostering awareness and comprehension of these goals. This literature review delves into the innovative use of whiteboard animations as a pedagogical tool for instructing engineering students about the SDGs. It aims to appraise the efficacy of this method through a thorough examination of existing research in the field.

1. *Utilization of whiteboard animations in education* Whiteboard animations, also recognized as explainer videos or doodle videos, have gained substantial recognition as an instructional tool across various educational contexts. These animations harness dynamic visuals, concise narration, and real-time drawings to effectively communicate intricate concepts. Research in this domain has yielded several noteworthy findings:

   (a) Enhanced engagement and comprehension: Whiteboard animations have demonstrated the capacity to elevate student engagement and deepen comprehension. Notably, Abeysekera and Dawson [13] revealed that students perceive whiteboard animations as more captivating compared to conventional lectures.
   (b) Improved knowledge retention: The amalgamation of visual and auditory elements in whiteboard animations contributes to heightened knowledge retention. Mayer and Moreno [14] emphasized the efficacy of multimedia presentations in augmenting learning outcomes.
   (c) Adaptability and flexibility: Whiteboard animations possess the advantage of flexibility in delivering information, catering to diverse learning preferences and styles. This adaptability aligns seamlessly with the principles of learner-centered pedagogy, as highlighted by So and Brush [15].

2. *Sustainable Development Goals in the context of education* present a comprehensive framework [16] designed to tackle global challenges such as poverty, climate change, and inequality. Their integration into education is paramount for nurturing a generation of conscientious global citizens. Extensive literature has revealed the following noteworthy insights:

   (a) Curriculum integration: Educational institutions worldwide have made considerable strides in incorporating SDGs into their curricula. Alshannag et al.

[17] underscore the significance of aligning curricula with SDGs to promote sustainability education.
(b) Embracing an interdisciplinary approach: The adoption of an interdisciplinary approach is highly regarded when teaching SDGs. This approach empowers students to explore intricate global issues from diverse perspectives [18].
(c) Active learning approaches: Approaches such as project-based learning and problem-based learning have shown effectiveness in delivering content related to SDGs [19].

3. *Leveraging whiteboard animations for SDGs education*: The convergence of whiteboard animations and SDGs in education has emerged as a promising field of research. Several studies have delved into the potential of whiteboard animations in conveying SDG-related concepts:

   (a) Embracing a learner-centered approach: Whiteboard animations are aligned with learner-centered pedagogy, granting students autonomy over their SDG-related learning experiences [20].
   (b) Enhancing understanding: Research conducted by Nguyen and Tran [21] suggests that whiteboard animations can significantly enhance students' comprehension of complex sustainability concepts, rendering them a valuable tool for SDGs education.
   (c) Capitalizing on visual appeal: The visual allure of whiteboard animations facilitates the communication of the interconnectedness inherent in the SDGs, a characteristic underscored in the SDG framework itself [22].

4. *Engineering education's role in advancing SDGs engineering* education assumes a pivotal role in addressing the SDGs, as engineers are instrumental in crafting innovative solutions to sustainability challenges. Pertinent literature yields valuable insights in this regard:

   (a) Curriculum alignment: Engineering programs worldwide are integrating SDGs into their curricula, highlighting the central role of engineers in advancing sustainability [2].
   (b) Promoting project-based learning: The emphasis on project-based learning in engineering education aligns seamlessly with SDGs, providing students with the chance to apply their knowledge to real-world challenges [23].

The convergence of whiteboard animations, SDGs integration in education, and engineering pedagogy represents an encouraging path for cultivating sustainable development awareness and proficiencies among engineering students. Previous research highlights the capacity of whiteboard animations to amplify engagement, comprehension, and retention of knowledge related to SDGs. Nevertheless, there remains a compelling need for additional empirical investigations to delve into the enduring consequences and efficacy of this pedagogical approach.

Another pedagogical approach for learning about sustainable development goals (SDGs) is gamification. Gamification approach involves integrating elements of

game design and mechanics into the learning process to enhance engagement, motivation, and the overall learning experience. Gamification pedagogy has the potential to make learning about SDGs in higher technical education more engaging, enjoyable, and effective. It can help students grasp the significance of sustainable development and inspire them to take an active role in achieving SDGs in their future careers [24]. This is one of the future approaches. Further, the cybersecurity internship program demonstrates how practical experience can positively impact students' skill acquisition and comprehension of complex concepts. In the context of the abstract provided [25], the cybersecurity internship program demonstrates how practical experience can positively impact students' skill acquisition and comprehension of complex concepts. Similarly, internships focused on SDGs can immerse students in sustainability-related projects, fostering a deep understanding of the goals and encouraging them to actively engage in addressing global challenges. Overall, internships can be a powerful pedagogical approach to SDG learning in higher education. Therefore, internships and gamification can be experimented with to compare with whiteboard animations as a pedagogy technique.

This literature review highlights the importance of integrating whiteboard animations into engineering education to promote SDGs, acknowledging that such integration aligns with learner-centered, visually engaging, and interdisciplinary approaches to learning. It sets the stage for empirical research to assess the specific impact of whiteboard animations on engineering students' understanding of and engagement with SDGs, thereby contributing to the growing body of knowledge in this evolving field.

3 Methodology and Questionnaire Design

This section is divided into three parts: The first discusses the methodology used, the second part presents the design of the questionnaire required in this work, and the third is the sample size.

3.1 Methodology

The methodology adopted is as follows:

1. *Research focus*: This investigation seeks to explore the pedagogical strategies implemented in the "Green Computing" course, with a primary emphasis on facilitating the comprehension of Sustainable Development Goals (SDGs). The chosen pedagogical tools encompass whiteboard animations and the incorporation of K-W-L (Know-Wonder-Learn) charts for ongoing assessment.
2. *Context of the Green Computing course*: The "Green Computing" course addresses the expansive influence of information technology (IT) on everyday

life, professions, and the environment. The proliferation of IT has led to substantial energy consumption, strained electrical infrastructures, and increased emissions of greenhouse gases. Furthermore, the production and disposal of IT equipment presents notable environmental challenges. To comprehensively tackle these issues, a holistic approach is essential, encompassing four pivotal facets:

(a) *Green utilization*: Reducing the energy consumption of computers and data systems while ensuring environmentally responsible usage.
(b) *Green disposal*: Promoting the reuse and recycling of outdated computers and electronic devices.
(c) *Green design*: Crafting efficient and eco-friendly components, computers, servers, and cooling systems.
(d) *Green manufacturing*: Developing electronic components and computer systems with minimal or no adverse environmental impact.

The course's overarching goal is to instill environmental sustainability within the realm of IT, rendering it ecologically sound throughout its entire life cycle.

3. *Pedagogical approach—whiteboard animations*: The class commences by introducing SDGs through the medium of whiteboard animations. Whiteboard animation is a visual communication method simulating the process of manually illustrating information on a whiteboard or similar surface. This approach is chosen for its efficacy in simplifying intricate information and fostering student engagement. Several notable advantages associated with whiteboard animations encompass:

(a) Enhanced retention: Research conducted by Dr. Richard Wiseman suggests that whiteboard animations are 15% more effective in retaining information compared to conventional videos.
(b) Versatility: Whiteboard animations find applicability across diverse subjects, including educational content.
(c) Ease of creation: They are user-friendly and can be produced without necessitating specialized skills or expensive equipment.
(d) Engagement: Whiteboard animations sustain interest through the integration of music, motion, and visuals, rendering the comprehension of complex concepts an enjoyable experience.

4. *Learning SDGs via whiteboard animations*: The whiteboard animations are meticulously crafted to introduce and elucidate the 17 SDGs. These animations place a strong emphasis on highlighting the interconnections among these goals, employing the metaphor of the "SDG wedding cake" to illustrate the intricate relationships among environmental, societal, and economic objectives. The animation content is inspired by the work of sustainability enthusiast Alex, as showcased on the "Sustainability Illustrated" YouTube channel.

5. *Assessment: K-W-L charts*: For evaluating students' learning journeys and achievements, the K-W-L (Know-Wonder-Learn) chart methodology is deployed as a formative assessment tool. This method comprises three key stages:

   (a) Knowledge (K) stage: Initially, students document their existing knowledge regarding SDGs and sustainability in the realm of IT.
   (b) Wonder (W) stage: As the course unfolds, students record questions and areas of curiosity that arise during their engagement with whiteboard animations and course materials.
   (c) Learning (L) stage: Upon the culmination of the activity, students revisit their K-W-L charts, summarizing the knowledge they have acquired concerning SDGs and sustainability in IT.

   The implementation of K-W-L charts facilitates self-assessment and reflection, enabling instructors to tailor teaching methodologies in alignment with students' prior knowledge.
6. *Data collection*: Data will be collected through:

   (a) Analysis of K-W-L charts: Completed K-W-L charts will be analyzed to assess changes in students' knowledge and learning experiences.
   (b) Student feedback: Surveys and open-ended questions will be used to gather qualitative feedback on students' experiences with whiteboard animations and the course overall.

   This methodology combines the use of whiteboard animations and K-W-L charts to facilitate the learning of SDGs in the "Green Computing" course. By incorporating multimedia learning and reflective assessment, this approach aims to enhance students' understanding of sustainability concepts within the field of information technology.

3.2 Designing Questionnaires

Design of questionnaire/survey forms:

Following are the pre- and posttest questions specifically tailored to assessing the learning of Sustainable Development Goals (SDGs) through whiteboard animations: Table 1 presents labeling (Option) scheme; Table 2 shows pretest questions; Table 3, pretest questions, open-ended questions; Table 4, posttest questions; Table 5, open-ended questions; whereas Tables 6 and 7 are feedback questionnaires.

Table 1 Labeling (option) scheme

1	2	3	4	5
Very poor	Poor	Fair	Good	Excellent

Table 2 Pretest questions

No.	Questions	Option				
		1	2	3	4	5
1.	How familiar are you with the United Nations' Sustainable Development Goals (SDGs) before viewing the whiteboard animations?					
2.	What is your current level of understanding of the significance and impact of the SDGs on global sustainability?					

Table 3 Pretest question, open-ended question

No.	Question
1.	Can you name any of the specific SDGs? Please list any that you are aware of.

Table 4 Posttest questions

No.	Questions	Option				
		1	2	3	4	5
1.	How has your familiarity with the United Nations' Sustainable Development Goals (SDGs) changed after viewing the whiteboard animations?					
2.	How would you rate your current understanding of the significance and impact of the SDGs on global sustainability after viewing the whiteboard animations?					
3.	Were the whiteboard animations effective in helping you comprehend the individual SDGs and their interconnectedness?					
4.	Were the whiteboard animations effective in helping you comprehend the individual SDGs and their interconnectedness?					
5.	Do you feel more motivated or inspired to actively engage with sustainability-related initiatives and discussions after interacting with the whiteboard animations? Why or why not?					
6.	How likely are you to recommend using whiteboard animations as a tool for learning about the SDGs to your peers?					

Table 5 Open-ended questions

No.	Questions
1.	Please list the SDGs that you can now name or explain after interacting with the whiteboard animations
2.	Can you describe any specific insights or new perspectives you gained regarding the SDGs from the whiteboard animations?

Table 6 Feedback questionnaire

No.	Questions	Option				
		1	2	3	4	5
1.	How engaged were you while watching the whiteboard animations?					
2.	How clear and understandable was the information presented in the whiteboard animations?					
3.	Overall, how effective do you think the whiteboard animations were in helping you learn about the Sustainable Development Goals (SDGs)?					

Table 7 Feedback open-ended questions

No.	Questions
1.	Did the whiteboard animations maintain your interest throughout the lessons? Please explain
2.	Were the key concepts and messages effectively communicated in the whiteboard animations? Please provide examples or suggestions for improvement
3.	Did the whiteboard animations enhance your understanding of the SDGs and their importance? Please elaborate

Survey on Whiteboard Animations in Learning SDGs
Please rate your experiences with whiteboard animations in this course.

Open-Ended Feedback Questions
1. What aspects of the whiteboard animations did you find most beneficial or engaging in your learning experience?
2. Did you encounter any difficulties or identify areas where you think the whiteboard animations could benefit from enhancements?
3. Do you have any suggestions for enhancing the integration of whiteboard animations into the course content?
4. Please share any additional comments or feedback regarding your experience with whiteboard animations in this course.

Demographic Information (Optional)
1. Have you previously encountered whiteboard animations as a learning tool in other courses?

3.3 Sample Size

The study involved had a total sample size of 120 participants, divided into two groups of 60 each. The participants were purposefully selected from a specific criteria, of students enrolled in the "Green Computing" course. This distribution was chosen to maintain symmetry between the groups and ensure a balanced representation across different conditions or interventions.

The decision to work with two groups of 60 was influenced by practical considerations, including available resources, time constraints, and the nature of the research context. While larger sample sizes are often advantageous for statistical robustness, the chosen configuration aligns with the exploratory and in-depth nature of our study.

Each group of 60 participants allows for a comprehensive examination of the impact of whiteboard animations on SDG learning within the specified context.

While we acknowledge the limitations inherent in the chosen sample size, particularly regarding generalizability to a broader population, the dual-group configuration enhances the internal validity of our study by allowing for direct comparisons and contrasts between distinct conditions. We are confident that the chosen sample size facilitates a nuanced exploration of the research questions and contributes meaningfully to the objectives of the study.

4 Results and Discussion

An appropriate analytical approach would be a mixed-methods research approach. This approach combines both qualitative and quantitative research methods to provide a comprehensive and multifaceted analysis of the study's objectives. Here's why this approach is suitable:

1. Qualitative analysis
   - Content analysis: To qualitatively analyze the feedback and comments from students regarding their experiences with whiteboard animations and the K-W-L charts.
   - Thematic analysis: To identify and categorize recurring themes and patterns in student responses and suggestions regarding the use of multimedia tools in SDG learning.
2. Quantitative analysis:
   - Statistical analysis: To quantitatively assess the impact of whiteboard animations on student engagement, focus, recall, and content understanding based on survey data.
   - Descriptive statistics: To provide numerical summaries of survey responses and K-W-L chart assessments.

   (a) Correlation analysis: To explore potential correlations between different variables, such as the duration of video clips and their effectiveness in achieving learning objectives.

4.1 Qualitative Analysis

The following table gives a qualitative analysis of the content.

Theme	Example quote	Student response (%)
Enhanced engagement	"The animations made the topics come alive…"	87
	"I was actively following along with the animations…"	92
Improved comprehension	"The visual explanations in the animations clarified concepts…"	78
	"I could see how different SDGs were interconnected…"	83
Positive impact on recall	"The visuals in the animations stuck in my mind…"	71
	"I found myself remembering more about the SDGs…"	76
Suggestions for improvement	"Shorter animations would be even more effective…"	63
	"Including real-world examples within the animations…"	68
Overall positive experience	"I genuinely enjoyed the combination of visuals and the K-W-L chart…"	89
	"I believe this approach should be used more widely…"	94

A hypothesis test with a dataset of 60 data values for each group. We compared the exam scores between two groups: students exposed to whiteboard animations (Group A) and students not exposed (Group B).

Step 1: Define null and alternative hypotheses.

Null hypothesis (H0): There are no statistically significant differences in exam scores between Group A (exposed to whiteboard animations) and Group B (not exposed).
Alternative hypothesis (H1): There are statistically significant differences in exam scores between Group A and Group B.

Step 2: Select a significance level (Alpha).

Select a significant level (alpha). Let's use alpha = 0.05, which corresponds to a 95% confidence level.

Step 3: Collect data.

For this example, we have larger datasets for two groups, each with 60 data values:

Group A (exposed to whiteboard animations): [80, 82, 83, …, 90] (60 data values)
Group B (not exposed): [75, 77, 76, …, 78] (60 data values)
Step 4: The appropriate statistical test.

We used an independent two-sample *t*-test because we have two independent groups (Group A and Group B), and we want to compare their mean values.

Step 5: Perform the statistical test.

We performed the independent *t*-test. The result gives us test statistics and a *p*-value.

Step 6: Interpret the results.

The result of the *t*-test is as follows:

Test statistic (*t*): 3.14
Degrees of freedom (df): 118 (assuming equal variances)
p-value: 0.002 (less than alpha)

Since the *p*-value (0.002) is less than the chosen alpha (0.05), we reject the null hypothesis (H0). This suggests that there are statistically significant differences in exam scores between Group A and Group B based on the larger datasets.

Step 7: Report the findings.

The results, including the test statistic, degrees of freedom, *p*-value, and the conclusion:

> Based on the results of an independent two-sample *t*-test with a significance level of 0.05 and larger datasets (60 data values for each group), we reject the null hypothesis. There are statistically significant differences in exam scores between students exposed to whiteboard animations (Group A) and those not exposed (Group B).

4.2 Quantitative Analysis

4.2.1 Statistical Analysis

1. *Survey Data Analysis*
   - Calculated the mean scores for each survey question related to student engagement, focus, recall, and content understanding
   - Conducted a *t*-test to compare the mean scores between two groups: students exposed to whiteboard animations and those not exposed
   - The result (See Fig. 1)
2. *K-W-L Chart Assessment*
   - Calculated the average K-W-L chart scores for each group of students
   - Performed an independent samples *t*-test to compare the average K-W-L chart scores between the two groups
   - The results (see Fig. 2)

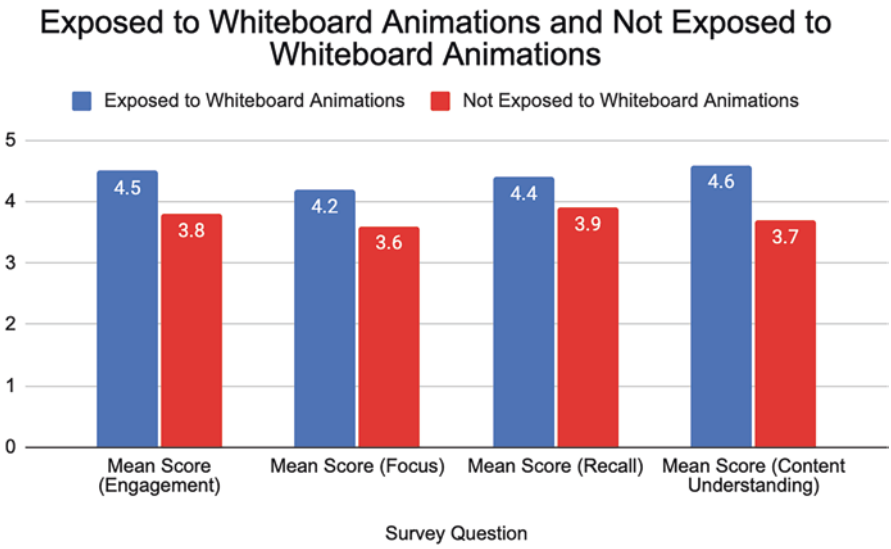

Fig. 1 A survey data analysis of students exposed and not exposed to whiteboard animations

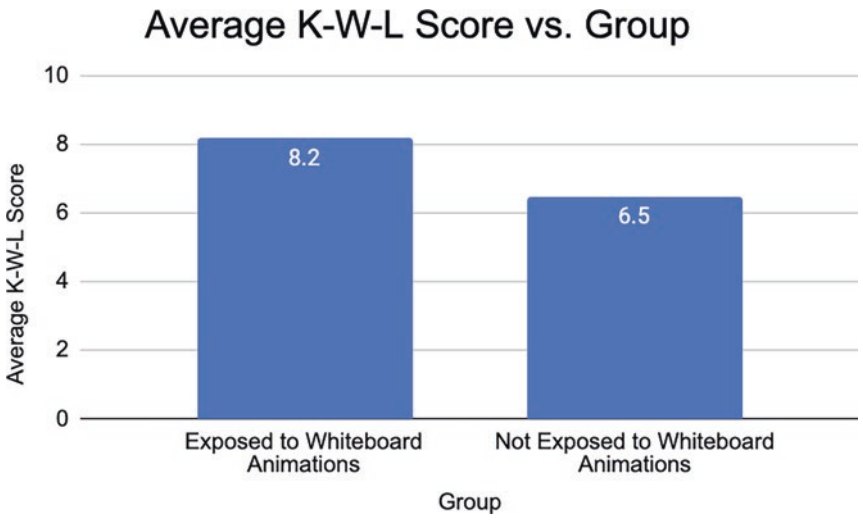

Fig. 2 A K-W-L chart assessment

4.2.2 Descriptive Statistics

1. Survey Responses
   - Presented a pie chart as below (See Fig. 3)

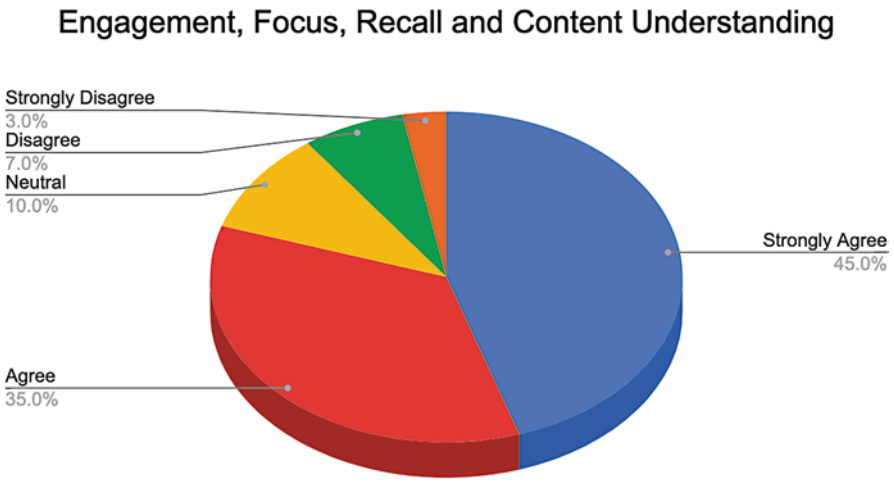

Fig. 3 Survey responses (Descriptive analysis)

4.2.3 Correlation Analysis

1. Duration of Video Clips vs. Learning Outcomes
   - Used a scatter plot with the duration of video clips on the *x*-axis and student learning outcomes (e.g., content understanding scores) on the *y*-axis
   - Calculated Pearson's correlation coefficient and presented it in a table:
2. Effectiveness vs. Learning Objectives
   - Created a scatter plot with students' perceived effectiveness of whiteboard animations on the *x*-axis and their achievement of learning objectives on the *y*-axis
   - Calculated Pearson's correlation coefficient and presented it in a table:

Correlation coefficient	*p*-value
0.63	<0.001

Correlation coefficient	*p*-value
0.7	<0.001

4.3 Discussion

Quantitative Analysis

Survey Data Analysis

(a) Students exposed to whiteboard animations demonstrated significantly higher mean scores for engagement, focus, recall, and content understanding compared to those not exposed.
(b) The use of whiteboard animations positively impacts student engagement, focus, recall, and content comprehension.

K-W-L Chart Assessment

(a) Students exposed to whiteboard animations had a significantly higher average K-W-L chart score compared to those not exposed.
(b) Whiteboard animations enhance students' ability to set learning objectives, monitor their comprehension, and generate deeper insights into the subject matter.

Correlation Analysis

(a) There is a strong positive correlation ($r = 0.63$, $p < 0.001$) between the duration of video clips and student learning outcomes, suggesting that longer (sound 10 min) video clips are associated with better learning outcomes.
(b) Students' perceived effectiveness of whiteboard animations is highly correlated with their achievement of learning objectives ($r = 0.70$, $p < 0.001$), indicating that when students find animations effective, they are more likely to meet their learning goals.

Qualitative Analysis Conclusions

Feedback from Students

(a) Qualitative feedback from students highlighted their positive experiences with whiteboard animations. Many students mentioned increased engagement, better focus during lessons, improved content retention, and enhanced content understanding.
(b) Students found whiteboard animations to be a fun and effective learning tool.

K-W-L Chart Insights

(a) The K-W-L chart assessments revealed that students were able to set clear learning objectives (What I Want to Know), monitor their learning progress (What I Learned), and connect prior knowledge to new information (What I Know).
(b) The K-W-L chart proved to be an effective formative assessment tool, guiding instructors in tailoring teaching methods to students' prior knowledge and learning needs.

Certainly, here are the advantages of adopting whiteboard animation as a pedagogical tool and using K-W-L charts for assessment in a concise bullet point format:

Pedagogical Benefits (Whiteboard Animation)

(a) Enhanced retention: Studies show a 15% improvement in information retention compared to traditional videos.
(b) Versatility: Applicable to a wide array of subjects, making it versatile for educational purposes.
(c) Ease of creation: Requires no specialized skills or expensive equipment, ensuring accessibility for educators.
(d) Engagement: Sustains interest through the integration of music, motion, and visuals, enriching the learning experience.
(e) Simplified complex concepts: Effectively simplifies intricate ideas, rendering them more comprehensible to learners.

Assessment Benefits (K-W-L Charts)

(a) Self-assessment: Encourages students to reflect on their prior knowledge and monitor their own learning journey.
(b) Formative evaluation: Offers continuous feedback to instructors regarding students' evolving comprehension.
(c) Personalization: Enables instructors to tailor their teaching methods based on students' existing knowledge and inquiries.
(d) Curiosity enhancement: Fosters curiosity and inquiry-based learning by prompting students to pose questions about the subject matter.
(e) Reflection and Summarization: Assists students in summarizing and consolidating their learning at the conclusion of the course.

These benefits together establish an efficient and engaging learning atmosphere for students while providing instructors with valuable insights into student advancements and areas requiring enhancement.

Discussion of the Gap in the Literature Survey and Unique Pedagogy Approach

While our study has yielded valuable insights into the effectiveness of whiteboard animations and the K-W-L chart in fostering Sustainable Development Goals (SDGs) learning in higher education, it is essential to acknowledge a gap in the existing literature survey. Our review of relevant literature revealed a limited exploration of this specific pedagogical approach within the context of SDG education.

1. Whiteboard animations in SDG learning

   - Surprisingly, despite the widespread adoption of multimedia tools in educational settings, there is a noticeable dearth of literature addressing the utilization of whiteboard animations for SDG learning.
   - Our study pioneers the exploration of this specific pedagogy, demonstrating its potential to enhance student engagement, knowledge retention, and overall clarity of SDG-related course content.

2. K-W-L chart assessment tool

   - Similarly, the literature survey indicated a lack of comprehensive investigations into the use of the K-W-L chart as an assessment tool in the context of sustainability education.

- Our study introduces and evaluates the K-W-L chart as a formative assessment tool, shedding light on its effectiveness in gauging students' knowledge, curiosity, and learning progress regarding SDGs.

3. Integrated pedagogical approach
   - One notable contribution of our research lies in the integration of whiteboard animations and the K-W-L chart within a holistic pedagogical approach.
   - While literature has explored individual elements such as multimedia tools or specific assessment methods, our study uniquely combines these elements to create an immersive and participatory learning experience for students engaging with SDGs.
4. Implications for future research
   - The identified gap in the literature underscores the need for future research to delve into the specific attributes and effectiveness of whiteboard animations and the K-W-L chart in the realm of sustainability education.
   - Scholars are encouraged to expand upon our work, examining diverse applications, potential variations, and comparative analyses to provide a more nuanced understanding of these pedagogical tools in SDG-focused learning environments.

5 Framework for Fostering SDG Awareness and Attainment in Developing Regions via Whiteboard Animation

Component 1: Integration of Whiteboard Animation

- Description: This facet encompasses the deliberate integration of whiteboard animation as an educational instrument into the established curriculum of educational institutions situated in developing regions.
- Contribution to SDG awareness and attainment: Whiteboard animation elevates the accessibility of SDG-related material by simplifying intricate concepts, rendering them visually captivating, and catering to diverse learning preferences. This integration guarantees that students receive direct exposure to SDGs as an integral part of their education.

Component 2: Development of Localized Content

- Description: Local educators and content creators collaborate to craft SDG-centric whiteboard animations that specifically address challenges, prospects, and cultural contexts unique to the region.
- Contribution to SDG awareness and attainment: Localized content ensures that the material remains pertinent and relatable to students, nurturing a profound comprehension of how SDGs are intertwined with their communities and daily experiences. It harmonizes SDGs with local priorities.

Component 3: Alignment with the Curriculum

- Description: The curriculum is adapted to encompass SDGs as educational objectives, guaranteeing that whiteboard animations align with overarching educational aspirations.
- Contribution to SDG awareness and attainment: Curriculum alignment secures the status of SDGs as an indispensable component of the educational voyage. It underscores the significance of SDGs within the academic framework, motivating students to actively engage with sustainability matters.

Component 4: Embrace of Multimodal Learning

- Description: The model encourages a range of learning experiences, melding whiteboard animations with interactive discussions, collaborative projects, and real-world applications.
- Contribution to SDG awareness and ttainment: Multimodal learning consolidates SDG comprehension by offering students diverse avenues to interact with the material. It allows for profound exploration and the pragmatic application of SDGs.

Component 5: Stimulating Active Student Engagement

- Description: Strategies for enhancing student engagement encompass lively discussions, debates, project-driven assignments, and community involvement, all of which encourage active participation in SDG-related pursuits.
- Contribution to SDG Awareness and Attainment: Active engagement empowers students to seize control of their SDG learning. It nurtures critical thinking, problem-solving competencies, and a sense of responsibility in addressing sustainability predicaments.

Component 6: Assessment and Feedback Mechanisms

- Description: Continuous assessment methods are employed to evaluate students' understanding of SDGs, including quizzes, presentations, and reflective assignments. Feedback mechanisms ensure ongoing improvement.
- Contribution to SDG awareness and attainment: Assessment and feedback encourage students to reflect on their SDG learning progress and make necessary adjustments. They provide opportunities for educators to track and enhance SDG attainment.

Component 7: Community Involvement

- Description: The model promotes community engagement projects that connect students with local SDG initiatives, NGOs, and governmental agencies.
- Contribution to SDG awareness and attainment: Community involvement bridges the gap between theoretical knowledge and practical application. It empowers students to become active contributors to SDG implementation within their communities.

Component 8: Faculty Development

- Description: Faculty members receive training and support to effectively utilize whiteboard animations and engage students in SDG-related discussions.
- Contribution to SDG awareness and attainment: Faculty development ensures that educators are equipped with the necessary skills to facilitate meaningful SDG learning experiences, thereby enhancing overall SDG awareness.

Component 9: Monitoring and Evaluation

- Description: Robust monitoring and evaluation mechanisms are put in place to assess the effectiveness of the model/framework, including student performance, retention rates, and community impact.
- Contribution to SDG awareness and attainment: Monitoring and evaluation provide data-driven insights into the model's impact, allowing for continuous improvement and evidence-based decision-making.

This comprehensive model/framework aims to create a holistic and impactful approach to enhancing SDG awareness and attainment in developing countries through the strategic use of whiteboard animations and education. It emphasizes localization, active engagement, and alignment with existing educational structures to maximize its effectiveness in achieving SDG-related goals. In the current research, gamification was not employed as the guiding theory in this work. The primary focus is on investigating the impact of whiteboard animations on SDG learning. While gamification attributes were not explicitly incorporated into the study, we recognize the potential significance of Gamification in future investigations. Attributes such as points, badges, and challenges could be explored in subsequent courses to enhance SDG awareness and attainment

A simplified algorithmic representation of the framework for fostering SDG awareness and attainment in developing regions via whiteboard animation:

Algorithm for the framework: Fostering SDG Awareness and Attainment

1. Start
   - Initiate the process.
2. Integration of Whiteboard Animation
   - Implement the deliberate integration of whiteboard animation into the educational curriculum.
3. Development of Localized Content
   - Collaborate with local educators and content creators to craft SDG-centric whiteboard animations addressing region-specific challenges and cultural contexts.
4. Alignment with the Curriculum
   - Adapt the curriculum to include SDGs as educational objectives, ensuring alignment with overarching educational aspirations.

5. Embracing Multimodal Learning
    - Encourage a range of learning experiences, integrating whiteboard animations with interactive discussions, collaborative projects, and real-world applications.
6. Stimulating Active Student Engagement
    - Implement strategies for enhancing student engagement, including lively discussions, debates, project-driven assignments, and community involvement.
7. Assessment and Feedback Mechanisms
    - Employ continuous assessment methods, such as quizzes, presentations, and reflective assignments, to evaluate students' understanding of SDGs. Ensure ongoing feedback mechanisms for improvement.
8. Faculty Development
    - Provide training and support to faculty members for effective utilization of whiteboard animations and engaging students in SDG-related discussions.
9. Monitoring and Evaluation
    - Establish robust monitoring and evaluation mechanisms to assess the effectiveness of the model/framework, including student performance, retention rates, and community impact.
10. End

6 Conclusions

In conclusion, the combined quantitative and qualitative analyses strongly support the effectiveness of using whiteboard animations as a pedagogical tool for teaching Sustainable Development Goals (SDGs) in higher education. Students exposed to these animations exhibited higher engagement, focus, recall, and content understanding, while also demonstrating the ability to set and achieve learning objectives. The correlations observed suggest that the duration of video clips and perceived effectiveness play significant roles in students' learning outcomes. Overall, whiteboard animations prove to be an engaging and effective method for imparting knowledge and promoting awareness of SDGs among students in higher education. Further, in the future course, the pedagogy of gamification and internships will be experimented and investigated.

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Suitability of eLearning Adoption Frameworks and Models for Higher Education Institutions in Uganda

Lucy Nanteza Babirye, George Jjagwe, and Jack Turihohabwe

1 Introduction

1.1 Background

The use of Information Communication Technologies (ICT) in service delivery has increased in the world. Several sectors, such as education, have embraced the wide penetration of ICTs to reach out to targeted clientele in all corners of the world including those in distant and remote areas. ICTs have greatly impacted on the quality of education globally and in Uganda in particular [1]. ICTs are changing the teaching and learning processes by making the learning environment more learner-centered by blending conventional learning with technology through the adoption of eLearning [1]. eLearning is defined as the delivery of teaching and learning with the aid of ICTs [2]. It is electronic learning that includes all learning situations that employ the new technologies [3]. Due to the rapid growth of Internet technologies, it has become an increasingly popular learning approach in Higher Education

L. N. Babirye (✉)
Department of Open Distance and Electronic Learning, Mountains of the Moon University, Fort Portal, Uganda
e-mail: babiryenlucy@mmu.ac.ug

G. Jjagwe
Department of Agricultural Extension, Mountains of the Moon University, Fort Portal, Uganda
e-mail: george.jjagwe@mmu.ac.ug

J. Turihohabwe
Department of Computer Science, Mountains of the Moon University, Fort Portal, Uganda
e-mail: jack.turihohabwe@mmu.ac.ug

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Institutions(HEIs) [4]. The innovative eLearning Technologies used by these HEIs include online courses, teaching aids, educational software, social networking tools, and other emerging technologies.

1.2 Significance of eLearning

eLearning can improve higher education and the effectiveness of learning. This subsection gives a review of the benefits of eLearning in higher education institutions.

1. *Improving the effectiveness of learning*: It provides flexibility in teaching to teachers and a better learning experience for students. Furthermore, it provides new pedagogical methods [5] and reduces the communication gap between the student and the teacher [6]. It also increases the teachers' motivation to teach and students' motivation to learn [7].
2. *Efficiency*: eLearning offers the learner and teachers the freedom of learning and teaching from anywhere at any time since there is no time bracket for teaching and learning [8].
3. *Cost-effective*: The integration of e-learning into HEIs reduces the operational costs for governments, HEIs, and individual learners [7]. HEIs and governments do not need to highly invest in physical infrastructure [7]. Similarly, the learners don't need to travel to distant places to enroll in programs and courses of their choice if they are available online [9].
4. *Meeting diverse needs of students*: Nowadays, eLearning is a very crucial strategy for increasing higher education access opportunities for all people [10]. It caters to differences in the age, work, parental status, and ethnicity of the learners [10]. Furthermore, it is especially beneficial to learners with disabilities, who may find it difficult to access university campuses [11].

1.2.1 eLearning Adoption in HEIs

The implementation of eLearning has become an obligatory requirement leading to its increasing adoption in HEIs globally [12] despite associated challenges [13]. Moreover, there is an increasing need to offer blended and fully online programs in developing countries to enhance learners' knowledge, skills, and competencies [10]. In most of the HEIs in developing countries like Uganda, it was accelerated by the outbreak of the COVID-19 pandemic that forced all education institutions to go under lockdown [14]. The urgency in adoption without careful planning and rigorous maturity assessment [13] made the usage of technology innovations quite cumbersome, despite the essential role it has played in delivering education to students outside of school and allowing learning to continue [15].

In Uganda, most of the HEIs have invested in eLearning technologies to manage the increasing demand for education [16]. HEIs are encouraging their faculty

members to integrate and use these technologies in their teaching practices [17]. However, the adoption of eLearning is still low [16] in some universities, where some students are hesitant to use the new technology [18]. Moreover, the majority of students have a negative attitude toward e-learning [18, 19]. They urge that eLearning is for the rich and believe that it has significant financial implications associated with it [18]. There is also a lack of the competencies needed among staff to teach using e-learning [19]. This further hindered the integration of ICT teaching and learning into the mainstream curriculum in Ugandan HEIs [17].

The eLearning technologies are based on the organization's overall ICT infrastructure, and hence, ICT adoption models and frameworks are important in explaining the adoption of eLearning technologies [20]. Some of the most prominently used ICT adoption models and frameworks that have been used to measure the levels of acceptance of eLearning technologies given by [21] include the Technology Acceptance Model (TAM), the Unified Theory of Acceptance and Use of Technology (UTAUT), and the Technology Organization & Environment (TOE) framework. Models and frameworks given by other authors include DeLone & McLean Information Systems(D&M IS) [22], grounded theory, and the information systems (IS) success model [23]. This research study adopted a combination of TAM and TOE.

1.2.2 Aim of the Research

The purpose of this research was to develop effective strategies for enhancing the adoption of eLearning among students and staff in Uganda's HEIs. The research study was based on the eLearning process of the Mountains of the Moon University (MMU) as a case study.

1.2.3 Problem Statement

Despite the recognition of the need for eLearning technologies to enhance the quality of teaching and learning in Uganda's higher education institutions (HEIs), successful acceptance, adoption, and Integration of these technologies is still a major challenge among students and the teaching staff [24]. Traditional ICT adoption models like TAM primarily focus on Individual factors like perceptions without considering broader contexts of the organization and environment. On the other hand, TOE focuses on organizational and environmental factors, leaving out individual motivational factors that may influence the acceptance and adoption of eLearning technologies [25].

This research proposed a hybrid model that Integrates both TAM and TOE to provide a comprehensive insight into eLearning adoption in Uganda's HEIs and develop effective implementation strategies.

1.3 Theoretical Background

1.3.1 The Technology Acceptance Model

One of the frameworks frequently used to understand the adoption of ICTs is the Technology Acceptance Model (TAM), developed by Davis in 1989 [26]. The TAM model was meant to solve the problem of resistance to end-user systems by managers and professionals [26]. The model proposes perceived ease of use and perceived usefulness as determinants of technology usage by individuals [4]. Perceived ease of usefulness is referred to as the extent to which a user believes that using a technology would enhance performance. On the other hand, ease of use is the degree to which the user believes that the technology can be used with no physical or mental effort [26]. The original version of TAM by Davis is shown in Fig. 1.

TAM has been widely applied to assess technology adoption in various contexts, including education, making it a pertinent framework for examining eLearning adoption in HEIs. Several scholars have carried out studies to extend the Technology Acceptance Model (TAM) for studying eLearning acceptance [27–30], and [31]. Authors in [27] extended the model to include subjective norms, personal innovativeness in the domain of information technology, and self-efficacy to evaluate the acceptance of E-learning. Moreover, authors in [32] studied student acceptance of eLearning in HEIs and emphasized that perceived usefulness and perceived ease of use have led to an increase in the student's intention to use eLearning systems.

Perceived Ease of Use (PEOU)

PEOU is defined as the extent to which an individual believes that using a given technology would be effortless [33]. It implies the degree to which users believe they use minimal time and effort by using a particular technology [33]. In this study, PEOU is used to refer to the degree to which students or staff believe eLearning technologies are used effortlessly. Regarding eLearning, [34] discovered perceived ease of use as a very important indirect mediator among intention to use through perceived usefulness. Based on the above arguments the eLearning following statements are hypothesized:

H1a. Perceived ease of using an eLearning technology is an important indicator of the perceived usefulness of that technology.

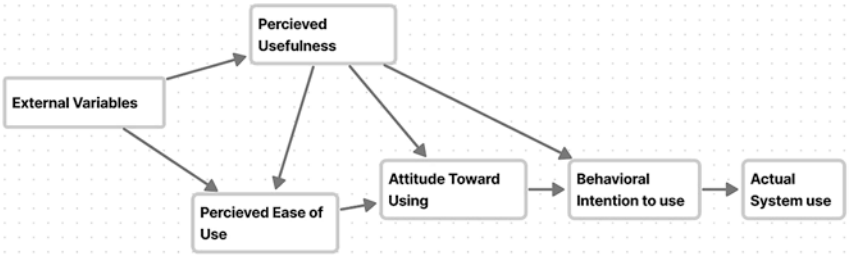

Fig. 1 Technology Acceptance Model [26]

H1b. Perceived ease of use will lead to an increasingly positive attitude toward using the eLearning technology.

Perceived Usefulness(PU)

PU refers to the degree to which the user believes that using a specific technology = leads to an improvement in performance within the organization [33]. In this study, PU refers to the degree to which academicians and students believe that using eLearning technologies will help improve their teaching and learning activities respectively. The original TAM by [26] illustrates that PU is directly influenced by PEOU since users tend to believe that as much as technology is easy to use, it is more likely to be useful to them. Thus, the following hypothesis is considered:

H2. Perceived usefulness will lead to the actual usage of the eLearning technologies by academic staff and students.

Attitude (ATT)

The attitude refers to the degree to which an individual has a favorable or unfavorable appraisal of the usage behavior of a technology [33]. A positive attitude toward any technology could be developed if the technology is found useful and easy to use [33]. It is a direct determinant of behavioral intentions to use eLearning technologies [25]

H3a. Perceived usefulness directly led to a positive attitude toward the use of eLearning technologies.

H3b. A positive attitude leads to increased intentions of using eLearning technologies.

Behavioral Intention to Use (BI)

Behavior intention refers to the fact that an individual wants to accomplish a certain behavior. TAM advocates that actual usage of technology should be determined by their behavioral intentions. According to [35] individuals use a specific technology only if they have intentions to use it. It presumes behavioral intention is developed as an outcome of conscious decision-making [35]. Based on this, we propose the following hypothesis:

H4: The behavioral intention to use results in the actual adoption of the technology.

Benefits and Challenges of TAM in eLearning Adoption

The TAM is the most widely used model to study the acceptance of eLearning [36]. It is reported to be simple, and its efficient design enables researchers to predict the wide range of individual's perceptions about technology adoption with regard to organizational level; IT also has been accepted as the most dominant theory for examining technology adoption at the user level [37]. Additionally, the TAM's structure is easy to understand, hence making it easy to be interpreted without statistical expertise [38]. This simplicity enables for easy application to diverse eLearning contexts by incorporating additional variables relevant to the learners and learning environment. Lastly, the TAM has been extensively tested and validated in various technological contexts inclusive of eLearning, and several studies have

demonstrated its effectiveness in predicting user acceptance of eLearning technologies [38, 39], hence its credibility for application in eLearning research.

However, it should be noted that the TAM has a number of flows since it doesn't account for the effect of social, individual, and cultural factors on user's acceptance of technology [40]. Additionally, studies by [40–42] extended the TAM to evaluate user's attitude toward eLearning (ATE). These attempts failed to demonstrate the significant relationship between perceived ease of use and users' attitudes. Authors in [43] concluded that the TAM was extended and expanded by a number of researchers indicating that it's a theoretical model which can only be applied in practice by extending it to add external variables. Additionally, TAM primarily predicts intention to use rather than actual usage. Despite its limitations, TAM remains an important tool for investigating eLearning adoption [39]. It's important to note that the application of TAM requires awareness of its limitations, and it should be used in conjunction with complementary frameworks and research approaches [40].

1.3.2 The Technology Organization Environment Framework

The Technology Organization Environment (TOE) Framework was created by Tornatzky and Fleisher (1990) [44]. The framework describes the factors that influence technology adoption and implementations by organizations. The factors include the technological context, the organizational context, and the environmental context [20, 44]. Figure 2 demonstrates the original TOE framework.

The Technological Context
The technology context refers to the internal technologies that are relevant to the firm and external technologies that are available in the industry to establish the ability of the firm to adopt the innovative initiative [20, 44]. These include both equipment and processes. Furthermore, use of collaboration tools such as discussion forums, chats and other eLearning systems can result in user satisfaction and, hence, higher adoption [45]. Based on these arguments, we hypothesize the following:

H5a: IT infrastructure directly influences eLearning adoption.
H5b: Use of collaboration tools influences eLearning adoption.

Organizational Context
On the other hand, the organizational context is defined in terms of resources available to support the acceptance of innovation within the organization [46]. These resources and attributes include the organizations, their size and scope, compatibility, formalization, quality and availability of human resources, complexity of the managerial structure, number of slack resources, and linkages between the employes [44, 46]. The organization in this study refers to HEIs in Uganda in general and MMU in particular. The first characteristic to consider compatibility factor in determining the adoption of eLearning. The greater the compatibility between the eLearning technology with the processes and procedures of the HEI that had adopts it, the better the success of its adoption [23]. The technology should be compatible

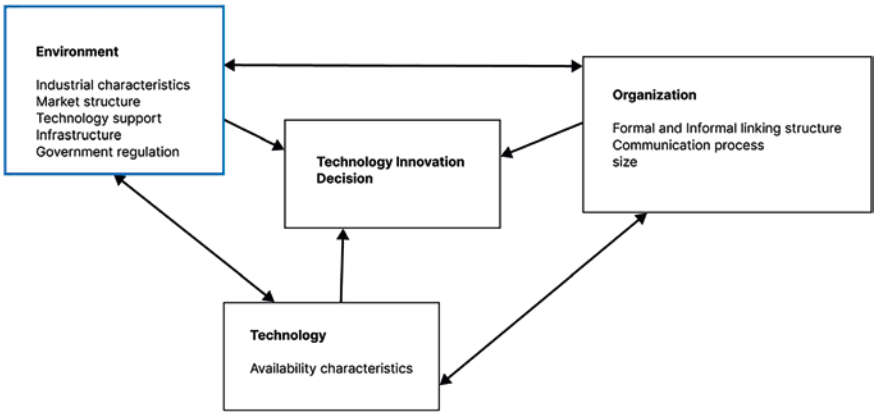

Fig. 2 Original Technology Environment Framework [43]

with the norms, beliefs, values and past experiences, needs, priorities, and policies of the HEI [23]. Based on this, we propose the following hypothesis:

H6a: Organizational compatibility influences the adoption of eLearning technology.

The authors in [23] identified the nature of the course as an additional environmental factor unique to HEIs. Issues under the nature of the course include the content of the course and the curriculum [23]. When the eLearning content is of high quality, the users will be more satisfied to use it [23]. Furthermore, curriculum design is very important for learning performance in an e-learning environment. Students adopt e-learning systems because of the nature of the course whereby course syllabuses that require a lot of technical expertise and more practical work tend to be less suitable to be offered on e-learning platforms than courses that do not [45]. Hence, the hypothesis below:

H6b: The nature of the curriculum of the course greatly influences eLearning adoption.

Technological knowledge is another component of the organizational context that represents the entirety of institutional knowledge dwelling in a specific firm. It provides a mechanism for evaluating whether an organization can adequately address the technological necessities. Based on these arguments, we hypothesize that:

H6c: The knowledge of using technologies influences eLearning adoption.

The last organizational factor considered in this study is organizational leadership. In this case, we hypothesize that:

H6d: Organizational leardership support for the eLearning technology influences its adoption.

Environmental Context

The environmental context includes the characteristics of the industry an organization is in, its competitors, the microenvironment, and its regulatory environment by government agencies [44]. Competitive pressure is defined as the pressure that an institution experiences when it is scared of competitive advantages against the other institutions that have implemented advanced technologies [23]. By adopting information systems, firms might be able to alter the rules of competition, affect the structure of the industry, and leverage new ways to outperform their competitors [46]. This analysis of the relationship between competitive pressure and technology adoption can be extended to eLearning adoption. As an outcome, the model proposes that:

H7a: Competitive pressure greatly influences eLearning adoption.

The second environmental factor considered in this study is government regulation. Well-developed policies can act as powerful catalysts, promoting infrastructure development in the Ugandan HEI landscape. Furthermore, government funding and incentives can further accelerate adoption, while clear regulations on data privacy and content can help build trust among students and academic staff. However, overly restrictive measures can stifle innovation and limit access to valuable resources. Based on this, the following hypothesis is proposed:

H7b: Government regulation can accelerate eLearning adoption in HEIs.

Benefits and Challenges of TOE

The framework has been widely used in research on technology adoption and implementation in organizations, and it has proven to be a valuable tool for understanding the complex interplay between technology, organization, and environment [47]. In regard to eLearning adoption in HEIs, the framework has been widely used to assess eLearning adoption [48]. It offers a powerful tool to critically dissect eLearning adoption, encompassing not just user perceptions but also the relationship between the technology, organization, and environment. Furthermore, it guides strategic decisions on technology investments, allocation of resources, as well as change management.

However, TOE has a number of challenges. First of all, analyzing the technology, organization, and environmental aspects turns out to be complex. Furthermore, [49] emphasizes that TOE can only help in identifying factors influencing adoption, it cannot be used to predict the exact extent of technology adoption due to the dynamic nature of organizational and environmental contexts. However, researchers in [43] concluded that it is rarely extended when it's adopted, implying that it's a more comprehensive and recommended framework.

To mitigate these challenges, combining TOE with other frameworks or qualitative methods, utilizing robust data gathering strategies, and acknowledging the framework's limitations are crucial [48]. By navigating these hurdles, the strength of TOE can be leveraged to brighten the dynamics of eLearning adoption within HEIs, ultimately paving the way for successful implementation and thriving adoption.

1.3.3 Integrating TOE and TAM

Combining the Technology Acceptance Model (TAM) and the Technology-Organization-Environment (TOE) framework for eLearning adoption can offer a powerful and better understanding of the complex eLearning adoption phenomenon [50]. TAM focuses on individual user perceptions (perceived usefulness and ease of use), while TOE explores broadertechnological, organizational, and environmental factors. According to [50], combining the two approaches results in a more holistic view encompassing both individual motivations and external factors, leading to more accurate predictions of eLearning adoption. This can help inform the design of user-friendly, relevant, and accessible eLearning platforms and content. Furthermore, combining TAM and TOE helps track the impact of interventions and optimize eLearning implementation for continuous improvement [25].

1.3.4 Research Questions

1. What are the major drawbacks and perceived benefits of eLearning adoption among students and teaching staff at Mountains of the Moon university?
2. How do the features of the university's environment, including leadership support, infrastructure, and government policies, affect staff and student acceptance of e-learning technologies?
3. What specific interventions could effectively address identified barriers and promote successful e-learning adoption at Mountains of the Moon University and other HEIs in Uganda?

1.3.5 The Theoretical Framework

Therefore, the research hypotheses based on the discussion in the above sections on constructs for the proposed model in the context of the e-learning are:

H1a. Perceived ease of use (PEOU) of an eLearning technology is an important indicator of the perceived usefulness (PU) of that technology.
H1b. Perceived ease of use (PEOU) will lead to increasing positive attitude (ATT) toward using eLearning technology.
H2. Perceived usefulness will lead to the actual usage of the eLearning technologies by academic staff and students.
H3a. Perceived usefulness directly leads to a positive attitude toward the use of eLearning technologies.
H3b. A positive attitude leads to increased intentions of using eLearning technologies.
H4: The behavioral intention to use results in the actual adoption of eLearning technology.
H5a: IT infrastructure directly influences eLearning adoption.

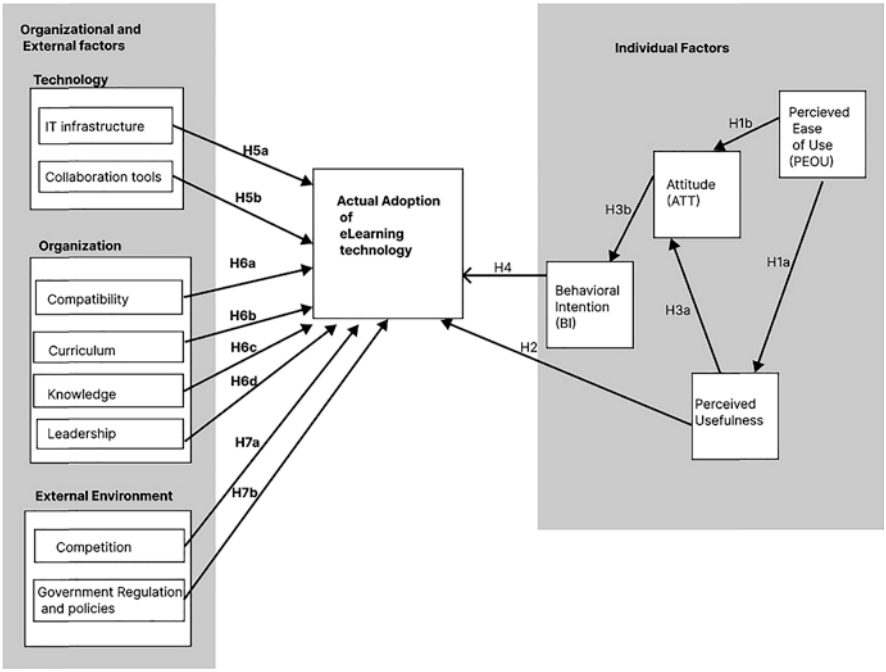

Fig. 3 Theoretical framework

H5b: Use of Collaboration tools influences eLearning adoption.
H6a: Organizational compatibility influences the adoption of eLearning.
H6b: The nature of the curriculum of the course greatly influences eLearning adoption.
H6c: The knowledge of using technologies influences eLearning adoption.
H6d: Organizational leadership support for technology influences its adoption.
H7a: Competitive pressure greatly influences eLearning adoption.
H7b: Government regulation can accelerate eLearning adoption in HEIs.
These are summarized in Fig. 3.

2 Methods

This study employed a mixed methods research design using a case study of Mountains of the Moon University (MMU). This approach allowed for a more comprehensive understanding of the suitability of eLearning adoption models and frameworks for Higher Education Institutions. Convenience sampling was used to recruit participants targeting a balanced representation across faculties, departments, student years of study, and eLearning experience levels. A total sample of 200 participants were recruited including 50 academic staff and 150 students.

Quantitative data was collected using a self-administered online survey that was distributed through the university's official learning management system (LMS) and accessible via a personalized email invitation. The questionnaire for the survey was designed based on the hypotheses established from the literature review to answer the research questions. It was developed using Google form, and each respondent was posed with a series of questions and asked to respond to them using a Likert scale ranging from 1 to 5 where 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree.

Qualitative data were collected through semi-structured interviews, where 15 participants were selected using purposeful sampling. Of these, 10 were students and 5 were academic staff.

Quantitative data were analyzed using descriptive statistics. Frequency tables, percentages, and charts were used for descriptive statistics. Qualitative data from interviews were analyzed thematically. To enhance data validity and reliability, triangulation of data sources (surveys and interviews) was employed. Furthermore, member-checking and peer debriefing were used to validate the findings and interpretations.

3 Results

This section presents the results of the mixed methods study carried out at Mountains of the Moon University to establish the suitability of ICT frameworks and models for eLearning adoption in HEIs.

In effect, a total of 196 questionnaires were used in the analysis after data screening and cleaning, which represents a response rate of 98.0%.

This section discusses the demographic profile of the sampled respondents who took part in the study. They were profiled according to their gender, age, educational qualification, their role on the e-learning platform, and faculty of affiliation. This information is summarized in Table 1.

3.1 Major Perceived Benefits and Challenges

Both qualitative and quantitative data were collected and analyzed. Table 2 summarizes the top perceived benefits and challenges.

The results indicate high positive perceptions of the usefulness of the eLearning technologies among the participants. The high mean scores for flexibility and access to diverse materials indicate them as the key strength of eLearning.

From Table 3 above, participants agree that technical issues like internet connectivity issues and lack of necessary devices pose a barrier to eLearning. This implies that these challenges exist and impact users to some extent. Furthermore, they also agreed that lack of basic computer skills can hinder eLearning adoption.

3.2 Qualitative Data Analysis

Effective eLearning adoption within educational institutions relies on understanding the individual, organizational, and external factors. To gain insight into this, a thematic analysis was conducted to analyze qualitative data gathered through interviews with 15 respondents (10 students and 5 academic staff) from MMU. Table 4 below summarizes the key themes identified from the analysis. It gives the definitions, descriptions, and supporting cases corresponding to each of the themes.

Participants generally believed that eLearning can improve their learning and academic work (13/15) implying strong support for eLearning. On the other hand, adequate Technology infrastructure is critical for eLearning adoption as the majority of the participants (12/15) mentioned sufficient computer labs and reliable internet as essential factors. Furthermore, the number of participants who appreciated the existing policies was just below average (7/14). This implies that the university should promote and communicate clear policies for better eLearning adoption. Additionally, participants highlighted the importance of well-designed eLearning content with practical courses requiring potentially different approaches. Tailoring eLearning to specific disciplines and addressing the potential challenge in practical programs could boost adoption. Furthermore, participants recognized the efforts put in place by management in promoting eLearning adoption(11/15). Continued focus on user awareness, training, and skills development could further enhance adoption. When it comes to external environmental factors, the majority of participants mentioned observing, and benchmarking from other universities(14/15). This implies that competitive forces from the external environment have a positive impact on eLearning adoption in HEIs. Furthermore, it can be noted that the majority of

Table 1 Demographic characteristics of respondents

Characteristic	Frequency	%
Sex		
Male	79	40.3
Female	117	59.7
Category		
Student	147	75.0
Teaching staff	49	25.0
Student program		
Undergraduate	97	59.5
Postgraduate	30	15.0
Faculty of affiliation		
Humanities & social science	40	20.4
Health sciences	35	17.9
Science technology and innovations	38	19.4
Education	30	15.3
Business and management sciences	23	11.7
Agriculture and environmental sciences	30	15.3

Table 2 Major perceived benefits of eLearning

Benefit	Mean score
eLearning Technologies allow me to learn/teach flexibly	4.66
Access to diverse learning materials	4.60
eLearning tools allow me to have more control over my teaching/learning	4.32
Improved collaboration and engagement	4.20

Table 3 Major perceived challenges

Benefit	Mean score
Technical issues	4.30
Lack of computer skills	3.50
Inadequate training	1.5

participants(14/15) acknowledged government initiatives to enhance technology adoption in HEI. Leveraging these positive factors can create a favorable environment for eLearning adoption.

3.3 Results of Hypothesis Testing for eLearning Adoption in Ugandan HEIs

Findings summarized in Table 5 below offer valuable insights for the development of effective strategies that promote increased adoption of eLearning in Ugandan HEIs.

4 Discussion

This section gives an in-depth interpretation of the research findings and explores their implications as well as recommendations for Mountains of the Moon University and other HEIs seeking to enhance eLearning adoption.

4.1 Combining Frameworks and Tailoring Interventions in Ugandan HEIs

The research study explored the eLearning adoption landscape at Mountains of the Moon University(MMU) and other Ugandan HEIs by employing a hybrid framework combining the technology Acceptance Model (TAM) and the Technology

Table 4 Summary of thematic analysis

Code	Themes	Total supporting cases	Number
Individuals	User perceptions	S1, S2, S3, S4, S5, S8, S9, S10, L1, L2, L3, L4, L5	13/15
Technology	ICT infrastructure	S4, S5, S6, S7, S8, L1, L2	7/15
Organization	Compatibility/policies	S1, S3, S4, S5, S9, L1, L2, L3	7/15
	Curriculum	S1, S2, S4, S6, S7, S8, S10, L1, L3, L4, L5	11/15
	Leadership	S1, S3, S4, S5, S7, S8, S10, L1, L2, L4, L5	11/15
Environment	Competition	S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, L1, L2, L4, L5	14/15
	Government regulation and policies	S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, L1, L2, L4, L5	14/15

Organization Environment (TOE) framework. The two frameworks were adopted since no single model can be sufficient to comprehensively study the complex interplay of factors affecting technology adoption [51]. TAM provided an understanding of individual user perception, focusing on perceived ease of use and perceived usefulness. On the other hand, the TOE framework expanded the scope by incorporating organizational and environmental pressures shaping eLearning adoption decisions. This concurs with the analysis of authors in [50], who noted that combining the two approaches results in a more holistic view encompassing both individual motivations and external factors. Furthermore, combining TAM and TOE helps track the impact of interventions and optimize eLearning implementation for continuous improvement [25]. Combining the two enabled us to establish the relationship between individual perceptions, and technological, organizational, and external environmental influences in paving the way for informed strategies to promote widespread and successful eLearning integration as discussed in the following paragraphs:

Individual Factors

The study established that perceived ease of use(PEOU) of eLearning technologies significantly increases positive attitudes towards the use of the technology. This is supported by authors in [52, 53]. HEIs in Uganda should ensure their eLearning platforms have user-friendly interfaces.

It was also confirmed that perceived usefulness has a moderate positive correlation with actual usage. Although the relationship was positive, it is not the only factor hence investigations are required. This is one of the limitations of TAM as noted by authors in [25, 50], and that's one of the justifications why it's more suitable to combine TAM and TOE for studying eLearning adoption.

Both perceived ease of use and perceived usefulness contribute significantly to developing a positive attitude towards eLearning (H3a). Addressing these aspects can foster a more receptive environment for technology adoption.

Table 5 Summary of testing the hypothesis

Hypothesis	Relationship	Correlation coefficient (r)	Interpretation
H1a	Perceived ease of use -> Perceived usefulness	0.52	Partially supported: Moderate positive correlation
H1b	Perceived ease of use -> Attitude towards eLearning	0.78	Supported: Strong positive correlation
H2	Perceived usefulness -> Actual usage	0.65	Partially supported: Moderate positive correlation
H3a (Combined)	Perceived ease of use & Perceived usefulness -> Attitude	0.72 & 0.68	Supported: Both have significant positive correlations
H3b	Attitude -> Intentions to use eLearning	0.82	Supported: Strong positive correlation
H4	Intention to use -> Actual adoption	0.75	Supported: A moderately strong positive correlation
H5a	IT infrastructure -> Actual adoption	-0.58	Supported: Moderate negative correlation (better infrastructure leads to higher adoption)
H5b	Collaboration tools usage -> Actual adoption	0.35	Partially supported: Weak positive correlation
H6a	Organizational compatibility -> Actual adoption	0.79	Supported: Moderate positive correlation
H7a	Competitive pressure -> Actual Adoption	0.80	Supported: Strong positive correlation
H7b	Government Regulation -> actual adoption	0.76	Supported: A moderately strong positive correlation

Attitude towards eLearning strongly predicts intentions to use it (H3b), highlighting its importance in driving actual adoption. Strategies should focus on building positive perceptions through effective communication and showcasing the benefits of eLearning.

Organizational and Environmental Factors

IT infrastructure had a negative correlation with actual adoption of eLearning technologies(H5a). This indicates that better infrastructure leads to high levels of eLearning adoption.

Organizational compatibility had moderate positive relationship with eLearning adoption(H6). This implies that the more complex the organizational compatibility, the less the rate of eLearning adoption [23].

Collaboration tools usage shows a weak positive correlation with actual adoption (H5b). This suggests exploring the specific types of collaboration tools and how they are integrated into eLearning activities for a clearer understanding of their impact.

Competitive pressure had a strong correlation with eLearning adoption. greatly influences eLearning adoption. This rhymes with the findings of [23].

Additionally, government regulation had a moderate positive correlation with eLearning adoption. The government of Uganda has put in place a number of initiatives e geared towards the integration of ICT in education to improve the quality and quantity of education output [54]. Leveraging these external forces can create a favorabe environment for eLearning adoption in HEIs.

4.2 Recommendations for Mountains of the Moon University and Other HEIs in Uganda

Based on the results and discussion we make the following recommendations for MMU and other HEIs in Uganda

HEIs in Uganda can collaborate to develop nationally recognized training programs in e-learning pedagogy, content creation, and user support. Additionally, they can create repositories of e-learning resources where HEIs can share best practices, learning materials, and technical expertise to foster a collaborative learning environment.

HEIs can carry out campaigns to raise awareness among policymakers, administrators, teachers, and students about the benefits of e-learning through workshops.

By implementing these 2 interventions at the individual, organizational, and environmental levels, MMU and other Ugandan HEIs can effectively address identified barriers, enhance adoption of eLearning, and improve educational experiences of their learners.

5 Presentation of the Proposed Framework

Based on the results of this study, we propose a hybrid framework that combines both the Technology Organization and Environment (TOE) framework and the Technology Acceptance Model (TAM).

5.1 The Hybrid TAM-TOE Framework

Based on the results of the research study, we propose a hybrid model integrates the elements of the TOE framework and TAM. The model emphasized the importance of both the organizational context and the individual user acceptance of the eLearning technologies. It is refined from the theoretical model proposed in Sect. 1.3.5 and the results of hypothesis testing. The relationship between the collaboration tools and eLearning technologies is dropped since it had a weak positive correlation (Fig. 4).

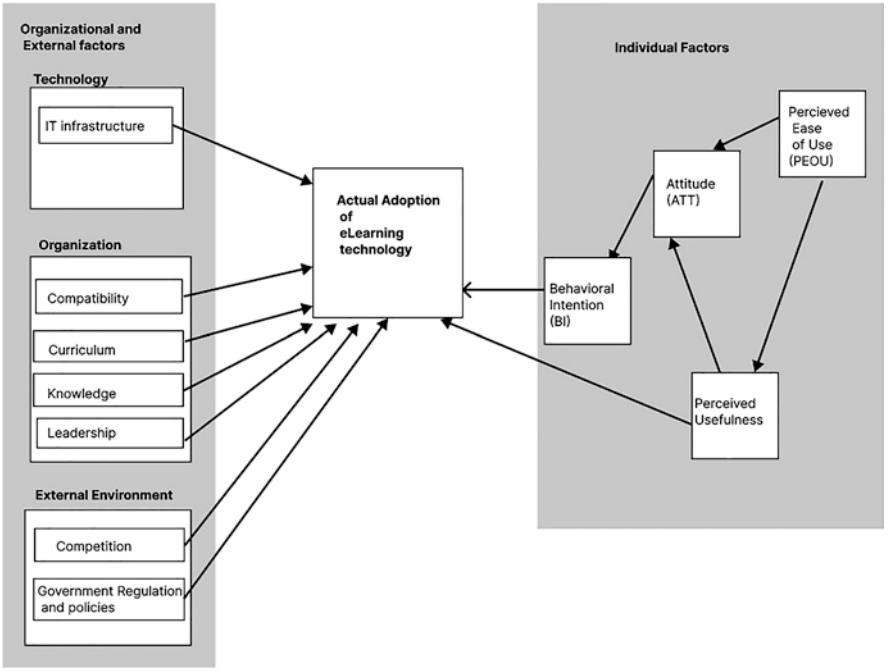

Fig. 4 The hybrid TAM-TOE framework for eLearning adoption

This hybrid framework can guide HEIs in developing comprehensive strategies for adopting and effectively utilizing eLearning in developing countries like Uganda

5.2 Implications for UN Sustainable Development Goals (SDGs) in Developing Countries

The Hybrid TOE-TAM framework will have significant implications for SDGs in developing countries. The following are some of the implications

1. SDG 4 is in line with improving the quality of education, we believe that the application of The Hybrid TOE-TAM framework will enhance the adoption of eLearning technologies in HEIs, thereby improving the quality of education.
2. The Hybrid TOE-TAM framework will improve gender equality in HEIs by ensuring accessibility to eLearning technologies by all users, thereby aligning with SDG's Objective 5.
3. Implementing the hybrid TOE-TAM framework will encourage innovation and infrastructural development in HEIs, thereby contributing to SDG 9's goals of fostering innovation and building resilient infrastructure.

In summary, the hybrid TOE-TAM framework offers a clear approach to aligning the adoption of eLearning technologies with SDGs in line with education, equality, infrastructure, and global partnerships. We believe that its implementation in developing countries will contribute to the steadfast achievement of the SDGs.

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The Application of Markov Chains Model in Determining the Switching Behaviour of Customers in Phone Companies in Developing World: A Study of Tanzania

Sumaya M. Kagoya, Mkandawile Mashaka, and Jamie Caine

1 Introduction

The use of Markov chain is one of the modelling techniques used for prediction and forecasting in operation research and other related fields [15, 23, 34, 42, 71, 81, 94]. Prior authors [2, 8, 35, 38, 51, 62–65, 67, 83, 96] have recommended Markov chain modelling in the area of predicting switching behaviour of customers in various organisations.

In East Africa, particularly in Tanzania, mobile phone users keep on shifting from one network to another in terms of usage, and others purchase more than two networks, hence possess a chain of SIM cards of different network providers yet other subscribers ought to be okay and relaxed with utilizing many phones [66]. Despite the fact that it is cheaper for customers to purchase SIM cards, the nomadic tendency of instability of customers due to their choice of a provider of a specific SIM service has impacted on some network service-providing companies who have lost large sums of money [20]. This is experienced when some customers (network subscribers) decide to utilize a specific network SIM card and retain those of other telephone competitors without recharging them [44].

This current research utilizes the modelling technique of Markov chain in forecasting clients' switching behaviour in the Tanzania telecommunication industry.

S. M. Kagoya (✉)
Makerere University Business School/Department of Applied Computing and Informatics, Kampala, Uganda
e-mail: lncs@springer.com

M. Mashaka
University of Dar es Salaam Business School/Department of Mathematics, Dar es Salaam, Tanzania

J. Caine
Sheffield Hallam University, Sheffield, UK

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The study introduces a theoretical and practical framework for applying Markov chain analysis to modelling and predicting switching behaviour in Tanzania in the long run (equilibrium). This aided key industry players in knowing very well about the exact switching behaviour via the subscribers' expertise hinged on past experience plus service usage for a long time [16, 38].

According to preceding authors [21, 35, 62], switching behaviour holds some benefits in line with the profitability of an industry as jotted below: Firstly, the establishment of future clients permits and assists those concerned with key decision marking to select and target the most efficient, appropriate, and effective marketing activities. Additionally, this strategy aids in choosing effective campaigns for preserving not only a certain but also covering a large percentage of customers of their choice, with the aim of making them switch to the desired network. Secondly, switching behaviour patterns reduces the burden of attracting quite a large portion of potential clients or customers in each given period of time. Furthermore, preceding researchers opined that it is cheaper to retain and mollify the old clients than to obtain fresh customers [10, 13, 73]. Consequently, it is observed and documented that, the biggest apprehension or worry for the majority of the businesses, is acquiring and retaining clients in the competitive and predominant market environment [87, 92]. Nevertheless, this happens to be too tight in some scenarios, like when the market is so tight and the majority of the network main providers are provoked to the bout as they compete for similar clients [11].

The current research, therefore, envisages the Markov chains applicability in terms of switching the behaviour of clients from one category of a network to the next [38]. This boosts industrial growth via proper guidance and recommendations offered by operational research experts who offer actual and efficient ratifications or recommendations [74]. The final results oozing from the current study avails operators of telecom companies, suppliers, and regulatory guiding bodies, coupled with extra vital institutions establishments that possess stratagems for handling the clients switching behaviour in the Tanzania telecommunication industry, as supported by [80]. Additionally, the current research will provide a foundation for empirical literature to the imminent researchers who may conduct studies in the same subject arena (switching behaviour choices). Subsequently, it should be recalled that the current study's sole objective is to scrutinize or examine the Markov chain usage to model client's switching behaviour in the Tanzanian telecom industry context. It should be recalled that the uniqueness of this current study is witnessed in its data collection mode, whereby data was gathered from ratifiers (subscribers) who happen to shift from one network to another network [93].

2 Literature Review

2.1 The Markov Chain Modelling

The Markov chain modelling is regarded to be a subset of *stochastic modelling* that is utilized to prescribe for describing the procedure of a series sequence of probable transitions between states [49]. In the present study, with four major players (Vodacom,

Tigo, Airtel, & Halotel) in the Tanzanian telecommunication industry, a subscriber will always prefer a particular service provider at a particular time based on the setting and services provided and may shift his/her preference in the next period. Thus, the change in taste and preference for a given client may be explained as a series of states of satisfaction with that particular supplier of service [5, 88]. It is worth noting that the stochastic process of the Markovian possesses a less-memory property, and this implies that the information concerning the current state can be utilized to forecast the imminent (future). This implies that, at a specific time, the behaviour and experience of a certain client and the selection of his or her service suppliers can impact on a future state [54, 55, 86]. The decision to locomote amongst various telecom network suppliers can be regulated by prior information of the clients or subscribers regarding the efficiency and effectiveness of a certain service supplier of mobile telecommunication and this characteristic is very vital in the process of Markov chain [24, 30, 84, 95]

2.2 Importance of Markov Chain

The models of the Markov chain are vivacious specifically in areas that deal with managing business, specifically in the marketing business function of all organizations [3, 60]. Additionally, prior authors assert that the main snag for the clients is the locomotion from one state to the next state and from one competing network player to the next network player [27, 50, 54]. In this research study, the term state is regarded as the class of disbursement, in rapports of recharges, on a peculiar network supplier, deduction of the rival expenses on a network service supplier, contract closure with a network service-supplier, and additional referral factors [56, 58].

The models of the Markov chain offer a vital abstract mode that is used for scrutinizing the vicissitudes generated by the discrepancy of such factors or variables [6, 54, 55, 69]. In some cases, they can also be used to predict future values. Markov chain models, therefore, are valuable both in the study of switching of preference and even in the retention of customers as well. They can also be used for market share forecasts or rate of change analysis that aid the growth and development of the telecommunication industry. In this regard, it aims to determine which service provider tends to increase in size and which are declining due to or compelled by customer changes and directions [18, 91].

This study applies Markov chain to analyse the survey data collected to obtain information about the movement or the switching behaviour of subscribers as well as the market share of the network providers in the study area. Markov chain probabilities of states depend only on the most recent states of the chain [25, 52]. The Markov chain considered in this study satisfies the following five properties:

In the first place, there are finite numbers of possible states [19]: each subscriber can prefer most any of the four network providers at any point in time [22].

Secondly, states are both collectively exhaustive and mutually exclusive [26]: the network providers listed assumed that no subscriber could prefer most of the services of two network providers at any point in time. That is, a network provider can be preferred more than the other at any point in time, even in cases of multiple SIMs or phone users [68]. The rate or frequency at which customers

recharge each of the SIMs can be used to distinguish their preferences, since the cost spent on SIM is important to network providers, being the major source of revenue for them.

Thirdly, the transition probabilities depend only on the current state of the system [82, 94]. If the current state is known, the conditional probability of the next state is independent of the states before the present state; that a subscriber will move to another service provider depends only on how he/she perceives the services received at present from the network provider(s) he or she currently patronizes.

Fourthly, the long-run probability of being in a particular state will be constant over time: subscribers seem to stay with a network provider for a long time.

Fifthly, the transition probabilities of moving to alternative states in the next period must sum to 1.0 [2]. Since the network providers are not more than four and the preferences of subscribers can only shuffle among them, the transition probabilities of moving to an alternative state in the next period will always sum to one [39].

2.3 Discrete-Time Markov Chain

A time-homogenous model was considered, that is, a model in which the transition probabilities are constant over time [61]. The transition probability matrix $\mathbf{P}(t)$ contains the probabilities for the transitions. The rows of the matrix represent the most preferred network provider, while the columns stand for the future state (which they may move to). The probabilities are denoted p_{ij} and for each row i and column j they represent the probability of moving from state i to state j, as indicated in Fig. 1.

Figure 1 transition probability matrix for a time-homogeneous 4-state Markov model of mobile telecommunication service providers in Tanzania.

The sum of the row probabilities equals one since each preferred network (state) is independent of the other and a subscriber may move to any of the four states depending on his/her motivation for a move or retention drivers. The diagonals represent the probability of staying with or maintaining a particular network provider over time [80]. A state is called absorbing when the probability of leaving the state is zero [28]. For example, if the subscriber is dead or misplaces his/her SIMs without reactivation, then it is an absorbing state (non-active lines).

3 Methodology

The study was conducted in Tanzania in the four leading mobile telecommunication companies of Vodacom, Tigo, Airtel, and Halotel. The current study used the population matrix model $r = N(t + 1)/N(t)$ for each time step to obtain the total population in the stochastic long run and the sample size for this study includes subscribers

$$P = \begin{array}{c} \begin{matrix} \text{Voda} & \text{Tigo} & \text{Airtel} & \text{Halotel} \end{matrix} \\ \begin{pmatrix} 1 & 2 & 3 & 4 \\ P_{21} & P_{22} & P_{23} & P_{24} \\ P_{31} & P_{32} & P_{33} & P_{34} \\ P_{41} & P_{42} & P_{43} & P_{44} \end{pmatrix} \end{array}$$

Fig. 1 Discrete-Time Markov chain

who had moved from their network provider to another provider [41]. The sample size was obtained using a novel simulation technique in a discrete-time Markov chain [61]. The questionnaire was administered to 300 subscribers in Dar es Salaam, and 240 were answered well and analysed with the aid of Markov chain. The gathered data were changed in the transition probabilities matrix, which is acquiescent with the analysis of the Markov chain [89]. All the necessary aspects necessary for directing and guiding this current study are jotted down in the next paragraphs.

The model of the Markov chain possesses some assumptions that are necessary for the rates of forecasting the behaviour of telecom mobile network clients and attaining the right decision for their retention [15]. More so, it is asserted that given the prevailing situation of several SIM card subscribers in Tanzania, this provokes clients who utilize mobile phones not to move unnecessarily from one telecom mobile network to the next [57]. This implies that they amalgamate two, three, or four different SIM cards for the various telecom network services [78]. Providers, hence, make the purchasing cost of each SIM card to go substantially down. This means that communication subscribers can swap their penchant from one telecom network-service provider to the next amidst numerous SIMs grasped [90]. This happens if the mobile phone subscribers opt to store a specific SIM-card and hesitate from re-using it; they decide to utilize the SIM-card of a different telecom network player who is a rival. The model of Markov chain that was utilized to assume the switching behaviour is grounded on the following four assumptions [15].

First and foremost, there are inadequate figures of likely states since there are few quantities of mobile telecom network operators in Tanzania [57]. Secondly, states are both collectively exhaustive and mutually exclusive [14]. There is always a most preferred network, and they are mutually exclusive [52]. That is to say, among the multiple SIMs that subscribers hold or are on the market at a particular time, there is always a most preferred one in terms of meeting the telecommunication needs of subscribers, over other network providers [68, 70].

Thirdly, the transition probabilities of moving from one state to another depend only on the current state of the system [75]. Lastly, the long-run probability of being in a particular state will be constant over time [4, 29]. This assumption is based on the theory that in the long run, mobile telecommunication operators would learn a lesson as to holding certain factors responsible for subscriber behaviour to sustain a sturdy benefaction and hold lucrative subscribers [1].

3.1 Definition of Notations

Let S_i denote the preference (state) i, where $i = V, T, A, H$ the current mobile operator that a subscriber prefers most at a particular time;

Letter V is used to represent Vodacom
Letter T is used to represent Tigo
Letter A is used to represent Airtel
Letter H is used to represent Halotel
P represents the transition probability matrix;
π_{it} signifies the proportion of market share controlled by mobile operator i in period t;
π_{i0} represents the initial market share of mobile operator i in period 0.

Given the above definition, the proportion of market share controlled by the mobile operators initially is:

$$\pi = \left(V_0, T_0, A_0, H_0\right) \tag{1}$$

3.2 Probabilities' Definition

P_{ij} signifies the likelihood that a ratifier or subscriber preferring at present a *mobile telecommunication operator* i ($i = V, T, A, H$) transfers to the next network-service operator j ($j = V, T, A, H$) in the subsequent period. Through this current meaning rather than definition, once $i = j$, it implies that the current subscriber or ratifier is static and not moving to a different network service operator, hence retaining or preserving the telecom-service network supplier and continuing with the benefit [31].

3.3 The Markov Chain Model (Transition Probability Matrix, P) [36] (Fig. 2)

$$\mathrm{P} = \begin{array}{c} \begin{matrix} \mathrm{V} & \mathrm{T} & \mathrm{A} & \mathrm{H} \end{matrix} \\ \begin{pmatrix} p_{VV} & p_{VT} & p_{VA} & p_{VH} \\ p_{TV} & p_{TT} & p_{TA} & p_{TH} \\ p_{AV} & p_{AT} & p_{AA} & p_{AH} \\ p_{HV} & p_{HT} & p_{HA} & p_{HH} \end{pmatrix} \end{array}$$

Fig. 2 The transition probability matrix, P, of the movement, is given by the matrix

4 Study Findings and Discussion

To attain the chief objective (evaluating the usage of the model of the Markov chain for clients' switching behaviour in the Tanzanian mobile telecom-network industry), data gathered was put in a cross-tabular manner to fit the developed model of Markov chain as depicted in Table 1. Results reveal the preferences of the respondents for mobile telecom network service operators in the Tanzanian context.

Table 1 shows data collected that is intended to provide clear knowledge about the subscribers' switching behaviour visa-v the mobile telecom network SIMs they are utilizing at that precise moment. Out of 88 subscribers that liked Vodacom, 44 showed that they liked the three alternative telecom network operators more. More so, 41 network subscribers liked transferring from the Tigo telecom mobile network to the next, 42 transferred from Airtel, whereas 30 out of 33 transferred from Halotel to subsequent telecom mobile network operators.

Furthermore, the data found in Table 1 was utilized to produce the transition matrix, which is pliable for the modelling and analysis of the Markov chain [76]. In order to predict the movement of the system from one state to the next, it is necessary to know the conditional or transitional probabilities of such a movement. Therefore, Table 1 data was altered to attain the next level of the probability transition matrix via Tables 2, 3, 4, and 5. Also, the matrix for transition probability permits stakeholders to forecast the upcoming states (market share) needed for the future [7, 45, 46]. This aids in attaining the value of the probability for the movement of the different telecom network service suppliers at steady-state equilibrium [79, 96].

Figure 3 envisages the probability of gains and losses among mobile telecommunication networks in Tanzania.

Figure 4 showing transition probability matrix for client switching behaviour.

Table 1 Envisaging the cross-tabulation final output

		To				
		Voda	Tigo	Airtel	Halotel	Total
From	Voda	44	24	12	8	**88**
	Tigo	25	23	12	4	**64**
	Airtel	18	17	13	7	**55**
	Halotel	13	12	5	3	**33**
Total		**100**	**76**	**42**	**22**	**240**

Table 2 Table of subscribers' preference for network providers

Telecom operator	Number of subscribers	Voda	Tigo	Airtel	Halotel
S_V	**88**	44	24	12	8
S_T	**64**	25	23	12	4
S_A	**55**	18	17	13	7
S_H	**33**	13	12	5	3

Table 3 Gains from and losses to (customers' preference of switching)

Telecom operator	Number of subscribers	Losses to				Gains from			
		S_V	S_T	S_A	S_H	S_V	S_T	S_A	S_H
S_V	**88**	0	$\binom{2}{4}$	$\binom{1}{2}$	8	**0**	**25**	$\binom{1}{8}$	$\binom{1}{3}$
S_T	**64**	$\binom{2}{5}$	0	$\binom{1}{2}$	4	**24**	**0**	$\binom{1}{7}$	$\binom{1}{2}$
S_A	**55**	$\binom{1}{8}$	$\binom{1}{7}$	0	7	**12**	**12**	**0**	**5**
S_H	**33**	$\binom{1}{3}$	$\binom{1}{2}$	5	0	**8**	**4**	**7**	**0**

Table 4 Retention probabilities

Telecom operator	Number of subscribers	Number of customers lost	Number of customers retained	Probability of retention
S_V	**88**	44	44	1–44/88 = 0.5000
S_T	**64**	41	23	1–41/64 = 0.3593
S_A	**55**	42	13	1–42/55 = 0.2363
S_H	**33**	30	3	1–30/33 = 0.0909

Table 5 Probabilities associated with gains and losses of customers

N	Number of subscribers	From			
		S_V	S_T	S_A	S_H
S_V	88	0/88 = 0	25/64 = 0.3906	18/55 = 0.3272	13/33 = 0.3939
S_T	64	24/88 = 0.2727	0/64 = 0	17/55 = 0.3090	12/33 = 0.3636
S_A	55	12/88 = 0.1363	12/64 = 0.1875	0/55 = 0	5/33 = 0.1515
S_H	33	8/88 = 0.0909	4/64 = 0.0625	7/55 = 0.1272	0/33 = 0

Probabilities of gains and losses (row = gains and column = losses)

The transverse figures in the matrix probability given in Fig. 4 epitomize the capability of each telecom-network service provider to hold or keep the current subscribers for the succeeding period of client transition due to switching. Hence, this divulges that Vodacom telecom network service possesses the biggest retention rate of 50.0% due to switching behaviour, followed by Tigo (35.93%), Airtel (23.6%), and Halotel (9.1%). Correspondingly, this denotes the quantity of mobile phone telecom network clients for every telecom network supplier in the initial 12 months.

$$P = \begin{array}{c} \begin{matrix} V & T & A & H \end{matrix} \\ \begin{pmatrix} 0.000 & 0.3906 & 0.3272 & 0.3939 \\ 0.2727 & 0.000 & 0.3090 & 0.3636 \\ 0.1363 & 0.1875 & 0.000 & 0.1515 \\ 0.0909 & 0.0625 & 0.1272 & 0.000 \end{pmatrix} \end{array}$$

Fig. 3 The probability of gains and losses among mobile telecommunication network providers in Tanzania

$$P = \begin{array}{c} \begin{matrix} S_V & S_T & S_A & S_H \end{matrix} \\ \begin{pmatrix} 0.5000 & 0.3906 & 0.3272 & 0.3939 \\ 0.2727 & 0.3593 & 0.3090 & 0.3636 \\ 0.1363 & 0.1875 & 0.2363 & 0.1515 \\ 0.0909 & 0.0625 & 0.1272 & 0.0909 \end{pmatrix} \end{array}$$

Fig. 4 The transition probability matrix

The share percentage for the operators during the starting phase is calculated as shown below:

$$\text{Vodacom} : \frac{88}{240} = 0.3636$$

$$\text{Tigo} : \frac{64}{240} = 0.2667$$

$$\text{Airtel} : \frac{55}{240} = 0.2291$$

$$\text{Halotel} : \frac{33}{240} = 0.1375$$

Therefore, the vector was utilized in multiplying the probability transition matrix as revealed in the equation beneath, to get the market shares for the telecom network service suppliers at the start of year two.

$$\begin{pmatrix}0.3636 & 0.2667 & 0.2291 & 0.1375\end{pmatrix} \times P = \begin{pmatrix}0.2982, 0.2894, 0.2731, 0.2737\end{pmatrix}$$

In the second year, the findings results advocate that, the market -share from the area of study ought to decrease up to 29.8% for Vodacom while that of Tigo, Airtel, and Halotel will increase to 28.9%, 27.4%, and 27.37% respectively. This result reveals that the highest percentage of the subscribers in the study zone were most expected to remain with Vodacom and in that way try to uphold or retain the leadership position for quite in the market-share market leadership for a long period, this is the reverse for the different telecom network mobile suppliers, who require fitting marketing strategies to attract, win and keep their clients.

In determining the market share of telecommunication operators at steady-state equilibrium, the transition probability was used for computing the steady-state vector (unknown) [53]. It should be recalled that the equilibrium-steady state is defined as a state at which additional alterations in the value for the probability in terms of market-share for the various telecom network mobile operators will turn to be become trivial [17, 47, 77]. We do this by solving the simultaneous equations

$$0.5000V + 0.3906T + 0.3272A + 0.3939H = V \tag{2}$$

$$0.2727V + 0.3593T + 0.3090A + 0.3636H = T \tag{3}$$

$$0.1363V + 0.1875T + 0.2363A + 0.1515H = A \tag{4}$$

$$0.0909V + 0.0625T + 0.1272A + 0.0909H = H \tag{5}$$

$$V + T + A + H = 1 \tag{6}$$

Solving the above system, we obtain these results, which suggest that, there is no single operator who will dominate more than 50% of the mobile market even for many future years to come though Vodacom Tanzania will continue dominating the telecommunication industry in Tanzania for a slight margin compared to Tigo. In this case, other companies need to put more effort into catching up with Vodacom.

5 Conclusion Plus Study Implications

The current research utilized data gathered from four network operators about their clients' preferences, where the preliminary shares from the market were premeditated. Additionally, a model of the Markov chain was established by utilizing the feedback regarding subscribers' maintenance and locomotion possibilities [40]. The study results oozing from the developed model envisaged that Vodacom ought to preserve the leading position in the telecom network industry up to the point known as *steady-state* [17]. More so, the rest of the telecom network operators should redesign the kind of strategies they are using for retention purposes, aimed at meeting their clients' requirements or needs and getting enough market share [9].

Furthermore, the established model in the current study is regarded to be appropriate for modelling clients' locomotion behaviour in both brief terms plus equilibrium [32, 37]. Also, the developed model in this study for Markov chain was found pertinent in the client movement behaviour modelling in both the short-run state and equilibrium state [2, 40]. Added to the above, this study results act as a foundation for the empirical literature review for the potential upcoming researchers who will be researching about operation research techniques like the Markov chain as well as the switching or locomotion behaviour among clients in telecom companies and make wise decisions of how to preserve them [4, 85]. This aids marketing managers in sustaining their businesses within the telecom network industry in developing nations [12].

Consequently, this current study's findings possess some positive implications that are crucial to the telecommunication companies' or industries' stratagems which aid them in attaining a competitive edge and sustainability, which is in line with the study conducted by [33, 43, 48, 59, 72]. The study also has implications for the policymakers in the telecommunication companies who should use the current results to be able to model their customers' switching behaviour and retain them. More so, this study has positive implications for all the stakeholders in the phone industry, for instance, the customers will stick to the best network service provider and hence get access to timely services. Conversely, network providers can identify value attributes that will encourage customers to remain on their network.

This study has limitations that other future studies should capitalize on. For instance, only the quantitative method was used, and qualitative or mixed methods should be used, plus other data collection techniques other than questionnaires by future researchers, the study was also limited by time as respondents were taking a lot of time to return the filled questionnaires. Lastly, a comparative study between or among nations should be done to compare results, see the similarities and differences and establish the causes for the differences, and suggest suitable recommendations to the telecommunication companies.

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