Investigating the Adoption of an Integrated Hospital Information System in Rural Uganda: A Case of Kisiizi Hospital

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Abstract. Electronic Medical Records (EMRs) have been proposed to improve the quality of services in healthcare organisations. However, sometimes, the design contexts of these systems tend to be different from the use contexts. This and other factors have been reported to cause failures of EMR adoptions. By focusing on factors from the Unified Theory of Acceptance and Use of Technology (UTAUT) model, we use interviews and questionnaire as data collection instruments to study the adoption of an EMR which was locally developed in rural Uganda; to generate lessons that would sustain the use of the EMR.

We found out that all of the following factors, from the UTAUT model, significantly affected the usage of the system and, consequently, facilitated the adoption of the EMR at Kisiizi Hospital: expected improvement in job performance, the easiness with which the system can be learned and used, support and influence from management and peers, and the availability of organisational and technical infrastructures to support the use of the system. All of these were largely due to the fact that physicians from Kisiizi Hospital initiated and drove the system development and implementation processes, making sure that correct requirements were captured, and championing the use of the system by staff at the hospital. The in-context explanations for the findings are also provided.

Keywords: Hospital Information System Adoption, Electronic Medical Records, Electronic Health Records, UTAUT.

1 Introduction

To improve the quality of healthcare services amidst huge routine workloads for clinicians and other staff in healthcare delivery organisations, EMRs have been proposed [1, 2, 3]. However, some of the EMR solutions are designed in contexts that differ from the use contexts [4, 5]. As a result of this and several other factors, users find it hard to appreciate the value of these systems in their (users) routine work flows. Further, in some cases, there is lack of appropriate mechanisms to sustain the use of EMR systems after their initial implementations, and so some of them go unused and phase out after short periods of time [6].

The value of EMRs in improving healthcare provision has been studied [7, 8], and the reasons for failure of EMR implementations have been studied [4]. Such failures have largely been attributed to poor implementation strategies which tend to focus more on technical and functional aspects of the systems at the expense of cultural, sociological and user dependent factors [9, 10].

To sustain the use of the newly adopted EMR (known as Stre@mline) at Kisiizi Hospital, it was deemed important to study the adoption process and generate lessons about what is being done better and what could be strengthened. In this paper, focusing on factors from the UTAUT model, we use interviews and a questionnaire to study the adoption of an EMR developed by local experts for the local hospital in rural Uganda; to understand how acceptable and useful it is in enhancing the quality of healthcare services. We also report about the significance levels of various factors that affect the adoption and describe the recommendations to sustain the use of the system. More specifically, this study provides answers to the following research questions:

RQ1: How acceptable and useful is Stre@mline as an Electronic Medical Records system at Kisiizi Hospital, and what affects its acceptability?

RQ2: What is the level of significance of the factors that have affected the adoption of Stre@mline as an Electronic Medical Records system by health workers at Kisiizi Hospital?

We found out that all of the following factors, from the UTAUT model [11], significantly affected the usage of the system and, consequently, facilitated the adoption of Stre@mline at Kisiizi Hospital: expected improvement in job performance, the easiness with which the system can be used, support and influence from management and peers, and the availability of organisational and technical infrastructures to support the use of the system. All of these were largely due to the fact that physicians from Kisiizi Hospital initiated and drove the system development and implementation processes, making sure that correct requirements were captured, and championing the use of the system by staff at the hospital.

2 Literature Review

Verbeke et al. [9] and Cresswell and Sheikh [10] investigated reasons for success and failure of Health Information Systems (HISs). They found out that paying too much

attention on technical factors, at the expense of social, economic, and political factors, could lead to adoption failure. Nilashi et al. [12] propose the use of human, technology, organizational and environmental factors in evaluating the adoptions of HISs. Ismail et al. [13] identified lack of computer skills by system users and system complexity as other factors that affect adoptions of HISs. Terry et al. [14] identified management involvement, change management strategies, and phased implementations of new systems to be key barriers and facilitators of system adoption processes.

Further, different theories and models have been proposed to guide the adoption of HISs. The Technology Adoption Model (TAM) [15] presents four factors that influence the choice of how and when users use a new technology. Specifically, the four factors are ease of use, usefulness, attitudes towards use, and intention to use. Also, the Theory of Planned Behavior (TPB) [16] introduces perceived behavioral control (people's appraisals of their ability to perform a behavior) as an additional determinant of the intention to use a system.

The UTAUT model [11] combines the just-introduced theories and use Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions and moderating variables of Gender, Age, Experience and Voluntariness of Use as determinants of user acceptance and use behavior. In particular, Performance expectancy is defined as the degree to which an individual believes that using the system will help them attain gains in job performance. Effort expectancy is the degree of ease associated with the use of the system. Social Influence is the degree to which an individual perceives as important others (boss, colleagues, etc) believe that he or she should use the system. And Facilitating Conditions are defined as the degree to which an individual believes that the organizational and technical infrastructures exist to support the use of the system, [11].

Hoque et al. [17] argue for the need to use existing technology adoption models to study the implementations and adoptions of information systems, particularly in the midst of slow diffusion of eHealth systems in developing countries. Other technology adoption theories have been used to study the adoptions of EMRs in a variety of settings [18, 19, 20, 5]. In a work similar to ours, Wills et al. [21] investigated the influence of several factors from the UTAUT model on the adoption of an EMR in the United States of America. In another similar work, the UTAUT model was used by Kijsanayotin et al. [22] to study the factors affecting the adoption of Information Technology (IT) systems in the community health centers in Thailand. We focus on the context of a locally developed solution, the implementation of which was initiated and driven by users. The preliminary impact of Stre@mline at Kisiizi hospital in rural Uganda was studied by Liang et al. [23]. We use four factors from the UTAUT model (Performance Expectancy, E ort Expectancy, Social influence, and Facilitating Conditions) to study the adoption of a locally developed EMR in the context of a developing country in rural Uganda. This work uses these factors to study the acceptability and usefulness of Stre@mline and studies the significance of influence of each of the four factors on the usage behaviour of the system.

3 A Brief Introduction to Stre@mline

Stre@mline is an EMR system implemented at Kisiizi Hospital in rural Uganda.It is the result of the collaboration between a local technology company (Innovation Streams Limited) and the team of physicians from Kisiizi hospital who wanted an EMR that would meet the data and information requirements of their context. It follows the patient journey, incorporating demographics, triage, consultation, patient safety, investigation ordering and results, prescriptions, stock control of medicines, insurance, finances and the generation of statistical data needed for reporting into government HIS systems such as the District Health In-formation Software (DHIS2) [24]. More information about Stre@mline, its functionalities, the process by which it is integrated to the hospital system, key context specific challenges addressed by the system, etc can be found in the work of Liang at al. [23]

The system has been under implementation since 2015 and is now in use in 5 different hospitals in Uganda. The implementation has seen the development, customization and installation of the software, hosting the system on a server complete with a power backup system, delivery of over 20 computers for use by clinicians as well as training and support to hospital staff on the system. Over this time, the system has been taken on to serve a wider range of the hospitals clinical and administrative functions.

4 Methodology

4.1 Interviews

We conducted qualitative interviews on 10 purposively sampled staff, to assess how acceptable and feasible Stre@mline is at Kisiizi Hospital. The profession distribution of the interviewees were: Medical Doctor (2), Clinical Officer (1), Nurse (2), Lab Assistant (1), Medical Laboratory Technologist (1), Data Officer-IT (1), Records Clerk (1), and Accountant (1). From the population of 93 staff, the 10 interviewees were chosen based on the substantive role they had played in the implementation of Stre@mline at Kisiizi Hospital. The interview questions focused on four key constructs from the UTAUT model: Performance Expectancy, Effort Expectancy, Social Influence and Facilitating Conditions (see Fig. 1).

4.2 Quantitative Questionnaire

A quantitative questionnaire developed in reference to the UTAUT model was administered to identify the level of significance of factors affecting the adoption of the system. In addition to introductory and demographic questions, the questions also included the 4 Likert-scale (1= Strongly disagree, 2= Disagree, 3= Agree, 4= Strongly agree) questions that captured the respondents' opinions regarding the four major constructs of the UTAUT model. Respondents filled in the paper-based questionnaire.

Inter alia, the questions on the questionnaire aimed at providing information that would be used to accept or reject the following hypotheses:

H1: Performance expectancy has significant influence on usage behaviour
H2: E ort expectancy has significant influence on usage behaviour

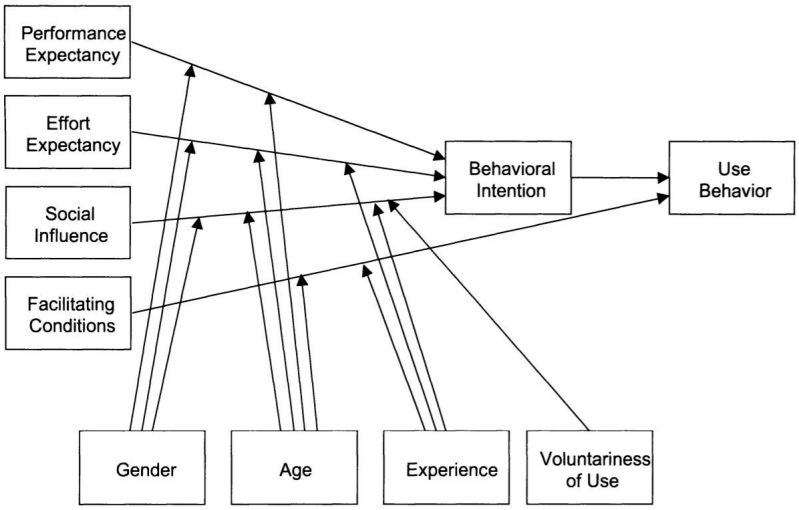


Fig. 1. Conceptual diagram for the UTAUT model (Source: Venkatesh et al. [11])

H3: Social influence has significant influence on usage behaviour

H4: Facilitating conditions have significant influence on usage behaviour

We got responses from 28 out of 30 (93.33% response rate) people who were given the questionnaire. Of the 28 respondents, 11 were male and 17 were female. Furthermore, the age distribution of the respondents were: 18-25 (14%), 26-30 (39%), 31-35 (29%), and 36-40 (18%). Besides, while the education qualifications of respondents were as shown in Fig. 2, the roles played by the respondents at the hospital were as shown in Fig. 3.

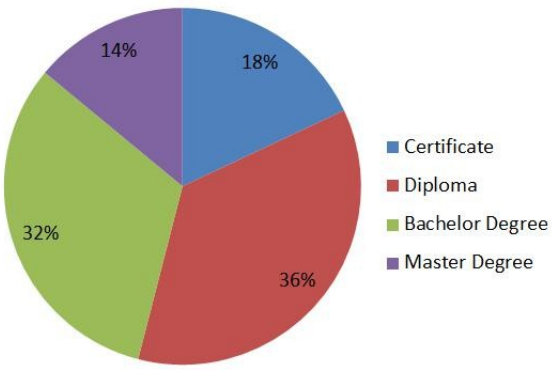


Fig. 2. Respondents' education qualifications

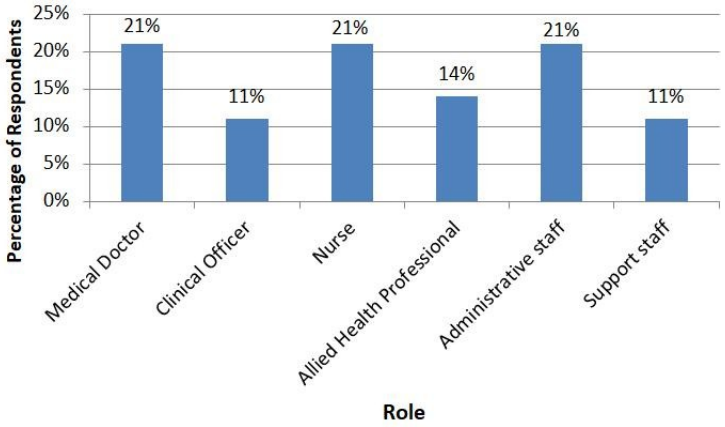


Fig. 3. Respondents' roles at Kisiizi Hospital

4.3 Data Analysis

We used Grounded Theory [25] to analyze interview data. Three stages were followed: (1) axial coding {relating codes (categories and properties) to each other via inductive and deductive thinking; (2) open coding {identifying, naming, categorizing and describing phenomena found in the text; and (3) selective coding {choosing one category to be the core category and relating all other categories to that category.

As for the quantitative data from the questionnaire, we tested each of the four null hypotheses using the one-way analysis of variance (ANOVA). We used SPSS 22.0 to conduct this analysis.

5 Results and Discussion

This section presents the results of our study and the discussion of their significance.

5.1 RQ1: System Acceptability and Usefulness

Regarding **Performance Expectancy**, the following were the main reasons for why the interviewed doctors, nurses and other clinicians accepted and used the system: the system's ability to act as diagnosis assistant, ensuring that important information is not missed during the diagnosis; facilitation of quick retrieval of patients' historical data; ensuring that drug prescriptions match guidelines; and facilitation of staff-staff and staff-patient communications. All of these can be linked to the fact that physicians from this hospital initiated and drove the system development and implementation process, capturing the local context; as opposed to other solutions whose development contexts might be different from the use contexts, introducing the design-reality gap [4]. However, medical

doctors also insisted that the system should as well be used by other staff in the hospital, to allow doctors enough time to cope well with loads of patients. As the implementation of the system at the hospital continues, this concern deserves due attention, to avoid lengthy workdays, reduction in numbers of patients seen, or both, as argued by Miller and Sim [26]. For example, the system can be adjusted in such a way that doctors and clinicians can appreciate the efficiency and effectiveness brought by the system in their routine work flows.

With respect to **Effort Expectancy**, interviewees thought that Stre@mline is easy to use as it mimics their usual work flows. However, since the system is used in only some departments in the hospital, some users were concerned with the need to write manual notes, in addition to entering the same data into the system. This is especially true when communication has to be done between two hospital sections, one of which does not use the system. In general, these are the challenges one can expect when the system is implemented in only some sections of a large integrated organisation. They can be addressed by implementing the system in all sections of the hospital.

As regards **Social Influence**, peer support and management support were reported by interviewees to have been the catalyst for system learning and use. Nonetheless, in some sections, the presence of a few staff trained on system use meant that the system could not be used to its full potential in service delivery. Training of all staff across all hospital sections could address this challenge. Finally, with respect to **Facilitating Conditions**, interviewees said that the management championed system use by ensuring that the infrastructure required to use the system is in place. Interestingly, given the level of support the hospital management has provided in developing and operationalizing the system, some interviewees believe that even the existing challenges, such as the scarcity of computers and the associated devices, and instability of the computer network at the hospital, will be addressed in due time.

Apart from the four factors of the UTAUT model, User Resistance came out of the interviews as another important factor that affected the adoption of the system. Particularly, a clique of hospital staff tried to resist the system in the early days of implementation:

> *"Some nurses claim they are quite busy and do not have the time to use Stre@mline. Because of the culture, there has been little resistance to change under the guise of the deception that it is adding more to their workload, I think most people are not keen to take on more work even if it provides more accurate data for the patient safety, but my hope is that continuous demonstration and education of the use of the system can help" (Interview 7, Medical Doctor).*

Apt leadership, with the ability to manage changes, would be required to see the hospital through the complete adoption of the system.

5.2 RQ2: Significance of Factors Influencing System Usage

As highlighted in section 4.3, we used the one-way Analysis of Variance (ANOVA) to test the hypotheses stated in section 4.2. This method compares the means

of more than two independent groups to determine whether the means are significantly different. A significance level of 0.05 indicates a 5% risk of concluding that a difference exists when there is no actual difference. If the p-value obtained is less than or equal to the significance level, the null hypothesis is rejected; and if the p-value is greater than the significance level, there is not enough evidence to reject the null hypothesis.

Table 1 summarises the significance levels of various factors that affect usage behaviour of the system, as reported by respondents. For H1, 3 variables (PE1, PE3, and PE6) had p-values (refer to the Sig. column in Table 1) greater than 0.05, with high significance levels; and 3 variables (PE2, PE4 and PE5) had lower levels of significance with p-values less than 0.05. Thus, because of the significance showed by the 3 independent variables, H1 was not rejected. For H2, while EE1 and EE2 registered p-values greater than 0.05, the p-value for EE3 was less than 0.05. Thus, H2 was not rejected because majority of the variables had higher levels of significance. Also, both two variables for H3 had p-values greater than 0.05, leading to accepting the hypothesis. Finally, H4 had 2 variables (FC2 and FC3) whose p-values scored greater than 0.05, and two variables with p-values less than 0.05. Thus, H4 was not rejected.

Table 1. Significance levels of factors influencing the adoption of the system

Hypothesis	Variable	Sig.
H1: Performance Expectancy	Stre@mline helps me do my tasks more quickly (PE1)	0.363
	Stre@mline has improved the quality of work I do (PE2)	0.001
	It has made it easier for me to do my job (PE3)	0.893
	It provides me with accurate information (PE4)	0.015
	It makes data analysis easier (PE5)	0.007
	It has given me greater control over my job (PE6)	0.498
H2: E ort Expectancy	Find it easy to use (EE1)	1.000
	Learning to use it was easy for me (EE2)	0.712
	I am comfortable with using it (EE3)	0.034
H3: Social Influence	Management thinks I should use it (SI1)	0.279
	Colleagues think I should use it (SI2)	0.307
H4: Facilitating Conditions	Training was availed to me (FC1)	0.013
	Management provides necessary resources (FC2)	0.197
	It fits well with my work (FC3)	0.085
	A specific person is available for support (FC4)	0.009

In general, from the ANOVA results in Table 1, all of the four factors from the UTAUT Model, Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions significantly influenced the usage of the system. More specifically, with respect to **Performance Expectancy**, while perceived job simplification significantly influenced the system usage behaviour (see PE1, PE3 and PE6), there was no significant evidence that the use of data and

information from the system to inform various aspects of the respondents' work significantly influenced the usage behaviour (see PE2, PE4, and PE5). This suggests that, so far, data from the system has not been widely used as the main decision supporter.

Further, with reference to **Effort Expectancy**, the easiness with which the system could be learned and used significantly influenced the usage behaviour (refer to EE1 and EE2). However, some respondents were yet be comfortable with using the system (refer to EE3). This suggests the need for more training and support as the system continues to be used at the hospital. As well, with respect to **Social influence**, the support from both management and peers had significant influence on the usage behaviour (see SI1 and SI2). Finally, as regards **Facilitating Conditions**, while management support and the perceived alignment of the system with the respondents' works significantly influenced the usage behaviour (see FC2 and FC3), neither training (FC1) nor availability of continuous support (FC4) seems to have significantly influenced the usage behaviour. However, it is our intuition that more training and institutional arrangements for continuous user support could improve system use in the long run.

6 Conclusions

Several factors affect the adoption and use of EMRs in low-income settings. In this paper, we have used interviews and questionnaires, focusing on four factors from the UTAUT model [11], to study the adoption of a locally developed EMR in rural Uganda. The following factors, mainly attributed to users' initiatives and continuous involvement, were found to have largely affected the adoption of the EMR: expected improvement in job performance, the easiness with which the system can be learned and used, support and influence from management and peers, and the availability of organisational and technical infrastructures to support the use of the system. We have also provided the implications of the findings.

Part of our future work is to evaluate the adoption of the system with large numbers of users, and from all of the five hospitals that are using the system; to generate more insights on the effectiveness of locally developed EMRs in low-income settings.

Bibliography

[1] R. Kukafka, J. S. Ancker, C. Chan, J. Chelico, S. Khan, S. Mortoti, K. Natarajan, K. Presley, and K. Stephens, Redesigning electronic health record systems to support public health," Journal of biomedical informatics, vol. 40, no. 4, pp. 398{409, 2007.

[2] F. Williams and S. Boren, The role of the electronic medical record (emr) in care delivery development in developing countries: a systematic review," Journal of Innovation in Health Informatics, vol. 16, no. 2, pp. 139{145, 2008.

[3] D. Roden, H. Xu, J. Denny, and R. Wilke, Electronic medical records as a tool in clinical pharmacology: opportunities and challenges," Clinical Pharmacology & Therapeutics, vol. 91, no. 6, pp. 1083{1086, 2012.

[4] R. Heeks, Health information systems: Failure, success and improvisation," International journal of medical informatics, vol. 75, no. 2, pp. 125{137, 2006.

[5] J. S. Mtebe and R. Nakaka, Assessing electronic medical record system implementation at kilimanjaro christian medical center, tanzania," Journal of Health Informatics in Developing Countries, vol. 12, no. 2, 2018.

[6] H. C. Kimaro and J. L. Nhampossa, Analyzing the problem of unsustainable health information systems in less-developed economies: case studies from Tanzania and Mozambique," Information Technology for Development, vol. 11, no. 3, pp. 273{298, 2005.

[7] M. Carey, N. Noble, E. Mansfield, A. Waller, F. Henskens, and R. Sanson-Fisher, The role of ehealth in optimizing preventive care in the primary care setting," Journal of medical Internet research, vol. 17, no. 5, 2015.

[8] H. Kelley, M. Chiasson, A. Downey, and D. Pacaud, The clinical impact of ehealth on the self-management of diabetes: a double adoption perspective," Journal of the Association for Information Systems, vol. 12, no. 3, p. 208, 2011.

[9] F. Verbeke, G. Karara, and M. Nyssen, Human factors predicting failure and success in hospital information system implementations in sub-saharan africa.," in MedInfo, pp. 482{486, 2015.

[10] K. Cresswell and A. Sheikh, Organizational issues in the implementation and adoption of health information technology innovations: an interpretative review," International journal of medical informatics, vol. 82, no. 5, pp. e73{e86, 2013.

[11] D. Venkatesh, V., Morris M, G., Davis G, B. and Davis F, User Acceptance of Information Technology: Toward a Uni ed View," MIS Quarterly, vol. 27, no. 3, 2003.

[12] A. Nilashi, M., Ahmadi, H., Ahani, A., Ibrahim, O and Almaee, \ Evaluating the Factors Affecting Adoption of Hospital Information System Using Ana-lytic Hierarchy Process', Journal of Soft Computing and Decision Support Systems," vol. 3, no. 1, 2016

[13] N. I. Ismail, N. H. Abdullah, and A. Shamsuddin, Adoption of hospital information system (his) in malaysian public hospitals," Procedia-Social and Behavioral Sciences, vol. 172, pp. 336{343, 2015.

[14] A. L. Terry, G. Giles, J. B. Brown, A. Thind, and M. Stewart, \Adoption of electronic medical records in family practice: the providers' perspective," Family medicine, vol. 41, no. 7, p. 508, 2009.

[15] H. Pedersen, P, E and Nysveen, Usefulness and Self-Expressiveness: Extending TAM to Explain the Adoption of a Mobile Parking Service," 16th Bled eCommerce Conference, 2003.

[16] D. Manueli, K., Latu, S. and Koh, ICT adoption models," Samuel, M. and Noel, B. (Eds.), paper presented at the 20th Annual Conference of the National Advisory Committee on Computing Qualifications (NACCQ), Nelson, New Zealand, Samuel, M. and Noel, B. (Eds.)., 2007.

[17] M. R. Hoque, Y. Bao, and G. Sorwar, Investigating factors in uencing the adoption of e-health in developing countries: A patient's perspective," Informatics for Health and Social Care, vol. 42, no. 1, pp. 1{17, 2017.

[18] S. A. Sherer, C. D. Meyerhoefer, and L. Peng, Applying institutional theory to the adoption of electronic health records in the us," Information & Management, vol. 53, no. 5, pp. 570{580, 2016.

[19] M. Nilashi, H. Ahmadi, A. Ahani, R. Ravangard, and O. bin Ibrahim, Determining the importance of hospital information system adoption factors using fuzzy analytic network process (anp)," Technological Forecasting and Social Change, vol. 111, pp. 244{264, 2016.

[20] H. Ahmadi, M. Nilashi, L. Shahmoradi, and O. Ibrahim, \Hospital information system adoption: Expert perspectives on an adoption framework for malaysian public hospitals," Computers in Human Behavior, vol. 67,
pp. 161{189, 2017.

[21] M. J. Wills, O. F. El-Gayar, and D. Bennett, Examining healthcare professionals acceptance of electronic medical records using utaut," Issues in Information Systems, vol. 9, no. 2, pp. 396{401, 2008.

[22] B. Kijsanayotin, S. Pannarunothai, and S. M. Speedie, Factors influenc-ing health information technology adoption in thailand's community health centers: Applying the utaut model," International journal of medical informatics, vol. 78, no. 6, pp. 404{416, 2009.

[23] L. Liang, M. O. Wiens, P. Lubega, I. Spillman, and S. Mugisha, A locally developed electronic health platform in uganda: Development and imple-mentation of stre@ mline," JMIR Formative Research, vol. 2, no. 2, p. e20, 2018.

[24] R. Dehnavieh, A. Haghdoost, A. Khosravi, F. Hoseinabadi, H. Rahimi, A. Poursheikhali, N. Khajehpour, Z. Khajeh, N. Mirshekari, M. Hasani, et al., The district health information system (dhis2): A literature review and

meta-synthesis of its strengths and operational challenges based on the experiences of 11 countries," Health Information Management Journal, p. 1833358318777713, 2018.

[25] L. S. Anselm, G. Barney, and G. Glaser, The discovery of grounded theory: Strategies for qualitative research," LWW, 1967.

[26] R. H. Miller and I. Sim, Physicians use of electronic medical records: barriers and solutions," Health affairs, vol. 23, no. 2, pp. 116{126, 2004