Usability Assessment of the Electronic Patient Management System for AIDS & TB Services in Zimbabwe

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Abstract

Introduction: Medical care is provided in a complex environment by multidisciplinary teams. There is great need for high levels of coordination among teams. Paper medical records pile up that need referring back to. Sometimes finding a piece of medical history can be difficult. Information and communication technology solutions can solve such problems. The Zimbabwean AIDS & TB Unit of the Ministry of Health installed an electronic Patient Management System in 83 health facilities to alleviate the overburdened paper system. It is important to for the Unit to carry out a usability assessment of the system, to determine how usable it is. The more competently the users operate the system, the better the service AIDS & TB patients receive from them. Aim: To perform a usability assessment of the new electronic Patient Management System based on user experiences at the 83 high volume facilities where it was installed. Objectives: Review literature on usability of the electronic Patient Managements System; To construct a questionnaire and investigate the usability of the system; To analyse the results and investigate factors affecting the usability of the system. Methods: A cross sectional survey of the 83 facilities was done using a self-administered questionnaire as the data collection tool. Multiple linear regression analysis was done to investigate factors affecting usability of the system. Differences between demographic subgroups were investigated. Results: 48 (57%) of the 83 facilities responded. In a multiple linear regression analysis only amount of time a facility had spent with the system was found to have a linear relationship with the usability of the system (R^2 = 0.2623; 95% CI). There were no differences among demographic sub-groups. Discussion: The training that came with the installation of the system was good enough to cancel out the demographic factors that would have influenced the usability of the system. Acquiescence response bias and social desirability bias may have been contributing factors. Conclusion and Recommendations: The perception of system usability and competency in use will improve with time. An assessment that captures all the facilities may give better insights into the issue of usability.

Keywords

Subject Areas: Nursing, Public Health

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1. Introduction

1.1. Background

Medical care is provided in a highly coordinated environment consisting of complex work processes performed by multidisciplinary teams. There is often great need for high levels of coordination between these teams. Paper work often piles up in the form of medical records that often need referring back to. Sometimes finding a piece of medical history can be difficult. The paper based records may be misplaced, may not be legible enough to read or could have been destroyed by a natural disaster. This may lead to errors such as prescribing certain drugs to a patient who is allergic to them. Coordination between these multidisciplinary teams can be flawed such that patients may have the same medical procedures unnecessarily repeated or done incorrectly.

Using information and communication technology solutions can help solve such problems. An example is electronic medical records. In Zimbabwe, the AIDS & TB Unit of the Ministry of Health and Child Care (MoHCC) installed an electronic patient management system (ePMS) in what they deemed were high volume (health) facilities in order to alleviate the overburdened paper system. Computers are not as passive as paper, and can give feedback when tasks are being performed. An alert signal when you prescribe a drug that a patient is allergic to for example. Medical records can also be stored in legible form as computer based records. The use of computer data backups can also help protect records from destruction and loss.

The Ministry of Health and Child Care (MoHCC) case of the AIDS and TB Unit:

HIV prevention programmes in Zimbabwe began the 1990's. Since then patient data has been collected and processed manually using paper based systems. However, because of the large numbers of people requiring HIV services, these paper based systems have become over-burdened. This has negatively affected the quality and timeliness of data used to monitor, track and report on patients [1].

In order to solve this problem MoHCC's AIDS and TB Unit has been installing electronic patient management systems (ePMS) in health facilities offering HIV services and prevention programmes. In the period between December 2012 and December 2013, MoHCC completed its initial phase of ePMS rollout in 83 "high volume" facilities. The intention is to expand the installation to 350 health facilities in the 2nd year and up to 454 health facilities by the 4th year [1].

The AIDS & TB Unit is carrying out assessments of their ePMS based on the first phase of their ePMS installation in order to correct the short comings of the first phase of ePMS installation and to prevent passing them on the next phases of the ePMS launch.

The AIDS and TB Unit therefore sent its teams to the different facilities scattered throughout the provinces of Zimbabwe (it routinely does so) to carry out it assessments and investigations on the ePMS. This study was piggybacked on one of the ePMS team's deployment to ePMS facilities and utilized that opportunity to distribute self administered questionnaires to ePMS users at the sites that the ePMS teams were visiting. Thus carrying out the study: Usability assessment of the electronic patient management system for AIDS and TB services in Zimbabwe.

The usability assessment was important for the purposes of investigating the perceptions and experiences of the users of the system, in order determine whether or not the users of the system are comfortable with system. The more comfortable the users are with the system the better they can use it and the more benefits patients can get from an improved and more efficient service delivery system. Usability is a quality attribute that assesses how easy user interfaces are to use [2]. This study will inform MoHCC's future decisions on how to proceed with the 2nd, 3rd and 4th phases of its ePMS rollout and better maximize the benefits of ePMS by correcting the areas to do with usability (if any) that the users are having problems with.

Usability testing is necessary because it gives a good indicator of how well the users of the ePMS system will be able to utilize it. Usability looks at the graphic user interface (heuristics) of the software and how it has been designed to be user friendly among other things. Usability aspects to do with the graphic user interface are known as heuristics and include software-user interaction, learnability, cognition facilitation, user control and software flexibility, system real world match, graphic design, navigation and exiting, consistency, defaults,

software system interaction, help & documentation and error management [2]-[4]. Use case frameworks have been designed to guide usability assessments based on these heuristics [4].

1.2. Statement of the Problem

The AIDS and TB Unit have not done a usability assessment of its electronic patient management system. Such information is crucial for the next phases of the system's roll out.

Research Questions

1) What is usability of the ePMS system in the 83 high volume facilities for AIDS and TB services in Zimbabwe?

2) What is the software-user interaction, learnability and cognition facilitation in the 83 high volume facilities that are using the ePMS system, based on recommendations from the Electronic Health Record Usability Evaluation and Use Case Framework document?

3) What is the user control, software flexibility, system real world match and consistency in the 83 high volume facilities that are using the ePMS system, based on recommendations from the Electronic Health Record Usability Evaluation and Use Case Framework document?

4) What is the software system interaction of the 83 high volume facilities that are using the ePMS system, based on recommendations from the Electronic Health Record Usability Evaluation and Use Case Framework document?

1.3. Purpose of the Research

The purpose of this research is to perform a usability assessment of the ePMS, based on the users' perceptions and experiences, at the 83 high volume health facilities where the ePMS was installed in the 1st phase of installation.

1.4. Specific Objectives

The specific objectives of this research were:

To construct a tool/questionnaire to investigate the usability of the ePMS at the 83 high volume facilities offering AIDS and TB services; To apply the assessment tool on the 83 high volume facilities; To investigate factors that affecting the usability of the ePMS.

1.5. Operational Definitions Used in the Study

Usability: The degree to which a user of an electronic (health) application, software or system finds it easy to use.

Users: The people that use the electronic patient management system to provide AIDS and TB services at the health facilities through Zimbabwe. They fall into categories: healthcare managers, healthcare providers and data entry clerks.

2. Literature Review

2.1. Introduction

Literature review was done to look at what other scholars, experts and specialist institutions have already found pertaining to usability of electronic medical records (EMR) and electronic patient management systems (ePMS). It also looks at studies that explore the relationship between demographics and response to information communication technologies (ICT), EMR and ePMS included.

2.2. Literature Review Body

Information and communication technology (ICT) has evolved rapidly and has made critical contributions in many sectors if not all. The health sector is also benefiting from the adoption of ICT applications designed to meet this sector's needs. These include clinical decision support systems, electronic medical records, telemedi-

cine systems, veterinary information systems, drug stock management systems, body area networks, tele-presence and tele-robotic surgery among others.

An Electronic Medical Record (EMR) system is one of the most commonly developed ICT applications. In particular, they benefit hospitals, clinics and private practice doctors. Other health related organizations can also use EMR. Health insurers are one example. EMR is intended to keep track with a patient's health and medical history in an electronic format (Torrey, 2012). Keeping these records in digital or computerized format makes them easy to retrieve. It also makes the patient's sequence of events within a health facility more efficient than one with paper records since relevant data is generally easier to retrieve. Different institutions will give different names to EMRs depending on the specific purpose for which they have them. Other forms of EMR are called electronic health records (EHR), personal health records (PHR) and electronic patient management systems (ePMS) among others.

EMR contains many components which include the following; computerized orders for prescriptions, computerized orders for laboratory tests, reports of the test results, patient support, clinical decision support systems, access to knowledge resources, billing and physician's notes, among others [5]. The ePMS mentioned in this study is essentially EMR. MoHCC calls it ePMS. Through the use of EMR, the information that was on patient paper charts is now kept electronically. As EMRs progress form being partly implemented to being fully implemented the hospital gravitates towards becoming a paperless system as far as patient records are concerned. This in turn solves issues to do with overburdened paper systems.

2.2.1. Benefits MoHCC Can Derive from Using EMR

EMR facilitates efficient administrative processes. Administrators skip the laborious process of having to dig through heaps of files to find patient information. EMR reduces cognitive load on the users by making patient information available at the click of a button. The patient goes through the hospital administrative processes faster and goes to get treatment faster, as a result.

Since ICT can duplicate information rapidly, once patient information is stored electronically, easy loss of that information can be prevented. Backup files can be made. Some EMR systems can automatically backup information. Fears of losing information due to natural disasters for example, are reduced. In the United Sates, after hurricane Katrina struck, patients who had their medical history in EMR systems got treatment easier, faster and safer since their accurate medical history was quickly retrieved and used [6].

Paper records will require large amounts of physical space to be stored as they accumulate. On the other hand EMR exists in electronic format and are stored in computers and servers which take up less physical space. Space that is taken up by medical records rooms and departments can be used for other purposes that are more clinical and hence the hospital can increase service delivery to its people through efficient use of space. The cost per square meter of building space is reduced since more of the building can now be used for more productive and/or income generating purposes.

Medication errors are reduced when using EMR systems. Paper is passive; therefore it will not warn a health professional if he/she attempts to prescribe medication that a patient is allergic to. Electronic systems on the other hand are interactive and can prompt the user to follow the right steps for whatever procedure they are doing. Also, because all the hospital visits of a patient can be stored in the EMR of patients together with the activities that took place, medical efforts are no longer duplicated. Clinicians can go straight to what has not yet been done for a patient since they can see all that was done for the patient on the EMR.

Diseases and disease trends can be monitored and tracked much more easily and possibly in real-time when using EMR since all the information can be obtained at the press of a button, complete and accurate. It is also easy to identify patients that are due for preventative measures for example patients that are at risk of drug resistance. The AIDS & TB Unit (Zimbabwe) can better monitor early warning signs for HIV drug resistance, which is the case with the ePMS that they have installed in their health facilities.

When using EMRs, research is also easier to carry out. The results of the research tend to be more accurate from EMR than from paper records. This is because paper records are more prone to deterioration. Therefore not all information will be retrieved from paper records. Paper records can also be lost or misplaced, making it difficult to find all the information necessary for research projects. Paper records also slow down research since researchers have to dig through heaps of paper files to find what they are looking for.

These are some of the benefits of electronic medical records among others.

2.2.2. Usability and Heuristics

Medical care is given in a highly coordinated and punctuated environment consisting of complex work process performed by multidisciplinary teams. This environment is almost always site and provider specific in terms of the workflow, the cognitive requirements and the decision making processes. ePMS or EMR systems are required to be effective in such clinical settings. The complex clinical environment is difficult to replicate in the lab where the ePMS is developed. Direct involvement of clinicians in the product development sometimes fails to accurately reflect clinician workflow [4].

In order to realize the full potential of the of the ePMS-user-patient relationship, wise choices must be made in terms of the choices of the system that a country or institution chooses to use. Issues such as environmental limitations and the uncertainty of the future need to be factored in. The information design of the system must be given careful consideration even after the implementation of a system so that the appropriate adjustments can be made [7].

Information design represents the art and science of preparing and conveying information so that it can be used by human beings with efficiency and effectiveness [7]. When done well it maximizes usability of information systems. An ePMS for example, should reduce the burdens of the following workloads on the user, among others; ergonomic workload, cognitive workload (to do with reading, thinking and deciding) and data comprehension [4]. This is achieved by providing the user with memory aid, computational aid, decision support and collaboration aid. The design of the system and the proper use of graphics within the user interface help achieve all this.

The system must use a language that the users are familiar with. The icons on the graphic user interface must be easy to understand in order to reduce cognitive workload. There should not be too much information—clutter—on one page such that the user will struggle to find the appropriate information.

Information required to perform a single task must be found on the same page and the system should not require the user to enter the same information over and over again. The system should provide task oriented action options such as ordering lab tests and electronic prescribing. Computational functions should be available on the software and graphs shown should aid data comprehension.

The computer displays must force the user to view the data spatially rather than sequentially in order to aid comprehension. This is done by increasing data density, which is the number of entries in the data matrix/area of the graphic [8].

2.2.3. Possible Factors Affecting Usability

The needs of the site (or health facility) and the users will vary depending on many factors, particularly demographic, geographical and socio-economic factors. This also means that, how different users rate the usability of the same ePMS may vary.

Not everyone will find the same system usable or rather usable to the same extent. In some settings, for example, children generally know how to use electronic gadgets far much better than their parents. In other words children generally find electronic gadgets more usable than their parents do. The things that motivate children to learn how to use gadgets are different from those that motivate their parents to learn how to use the same gadgets. The enthusiasm of the 2 groups is different as and so is the willingness to learn how to use these gadgets. The young are fundamentally different from the old in terms of their technological abilities, communication skills and the way they are socialized [9]. Nasi and colleagues did a study in Finland, in his article he mentions that young adults aged between 16 - 34 years are by far the most active users of ICT. Social networks motivate young adults to use ICT more often than older age groups do. In a health facility, young adult employees are likely to learn work related ICT faster than older employees and find ICT applications to be more usable. This is because of their frequent use of ICT outside of the work place. ICT applications in the work place probably will not feel like a new concept to them. This "age digital divide" is likely to influence variations in how employees at the same institution find their ePMS system.

Gender may also affect how usable one may find an ICT application such as an ePMS. Variations are likely to arise among employees in the same institution, using the same ePMS system. The ways in which ICTs are used by men and women reflect the sociocultural and economic contexts within which they are used [10]. This means in a health facility where both man and women are using the same ePMS and have the same opportunities to do so—the context—their usability rating are likely to be the same. On the other, it is the circumstance before the ePMS was introduced that may affect how usable an individual will found it. Gender disparities in ICT exposure,

if they exist outside of the work place are likely to influence how people of different genders will feel comfortable using the new ICT application in the work place. If it is not a socio-cultural norm for example for a certain gender to use ICTs outside of the work environment, when ICTs are finally introduced in the environment, people of that gender may take longer to adjust to the change.

Another factor that may cause variations in how users find the ePMS system usable is geographic location. If the ICT penetration in an area is low, that means for people in that area, regardless of gender, use of ICTs may not be a socio-cultural norm. Therefore if an ePMS is introduced in a health facility in such an area, they are likely to adjust at a different rate, regardless of training prior to the introduction of the system [10]. In 2010, 5.3% of households in Zimbabwe had a computer [11], however most of these households was concentrated in urban areas. ICTs agglomerate more around places where a power grid, as well as the necessary broadcast and communication networks, are available; in other words, more in urban than in rural areas [10], making ICT use in urban areas socio-cultural norm.

Highly educated individuals use the Internet more often and for more versatile purposes than less educated ones [9]. This means that educational back ground can be another influencing factor of how people get used to ICT applications in the workplace.

When the heuristics of the ePMS are done well the software becomes "usable" to the users, and there is easy buy-in to the new ePMS. This study sought to find out whether or not the users of the ePMS felt that its heuristics made it a usable system taking into accounts demographic and socio-cultural differences.

2.3. Scope of Literature Review

Search terms that were used in this literature review include; EMR, EHR, EMR usability, heuristics, gender and ICT use, questionnaire design, socioeconomic factors affecting ICT use, ICT age divide, change management and the digital divide.

3. Methods

3.1. Introduction

A self administered questionnaire was constructed using heuristics concepts from the Agency of Healthcare Research and Quality's "Electronic Health Record Usability—Evaluation and Use Case Frame Work" document. This 5 point likert scale questionnaire was designed to investigate user's perceptions of the electronic patient management system (ePMS) on its overall usability based on the heuristics of the system. Each heuristic aspect had its own section in the questionnaire. Essentially, the questionnaire asked whether or not the respondents agreed that the ePMS is usable. The study was piggybacked on the Ministry of Health and Child Care (MoHCC) AIDS and TB Unit's field work (which involved visiting the 83 high volume health facilities where the system was installed in the first phase of installation). Thus the questionnaire was distributed via AIDS and TB Unit team members who were doing MoHCC field work (the field work had nothing to do with the study) at those facilities. The piggybacking was done because that is the kind of access that the study was recommended allowed by MoHCC, and also because individually visiting the facilities without making use of the MoHCC teams and transportation resources would have been expensive and getting the questionnaires answered would have been difficult had it not been done true the MoHCC teams because despite the fact that permission to carry out the study had been granted by MoHCC, extracting information from government departments is generally difficult for non-government employees, even those with official written permission. The AIDS and TB unit ePMS teams interact with the target respondents (who are ePMS users in the following categories: healthcare managers; healthcare providers and data entry clerks) during their field work. Respondents would complete the questionnaire, if time permitted, while the ePMS was deal with their issues.

3.2. Type of Research

This research was both quantitative and qualitative in nature.

3.3. Study Design

The study was a cross sectional facility survey, to investigate whether or not the users of the AIDS and TB

ePMS agreed that it was a usable system based on its heuristics.

3.4. Target Population

The target population was all the health facilities in Zimbabwe offering AIDS and TB services under or in partnership with MoHCC.

3.5. Study Population

The study population was all the 83 facilities in which the ePMS was installed in the 1st of ePMS rollout in Zimbabwe by the AIDS and TB Unit of MoHCC.

3.6. Study Sample

This study was piggybacked on AIDS and TB Unit ePMS teams field work were 5 teams and been assigned by MoHCC to visit all 83 facilities. Therefore all 83 facilities were targeted by this study. It was convenience sampling.

3.7. Data Sources

The targeted respondents from which all data for this study came where any healthcare managers, healthcare providers and data entry clerks that had been trained by the ePMS team on the use of the ePMS and were involved in the use of ePMS for provision of AIDS and TB services at healthcare facilities where they worked. In this case the 83 healthcare facilities where ePMS was installed in the 1st phase of ePMS rollout. The questionnaire was reviewed by the AIDS and TB Unit heads of ePMS and piloted in 2 healthcare facilities with ePMS before it was deployed.

3.8. Variables

The first variable the study looked at was usability. The questionnaire was score and a threshold score was determined (the threshold score was the score that one would get if he/she answered undecided for every question). That score was 93 for the entire questionnaire. Any score above 93 indicated that the respondent generally agreed that the ePMS was usable. A score of 93 was interpreted as generally undecided and a score bellow 93, disagreement. Both the numerical score and the usability agreement (or disagreement or undecided) were recorded as variables for every respondent. The highest possible score for the questionnaire was 153.

The questionnaire was also divided into section of different heuristics, each section had its own threshold score, and the total of the threshold scores for the different sections was the threshold score of the entire questionnaire. The heuristics that the questionnaire covered are; software user interaction, learnability, cognition facilitation, user control and software flexibility, system real-world match, navigation and existing, consistency, defaults, software system interaction, help and documentation, and error management. These were adopted from the Agency for Healthcare Research and Quality "Electronic Health Record Usability: Evaluation and Use Case Frame Work" publication [4].

The other variables that were recorded include: The designation of the respondent—That is, whether he/she was a healthcare manager, a healthcare provider or a data entry clerk; The gender of the respondent was recorded; The age in years, of the respondents was recorded; The period of time the respondent had spent working at that institution was recorded in months and years; The number of years of experience that the respondent had in his/her profession was recorded in years and months; The period of time for which the facility had been using the ePMS was recorded; Exposure of the respondent to electronic health interventions prior to ePMS was also noted; If the respondent had prior exposure to electronic health interventions, the number of years of experience with electronic health interventions was also recorded; The province in which the health facility is situated was also recorded. These variables were recorded because they were thought to potentially influence the perception of usability, on a user based on the literature review that had been done.

Reliability and Validity of Data Source

The target respondents of the questionnaire were the best sources of data since they are the actual users of the

ePMS.

3.9. Bias and Limitations

This study like any other study was prone to levels of bias and limitations.

Since data was being collected using questionnaire, there were 3 possible types of bias in responding to the questionnaire. Central tendency bias where respondents avoid using extreme response categories, acquiescence response bias where respondents tended to agree with statements as they were presented and social desirability bias where respondents could have tried to portray their health facility and department a good light. The fact that it was a self administered questionnaire means that there was no way of ascertaining the sincerity of the respondents.

The ePMS teams were not able to bring a questionnaire back from every facility sometimes due to time constrains in performing their field work tasks. If this study had adequate funding, it would have been better not to rely on MoHCC employees for the delivery of questionnaires.

3.10. Statistical Processing

Data was analyzed using Stata® 13.

3.10.1. Descriptive Statistics

Measures of spread of the numerical score per questionnaire were calculated, the demographic of the respondents were described also, categorical and numerical variables were described.

3.10.2. Analytic Statistics

Multiple linear regression analysis to find out if the numerical score (and hence usability) varied with Age, Gender, "period of time a respondent had worked at a facility", "the respondent's number of years of experience in his/her profession", "the period of time for which the facility had had ePMS" and the respondent's number of years of experience with ehealth interventions if any. The multiple regression analysis was done at 95% confidence level taking not of the P-value and the t-statistic for each variable being analyzed. This is an appropriate test for all the numerical variables and some categorical variables such as gender.

Pearson's chi squared test and fisher's exact test where done for gender and usability; and of time the facility had ePMS and usability; age group (at 10-year interval) and usability; province and usability as well as previous exposure to ehealth interventions and usability. These were appropriate test for all the categorical variables measured. Fisher's exact test was added because is it appropriate where there are expected values below 5 and the number of observations is low.

3.11. Associations Measured

The following are the associations that were measured:

Age and the (usability) score; Gender and the (usability) score; Period of time a respondent had worked at a facility and the score; The respondent's number of years of experience in his/her profession and the score; The period of time for which the facility had had ePMS and the score; The respondent's number of years of experience with e health and the score; Gender and usability; Time the facility had had ePMS (as a categorized variable) and usability; The period of time for which the facility had had ePMS and usability; Age ground and usability and province and usability.

3.12. Ethics and Permissions

The study protocol was approved by the Postgraduate and Research & Higher Degrees Committee at the School of Nursing and Public Health University of KwaZulu-Natal.

Permission to carry out this research was granted by the AIDS and TB Unit of the Ministry of Health and Child Care.

The ethical approval was obtained from the Humanities and Social Sciences Research Ethics Committee of the Nelson R Mandela School of Medicine South Africa (Reference number HSS/0811/014M EXP003/06).

Informed consent was sought from all participants.

4. Results

4.1. Introduction

Self administered questionnaires were distributed via the ePMS teams of the AIDS and TB Unit that were on deployment to the 83 health facilities. The questionnaires ask whether or not the users of the ePMS agreed that the ePMS was usable. Multiple linear regression analysis was done using Stata® 13 for numerical variables and Pearson's chi-squared as well as Fisher's exact tests were done for categorical variables.

48 out of 83 facilities responded with one respondent per responding facility affording this research a study population representation at 95% confidence level at 10% confidence interval.

4.2. Presentation of Data

1) Description of important variables:

At n = 48, the mean score was 113.9167 with a standard deviation of 18.16454. A score bellow 93 was categorised as disagree, a score of 93 as undecided and a score above 93 was categorized as agree in the usability categories (**Table 1**).

Table 2 shows the number of respondents that agreed that ePMS was usable, by virtue of scoring above 93 in their questionnaire responses and those that disagreed by virtue of scoring belong 93 in the questionnaire responses along with those that were undecided by virtue of scoring of 93.

At n = 48 the mean age was 33.04167 with a standard deviation of 9.773952 (**Table 3**).

Table 4 shows the distribution of the respondents by age group where n = 48.

Table 5 shows the distribution of respondents by gender, n = 48.

2) Cross tabulations and analytical tests applied:

Table 6 shows gender against usability where n = 48. Pearson chi^2 (2) = 2.5415; P = 0.281 and Fisher's exact = 0.360.

Table 7 shows the cross tabulation of respondent's designation and usability. Pearson's chi^2 (4) = 4.8980 = P = 0.298 and Fisher's exact = 0.467.

In **Table 8**, tEPMS is the period for which a facility has had ePMS. The Pearson chi^2 = 4.9286 and P = 0.085. Fisher's exact test = 0.07.

Table 9, n = 48; Pearson chi^2 = 1.3174 and P = 0.504 and Fisher's exact test = 1.000.

A multiple linear regression analysis to find out if the numerical score (and hence usability) varied with Age, Gender, "period of time a respondent had worked at a facility", "the respondent's number of years of experience in his/her profession", "the period of time for which the facility had had ePMS" and the respondent's number of years of experience with ehealth interventions. The results are shown in **Table 10**. The confidence level for the analysis was 95% and n = 48 for all variables where yrfacilityn = the number of years a respondent had worked

Table 1. Distribution of questionnaire scores from respondents.

Percentiles		Total score
		Smallest
1%	70	70
5%	84	70
10%	93	84
25%	104	84
50%	113	
		Largest
75%	128.5	139
90%	138	139
95%	139	140
99%	140	140

Table 2. Distribution of usability perception.

Usable agreement level category	Frequency	Relative frequency (%)	Cumulative relative frequency (%)
Undecided	2	4.17	4.17
Agree	42	87.50	91.67
Disagree	4	8.33	100
Total	48	100	

Table 3. Distribution of respondent's numerical age in years.

	Age	
Percentiles		**Smallest**
1%	22	22
5%	24	22
10%	25	24
25%	26.5	24
50%	30	
		Largest
75%	37	57
90%	45	57
95%	57	60
99%	60	60

Table 4. Distribution of respondents' age by age group.

Age group in years	Frequency	Relative frequency (%)	Cumulative relative frequency (%)
20 to 29	22	45.83	45.83
30 to 39	18	37.50	83.33
40 to 49	4	8.33	91.67
50 to 59	2	4.17	95.83
60 to 69	2	4.17	100.00
Total	48	100	

Table 5. Distribution of respondents by gender.

Gender	Frequency	Relative frequency (%)	Cumulative relative frequency (%)
Male	22	45.83	45.83
Female	26	54.17	100.00
Total	48	100	

at a facility; yrprofn = the respondent's number of years of experience in his/her profession; tEPMS = the time in years and months for which the facility had been on ePMS; yrEHLTH = the number of years of experience (if any) that the respondent had with electronic health interventions. The R-squared value is 0.2623.

5. Discussion

5.1. Introduction

The possible factors that could influence the users' perceptions of the electronic patient management system

Table 6. Pearson chi² and Fisher's exact test between gender and usability (2 degrees of freedom).

Usability				
Gender	Undecided	Agree	Disagree	Total
Male	2	18	2	22
Expected frequency	0.9	19.3	1.8	22.0
Female	0	24	2	26
Expected frequency	1.1	22.8	2.2	26.0
Total	2	42	4	48
Expected frequency	2.0	42.0	4.0	48.0

Table 7. Pearson chi² and Fisher's exacts test for designation of respondent and usability (4 degrees of freedom).

Usability				
Designation	Undecided	Agree	Disagree	Total
Manager	0	6	0	6
Expected frequency	0.3	5.3	0.5	6.0
Provider	0	14	0	14
Expected frequency	0.6	12.3	1.2	14.0
Data entry clerk	2	22	4	28
Expected frequency	1.2	24.5	2.3	28.0
Total	2	42	4	48

Table 8. Pearson chi² and Fisher's exact tests for period for which the facility has had ePMS and usability (2 degrees of freedom).

Usability				
tEPMS	Undecided	Agree	Disagree	Total
Less than 1 year	0	30	2	32
Expected frequency	1.3	28.0	2.7	32.0
1 to 2 years	2	12	2	16
Expected frequency	0.7	14.0	1.3	16.0
Total	2	42	4	48
Expected frequency	2.0	42.0	4.0	48.0

Table 9. Previous exposure to ehealth interventions and usability, Pearson chi² and Fisher's exact test (2 degrees of freedom).

Usability				
Previous exposure to ehealth	Undecided	Agree	Disagree	Total
No	2	34	4	40
Expected frequency	1.7	35.0	3.3	40.0
Yes	0	8	0	8
Expected frequency	0.3	7.0	0.7	8.0
Total	2	42	4	48
Expected frequency	2.0	42.0	4.0	48.0

Table 10. Multiple linear regression analysis (95% confidence intervals).

Variable	t-statistic	P-value
Age	−0.16	0.871
Gender	0.56	0.581
Respondent's time in years at the facility (yrfacilityn)	−0.89	0.379
Respondent's years of experience in profession (yrprofn)	0.80	0.431
Period of time in years the facility has been on ePMS (tEPMS)	−3.20	0.003
Respondent's years of experience with electronic health interventions	0.52	0.608

(ePMS), for AIDS and TB service in Zimbabwe, were analyzed. Some of these factors, especially age and gender were inspired by the studies and findings of M. Geldof and R. Holloway and well as M. Nasi and colleagues. Though these studies were looking at the how response to information communication technologies (ICTs) (and not particularly ehealth applications such as ePMS), varies with age, gender and other socioeconomic factors, and in particular M. Nasi and colleague were looking at online communities. Reference can still be made to these studies since ePMS is essentially ICT in the healthcare setting and the same principles should apply.

5.2. Findings

The P-value for the chi2 test at 2 degrees of freedom for the effect of gender on usability was 0.281 as shown in Table 6. This implies that any differences between the 2 genders are by chance and there is no significant difference between the 2 genders in their perception of the usability of the ePMS. A difference would have been expected owing to gender inequalities and disparities in education and ICT use in Africa [10]. However, based on the findings of this study, it was not so. This could because the training on the use of the ePMS that was given to the users by the ePMS team and heads was good enough to cancel out that "gender divide". Part of this gender effect includes the education (literacy) gap found between males and females in some countries where women are marginalized. However, with a 2011 male literacy rate of 87.8% and a female rate of 80.1% [12] such gaps are highly unlikely in Zimbabwe, especially in the formal employment sector. However, it is important to bear in mind that this finding is based on the response of 48 out of the 83 facilities. An alternative test, Fisher's exact test had a P-value of 0.360, this is confirmatory of the chi^2 test findings.

Table 7 shows a chi^2 test and Fisher's exact tests that were done to assess differences in the designations (posts) of the healthcare works' perceptions on the usability of the ePMS system. The chi^2 P-value is 0.298 showing no difference. The Fisher's exact test of 0.467 is confirmatory. This is a rather interesting finding. The 3 different designations of the targeted respondents were healthcare manager, healthcare provider and data entry clerk. The data entry clerks are supposedly people that have an ICT educational back ground and are employed by the AIDS and TB unit to assist with operating the ePMS, chiefly their role is to enter data retrospectively, while the healthcare managers and healthcare providers and managers feed current (real time) data into the ePMS. None of the data entry clerks had been working at any of the health facilities for more than 2 years when the study was done. They essentially came together with, and were necessitated by the ePMS. They are expected to find the ePMS more usable compared to the 2 other groups, even if heuristic of the ePMS system were "bad", simply because of their ICT educational background [10]. Again the lack in difference may be attributed the training that was give by the ePMS heads. Healthcare managers, healthcare providers and data entry clerks received the same ePMS training. This implies again that the training may have been good enough to cancel out the "educational (ICT savvy) divide". Otherwise it implies that the heuristics of the system are good from the perspective of the users and the system is indeed usable.

In Table 9, previous exposure to ehealth interventions is not sufficient enough to create a difference in, because not all ehealth applications are the same or work the same way. Mobile health and ePMS, for example, are completely different. Having exposure (and experience) in one may not give proficiency in the other.

In the multiple linear regression analysis to find out if the numerical score (and hence usability) varied with; Age, Gender, "period of time a respondent had worked at a facility", "the respondent's number of years of experience in his/her profession", "the period of time for which the facility had had ePMS" and the respondent's

number of years of experience with ehealth interventions shown in **Figure 1**. Usability varies with none of the variables but one. Based on [10] and [9]'s opinions, these are unlikely findings. In this analysis, the one variable that usability varies with is "the period of time for which the facility had had ePMS". The variable has a *P*-value of 0.003 which shows significance. The Pearson chi^2 and Fisher's exact test for this variable (see **Table 8**) have *P*-values of 0.085 and 0.07 respectively. These are almost significant. This implies that the more time the healthcare works at a facility spend with the ePMS the better their perception of its usability (and heuristics) becomes. While this is good, this is also interesting because it is difficult to tell if that improvement in usability actually has anything to do with improved heuristics, which are the foundation of the usability assessment or the first place. It could be that the more time they spend with the system, the better accustomed they become to it, hence they become able to go around the unchanged heuristics of the system and find it more and more usable with time.

5.3. Bias and Confounding

Bias

The biases that questionnaires are prone to cannot be rule out. These are central tendency bias where respondents avoid using extreme response categories, acquiescence response bias where respondents tended to agree with statements as they were presented and social desirability bias where respondents could have tried to portray their health facility and department a good light.

Also, considering that the questionnaires were sent to respondents through the AIDS and TB Unit ePMS team and that the study was targeting 83 healthcare facilities and respondents from only 48 facilities were "willing" to participate. These factors coupled with the fact that 87.5% of the respondents agreed that the system was usable. It is possible the ePMS team on deployment by the AIDS and TB unit of MoHCC targeted healthcare facilities where they anticipated favourable results; since ePMS is their project. Otherwise the results imply the heuristic of the system are good from the perspective of the users and the system is indeed usable.

5.4. Limitations of Results and Study Design

This was a rather ambitious study considering that questionnaires had to be distributed to 83 healthcare facilities across the 10 provinces of Zimbabwe and had to rely on the owners (AIDS and TB unit ePMS) of the projects' resources (in terms of transportation of questionnaires) to achieve this. Lack of funding was definitely one limitation. It could have been better collecting data using an interviewer administered questionnaire.

Another shortcoming of the study is the number of respondents per facility. It would have been ideal to get at least 1 healthcare manager, 1 healthcare provider and 1 data entry clerk, respond and from each and every one of the 83 targeted facilities as was the initial plan (as opposed to one responded per healthcare facility from only 48

```
. regress Score Age Gender yrfacilityn yrprofn tEPMS yrEHLTH
```

Source	SS	df	MS		Number of obs =	48
					F(6, 41) =	2.43
Model	4068.40002	6	678.066671		Prob > F =	0.0421
Residual	11439.2666	41	279.006503		R-squared =	0.2623
					Adj R-squared =	0.1544
Total	15507.6667	47	329.950355		Root MSE =	16.703

Score	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Age	-.0691204	.4214013	-0.16	0.871	-.9201576	.7819167
Gender	3.167545	5.688755	0.56	0.581	-8.321128	14.65622
yrfacilityn	-.7298982	.8214289	-0.89	0.379	-2.388807	.9290112
yrprofn	.6208047	.7803179	0.80	0.431	-.9550793	2.196689
tEPMS	-23.43563	7.31692	-3.20	0.003	-38.21245	-8.658812
yrEHLTH	1.639126	3.172513	0.52	0.608	-4.767894	8.046146
_cons	120.5985	12.98048	9.29	0.000	94.38391	146.8131

Figure 1. Multiple linear regression analysis in Stata® 13.

of the facilities). This would have produced high quality reliable data compared to what the study actually got. However, relying on the resources and the of the AIDS and TB unit, made this impossible.

Another limiting factor was the scarcity of literature that directly pertains to usability of ePMS and EMR studies being carried out. However, information was drawn from the closest related studies.

The study was also unique in that heuristics test should normally be done by ICT experts looking at the system (expert diagnosis) and making their conclusions [4]. This study brought a twist, were the perceptions of the users pertaining to the heuristics and usability of the system were put in the forefront. At the end of the day it is the users that spend more time with these electronic health applications such as ePMS, not "passerby" experts.

6. Conclusions and Recommendations

6.1. Introduction

This study proved to be fairly ambitious. While it had limitations and was prone to bias insights can be drawn from it.

6.2. Conclusions

Literature in this area of study is certainly scarce; however, the little that is there can be used to build up good cases to initiate new research as well as to further current research.

The questionnaire was an applicable tool for the usability assessment, though it could have been augmented with experts performing diagnostics on the system and drawing conclusions on the heuristics and usability of the system as it recommended by the Agency for Healthcare Research and Quality.

While other associations could not be found, usability of the ePMS from the user's perspective improves with time.

6.3. Recommendations

If be Ministry of Health and Child Care through the AIDS and TB unit, is to maximise benefits from the use of their ePMS system, it is important that they among other things continue to acquire information to do with user perceptions and experiences. Doing this study in a way that will curb its limitations will produce reliable results of good quality. This includes getting response from all the facilities involved and having all categories of relevant healthcare workers (healthcare managers, healthcare providers and data entry clerks in this scenario) participating in the study from each healthcare facility.

6.4. Recommendation for Further Study

The issue of user perceptions of newly installed electronic health (ehealth) applications such as ePMS inevitably leads to issues of change management. Since this is a new ehealth intervention in the Zimbabwean setting, it is important for MoHCC to look into possible gaps in its change management strategy, before it proceeds to the next phases of ePMS rollout. Better the planning leads to better chances of success.

Acknowledgements

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Acronyms and Abbreviations

AIDS: Acquired Immune Deficiency Syndrome;
ehealth: Electronic Health;
EMR: Electronic Medical Records;
ePMS: Electronic Patient Management System;
HIV: Human Immunodeficiency Virus;
ICT: Information Communication Technology;
MoHCC: Ministry of Health and Child Care;
TB: Tuberculosis.

Appendix 1. Questionnaire

Usability assessment of the electronic patient management system for AIDS & TB services in Zimbabwe (Questionnaire to be answered by data capturers, healthcare providers and healthcare managers).

		Responses
1	Name of institution:	
2	Province:	
3	Designation of respondent (put an X where appropriate):	Healthcare **Manager** ☐ **Your post:** _____ Healthcare **Provider** ☐ **Your post:** _____
4	**Gender** of respondent (put an X where appropriate):	Male ☐ Female ☐
5	**Age** of respondent in years:	
6	Period you have spent in this **institution**? (please provide answer years and months)	
7	Number of years of experience in your **profession**? (please provide answer in years and months)	
8	For how long has the health facility been using this ePMS system? Since: Day Month Year	
9	Did you have any previous experience with ehealth interventions **before** this ePMS system?	**Yes** ☐ **No** ☐
10	If yes what is your number of years of experience with ehealth?	

Appendix 2. Heuristics

Put an X in the appropriate box, where you do not know or understand, put an X in the D/K box						
Software user interaction						
1	The ePMS system only performs functions and actions that have been prompted/initiated by the user.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
2	When using the ePMS software, the user is generally aware whether or not a function he/she has prompted has been completed.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
3	The system does not take long to complete most actions.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
4	The user does not have to guess the amount of time left to complete an action in the system.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
Learnability						
1	The ePMS software is user friendly and easy to learn.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
Cognition and facilitation						
1	The ePMS displays are not over-crowded with information.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
2	The ePMS brings all information needed for 1 step in a single page except for reports.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K

Continued

3	The ePMS maintains visibility of icons, options and actions.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
4	The ePMS includes tables and graphs to support and clarify data.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
5	The ePMS does not require the user to recall information from a previous page/dialog.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
6	The ePMS software always provides relevant and needed information as opposed to decorative information.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
7	The tables and graphs of this ePMS are of good quality and easy to understand.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
8	Fonts on this ePMS system are clear and easy to read.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K

User control and Software flexibility							
1	When using this ePMS users feel in control and the ePMS responds to user actions.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
2	ePMS allows the user to tailor the Graphic User Interface (GUI)/display settings to his/her preferences.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
3	The ePMS system does not burden the user with repetitive input.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K

System real-world match

1	The ePMS uses terminology that is familiar to the users without unnecessary ambiguous jargon.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
2	Icons used in this software are appropriate and easy to understand.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K

Navigation and exiting

1	The ePMS allows users a means of escape from opened pages and processes they had begun.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
2	The ePMS allows users to easily reverse actions and entries done in error.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K

Consistency

1	The ePMS uses consistent terminology and structure throughout the programme.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
2	The ePMS has well integrated parts (for example pharmacy, administration, etc.) to make up the whole software system.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
3	The ePMS always requires the same action for the same tasks and objectives.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K

Defaults

1	Defaults in this system are easy to change.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K

Software system interaction

1	Users do not have to wait for too long while the ePMS system processes information.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K

Help and documentation						
1	The ePMS software provides help files and documentation to support use of software.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
2	Help files and documentation for ePMS are easy to search and find.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
3	Help files and documents contain actionable information.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
Error management						
1	The ePMS software diagnoses errors and offers corrective measures.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
2	The ePMS provides backup and minimises loss of user work due to an error or power outage.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K
3	Error messages are easy to understand.	1) Strongly disagree	2) Disagree	3) Undecided	4) Agree	5) Strongly agree	D/K