

Electronic Health Record System: A Perspective to Improve the Value of Services Rendered to Patients in Healthcare Organization in Rwanda, Case of CHUB and Hopital De Nemba

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Abstract---In Rwanda, many healthcare organizations are still using a paper based patients' data record system although it still present weaknesses to share health patients' information across different services when necessary. In developed countries, the EHR has been put in place to revolutionize the paper based record system but still the EHR has some challenges related to privacy, security, or interoperability. The purpose of this research was to assess the existing patients' data record system in healthcare sector in Rwanda, see what an EHR can improve to the system in place and assess the acceptance of EHR as system which is interoperable, very secure and interoperable and see whether stakeholders are ready to adopt the system.

The case based methodology was used and TAM theoretical framework to design the questionnaire for the survey. A judgmental sample across two cases, CHUB and Hopital de Nemba, has been selected and SPSS has been used for descriptive statistics.

After a qualitative analysis, the findings showed that the paper based record is useful, gives complete information about the patient, protects the privacy of patients but it is still less secure and less interoperable. The respondents shown that they are ready to use the proposed EHR System and want it secure, capable of enforcing the privacy but still they are not all ready for the interoperability.

A conclusion has been formulated; recommendations and further research have been proposed.

Keywords---EHR system, healthcare service, TAM, privacy, interoperability.

I. INTRODUCTION

TODAY the world is in the information age whereby the information has become a valuable asset of power. The companies are investing in information technology to leverage their overall performance and strategies, taking into account advantages gained through technology like cutting cost, human error reduction, etc. The use of technology in communication and medical information processing has increased drastically over past several years due to benefits enjoyed like ability to maintain patient information and health data electronically. This increases the convenience and feasibility of health care administration for practitioners and patients, reduces repetitive tests and cross checking, and collaboration of gathered data. It eliminates errors on diagnosis and prescriptions [1]. However, the acceptance of

information technology in the healthcare sector has been slow due to presence of various payers and providers.

In fact, these actors may be reluctant to share their health related information and when they are ready, the existence of many individual systems, customized or vendor-driven software which are incompatible with other systems has become a serious obstacle [2]. Additionally, the risk of compromising the confidentiality, the integrity, and availability of patients' data once stored on a public server or website and the privacy of data, have contributed to the acceptance slow trend [1].

While implementing the EHR, features like interoperability, openness, data privacy and security should be taken into account as previous studies have shown that they constitute key success factors of implementing such systems on national level [3].

The healthcare sector of Rwanda is still dominated by a traditional system whereby patients' data are recorded on paper. Within this system, the quick access to information by practitioners and the interaction with other systems is still a big challenge. Many repetitions of same medical tests, lack of patients' history, etc., are observed. The EHR can be a perspective for a better system for patients' data management though it presents other challenges to cope with while implementing. The purpose of this paper is to make an assessment of a paper based records system and analyze at the same time the readiness of stakeholders to adopt an EHR with consideration of its challenges.

II. STATEMENT OF THE PROBLEM

Since decades, paper based records have been used and stored to keep information about patients and track the history of patients. In Rwanda, still almost even not all health care organizations rely on paper based record system; however the system seems not allowing proper patients' data sharing among doctors when needed as irregularities can still be observed in information about historical health of patients and availability of all clinical data. Its interaction with other available systems in the healthcare organizations like procurement or finances systems is difficult and its linkage with health insurance and pharmacy systems is impossible. To overcome all these issues surrounding the paper based health records system, an electronic health record (EHR) system may

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revolutionize the system and improve the service quality of treatment offered to the patients. In the same perspective, [4] argues that the use of EHR can facilitate clinical decision-making and minimize the potential for mistakes due to the inaccuracy and incompleteness of paper records. However, the EHR could create a number of challenges once implemented like data privacy, security and the most challenging may be its interoperability with other systems like financial or procurement systems or linkage with health insurance and pharmacists systems.

III. RESEARCH QUESTIONS

1. What are the benefits and major challenges that a paper based record system present in Rwanda Healthcare organizations?

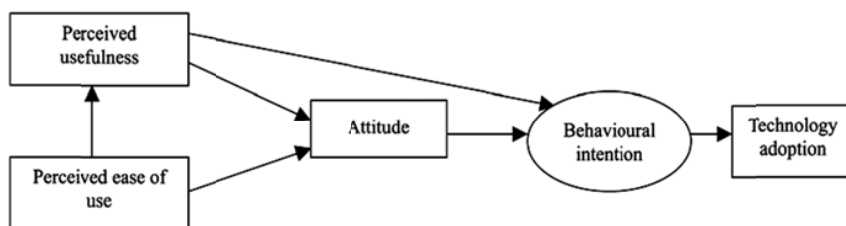


Fig. 1 Technology Acceptance Model [5]

V. RESEARCH METHOD

The Technology Acceptance Model (TAM) was widely accepted by the information system research community and was further verified and extended by other researchers [6]. The TAM [7] shows the causal relationships between system design features, perceived usefulness, perceived ease of use, attitude toward using and actual usage behavior. For this research, two hospitals, CHUB and Hopital de Nemba have been taken as Case studies, among which a judgmental sample of 25 healthcare practitioners and agents at CHUB and 15 at Hopital de Nemba were selected to complete the questionnaire. The case study method has the merit of being an empirical inquiry that investigates a contemporary phenomenon within its real-life context [8]. Data collected through questionnaires were encoded in SPSS and results from descriptive statistics were used for qualitative analysis and interpretation.

VI. FINDINGS

The total sample targeted for the research was 40 respondents amongst 25 from CHUB and 15 from Hopital de Nemba but 17 were received from CHUB, which is 68% of the responses and 13 from Hopital de Nemba, which is 86% of the responses.

A. CHUB

At CHUB, 17.6% of Nurses have responded the questionnaire, 47.1% of Physicians have expressed their views, 23.5% of administrative and technical staff have given their opinions and 11.8% of other staff (from laboratory, archivists, etc.) have given back the filled questionnaires.

2. What can an EHR improve to the value of medical care service offered to patients in healthcare organizations in Rwanda?
3. Are all stakeholders ready to adopt an EHR and cope with challenges like interoperability, patients' data privacy related to EHR Systems?

IV. OBJECTIVES

The study has the objectives of assessing the efficiency, the benefits and the drawbacks of the paper based record system within the healthcare organizations systems. In addition, the researcher will investigate on the attitudes of the stakeholders towards the adoption of the new system, EHR, taking into consideration challenges of data privacy, interoperability and security of an EHR.

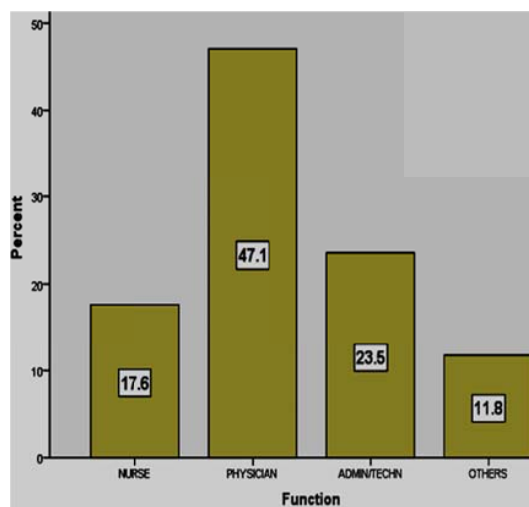


Fig. 2 Respondents from CHUB according their function

1. Existing Patients' Data Record System at CHUB

To find out the benefits and drawbacks of the existing system, the respondents were asked couple of questions.

At CHUB, the respondents acknowledged that they are using a paper-based record to keep patients' data. From their responses the researcher noticed that they have different views on assessing the paper based record system.

TABLE I
NUMBER AND PERCENTAGE OF RESPONSES PER SCALE FOR EACH QUESTION AT CHUB

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
<i>Usefulness of current patients' data record systems</i>			4	23.5%	8	47.1%	4	23.5%	1	5.9%
<i>Access to data in current patients' data record system</i>			2	11.8%	8	47.1%	6	35.3%	1	5.9%
<i>Quality of Information in current patients' data record system</i>					6	35.3%	8	47.1%	3	17.6%
<i>Security of data in current patients' data record system</i>			1	5.9%	8	47.1%	7	41.2%	1	5.9%
<i>Privacy of data in current patients' data record system</i>	3	17.6%	8	47.1%	4	23.5%	1	5.9%	1	5.9%
<i>Interoperability of current patients' data record system</i>			1	5.9%	5	29.4%	11	64.7%		
<i>Perceived user friendliness</i>					4	23.5%	12	70.6%	1	5.9%
<i>Perceived usefulness</i>					4	23.5%	11	64.7%	2	11.8%
<i>Attitude towards use</i>			1	5.9%	4	23.5%	12	70.6%		.0%
<i>Intention to use</i>			9	52.9%	4	23.5%	3	17.6%	1	5.9%
<i>security of ehr</i>					5	29.4%	6	35.3%	6	35.3%
<i>Privacy in ehr</i>					3	17.6%	13	76.5%	1	5.9%
<i>Interoperability of ehr</i>			1	5.9%	11	64.7%	5	29.4%		

On the questions regarding *the usefulness of the paper based record system*, targeting the work process improvement and quality of care, it has been found that 47.1 % did not express whether the system is useful or not, 23.5 % said that it is not useful and a small portion of 5.9% confessed that the system is somehow useful. Concerning *the quality of information provided by the paper based record system*, notably the completeness of historical patient's health, patient's clinical information, it has been found that 47.1 % agree that the system provides good quality of information and 17.6% have strongly emphasized that system gives required information and 35.3% were neutral about the quality of the information. The researcher also has evaluated *the access to data available on paper records*, emphasizing on the time required to get data, persons involved and availability across different departments. It has been found that 47.1 % of the respondents do not agree or disagree on quick and easy access, 35.3% have agreed, a small portion of 5.9% strongly approved and 11.8% disagreed. Coming to *security of data in the paper based record*, emphasizing on back up and physical protection, the researcher found that 47.1% of respondents were neutral, 41.2 % agreed that the system is protected, 5.9% have imperatively agreed and 5.9% of respondents have disagreed. The *privacy of patients' data* was also assessed by the researcher. The privacy focused on staff accessing the patient's information and susceptible of disseminating the information. It has been found that 47.1% of the respondents disagreed on the fact that any staff can access the data stored, 17.6 % strongly disagree, 23.5% were neutral, but 5.9% of the respondents agreed that any staff has access to data, finally 5.9%, strongly agreed the statement.

The researcher also has assessed *the interoperability*, the way the paper based record system interacts with other systems in the hospital, like finance, procurement, management, and pharmacy. It has been found that 67.4% of the respondents agreed that the system is interoperable especially with pharmacists, 29.4% were neutral, and 5.9% of respondents disagreed.

2. Features of EHR as Perceived by CHUB Employees

The attitude of the stakeholders towards acceptance of EHR has been assessed. About *EHR Security*, the researcher has found that about the 35.29% of the respondents want an EHR which is secure, 35.29% have strongly agreed on the security matter, and 29.41 were neutral. Coming to *the privacy of EHR*, 76.5% of the respondents agreed that the EHR should enforce the privacy of data, 5.9% have agreed strongly and 17.6 % have retained their opinions. Touching the *interoperability of the EHR*, 64.7% of the respondents were neutral, 29.4% just agreed on the feature, and 5.9% of respondents want a non-interoperable system.

3. The Acceptance of EHR at CHUB

In the TAM framework, scholars have said that the perceived usefulness and the ease of use, herein referred to as the user friendliness, are the most determinants of the attitude towards use or intension to use the technology.

For the *Perceived User Friendliness of EHR*, 70.6% of the respondents agreed that the system will be easy to use, 5.9% have strongly agreed and 23.5% of the respondents were neutral. Concerning the *Perceived Usefulness of the EHR*, the researcher found that 64.7% of the respondents agreed on the fact that the EHR will be useful, 11.8% have strongly accepted and 23.5 % of the respondents did not express their opinions. The *Attitude towards use of EHR* has been also assessed and 70.6% of the respondents have expressed their willing to use the system, 23.6% were neutral and 5.9% of the respondents disagreed. The researcher has assessed the *Intention to use the EHR* in CHUB and 52.9% have disagreed, 23.5% were neutral, 17.6% agreed and 5.9 % of the respondents have strongly agreed.

B. Hospital de Nemba

At Hopital de Nemba, out of 15 targeted respondents, 13 have responded, which constitutes 86% of the responses. 38.5% of the respondents was nurses, 30.8% was physicians, 15.4% was managers, and remaining 15.4% was administrative and technical staff.

TABLE II
NUMBER AND PERCENTAGE OF RESPONSES PER SCALE FOR EACH QUESTION AT HOPITAL DE NEMBA

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %	Count	Row N %
<i>Usefulness of current patients' data record systems</i>						.0%	9	69.2%	4	30.8%
<i>Access to data in current patients' data record system</i>					3	23.1%	4	30.8%	6	46.2%
<i>Quality of Information in current patients' data record system</i>					1	7.7%	3	23.1%	9	69.2%
<i>Security of data in current patients' data record system</i>	3	23.1%	1	7.7%	8	61.5%	1	7.7%		
<i>Privacy of data in current patients' data record system</i>	4	30.8%	2	15.4%	2	15.4%	3	23.1%	2	15.4%
<i>Interoperability of current patients' data record system</i>	2	15.4%	3	23.1%	2	15.4%	6	46.2%		
<i>Perceived user friendliness</i>		.0%			3	23.1%	8	61.5%	2	15.4%
<i>Perceived usefulness</i>	1	7.7%				.0%	6	46.2%	6	46.2%
<i>Attitude towards use</i>					3	23.1%	10	76.9%		
<i>Intention to use</i>					3	23.1%	5	38.5%	5	38.5%
<i>security of ehr</i>					4	30.8%	6	46.2%	3	23.1%
<i>Privacy in ehr</i>					2	15.4%	7	53.8%	4	30.8%
<i>Interoperability of ehr</i>					1	7.7%	10	76.9%	2	15.4%

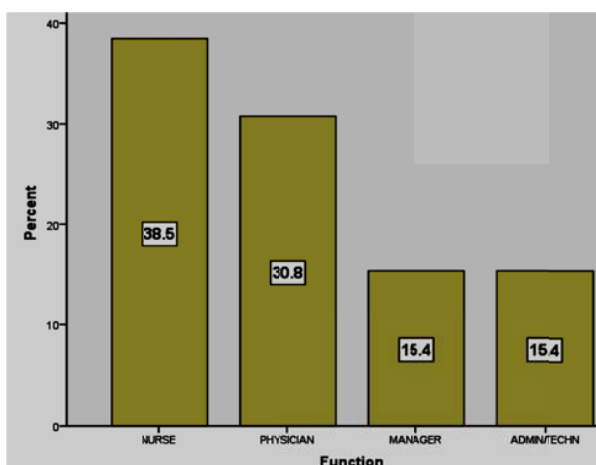


Fig. 3 Respondents from Hopital de Nemba according their function

1. Existing Patients' Data Record System at Hopital de Nemba

It has been found that Hopital de Nemba still use the paper based record system and this section will give a description of what has been found from respondents.

When evaluating *the usefulness* of the paper based record system, 69.2% of the responses have agreed and remaining 30.8% strongly agreed. The *Access to Data* was assessed and 23.1% of respondents were neutral, 30.8% agreed and the remaining 46.2% of the respondents have strongly agreed. The respondents were asked about *the Quality of Information* provided by the paper based system and 69.2% of the respondents strongly agreed, 23.1% agreed and remaining 7.7% of the respondents were neutral. The Security of data in the paper based record was taken into consideration in the research and a large number of respondents, 61.5% were neutral, 7.7% on one hand agreed and 7.7% on the other disagree, and 23.1% respondents have disagreed. *The Privacy of Data* in the patients' data record system was also assessed and 30.77% of respondents heavily disagreed, 23.08% agreed, 15.38% disagreed, 15.38% disagree, and remaining 15.38% of the respondents strongly agreed. *The interoperability*, the feature whereby the existing patients' data record system can

work and exchange data with other systems was assessed. It has been found that 46.2% of the respondents agree on its interoperability, 23.1% disagreed, 15.4% strongly disagreed and 15.4% were neutral.

The next section will elaborate on the assessment of the acceptance of EHR at Hopital de Nemba.

2. Features of EHR as Perceived by Hopital de Nemba Respondents

This section focuses on what the researcher has found about the security of data, privacy, and interoperability of the EHR.

About *the Security of data* in EHR at Hopital de Nemba, it has been found that 46.2% of respondents have agreed that data in EHR should be protected, 30.8% were neutral and the remaining part of 23.1% have strongly agreed. When respondents were asked about *the Privacy*, the researcher found that 53.8% of the respondents have agreed, 30.8% have strongly agreed and a portion of 15.4% of the respondents was neutral. The researcher did not forget to assess about the *interoperability* of EHR and from the respondents, it has been found that 76.9% want an interoperable system, 15.4% strongly want it and 7.7% of the respondents, were neutral.

3. Acceptance of EHR at Hopital de Nemba

As said previously, the acceptance of EHR has been assessed using the TAM and this model has 3 main determinants as attested by previously scholars, notably the perceived usefulness, the perceived ease of use herein referred to as perceived user friendliness and the attitude toward use of the system.

The Perceived User Friendliness has been assessed and the researcher found that 61.5% of the respondents agreed on the fact the system will be ease to use, 23.1% were neutral, and the remaining 15.4% strongly agreed. *The Usefulness of EHR* has been also assessed to see how the respondents from Hopital de Nemba expect the EHR to be useful. The researcher found that 46.2% of the respondents agreed that the system will be very useful, 46.2% strongly agreed and only 7.7% strongly disagreed about the usefulness of the EHR. About the *Attitude to use* the new EHR System, it has been found that 76.9% of the respondents want to use the system

and remaining 23.1% are mere neutral. Coming to the *Intention of using the system*, the researcher found that 38.46% of the respondents want to use the system and 38.46% strongly agreed on its usage and remaining 23.08% of the respondents are neutral.

VII. DISCUSSIONS

A. Existing Patients' Data Record System

The usefulness focused on how often the system is used, whether it enhances the work process or whether it improves the quality of medical care. From CHUB respondents, it has been noticed that the current system is not always used, more or less improves the work process and the quality of care. The researcher can say this because a large portion of respondents was neutral and other few respondents recognized that the paper based record does not improve work process.

From Hopital de Nemba, the paper based record system is always used and has been recognized as improving the work process and the quality of the care delivered to patients, thus a very useful system in healthcare services delivering at this hospital. This research has also assessed how quick the patients' data are accessed when needed in different departments of hospital and persons involved in the process of retrieval. At CHUB, it seems the access to stored data takes a long time span and when patients are transferred from one service to another, it is not sure that files are easily available across different departments as required. The retrieval of data involves more than one person which is costly in terms of human resources utilization.

From the side of Hopital de Nemba, except few respondents who were indecent, the researcher found that data in the paper based record system are accessed in short time though many persons are involved in the retrieval of data as processed at CHUB.

The quality of the information provided by the paper based record has been assessed focusing on the completeness of the information about the historical patient's health, the clinical information and whether every staff can decipher what available on the file. At CHUB, it has been found that the system in place gives complete required information about the patient.

At Hopital de Nemba, the information provided by the paper-based record is complete in the sense that it offers complete historical patient's health information and all required clinical information about the patient and whenever it is required in the hospital.

The paper-based record has been assessed for its security of data. The assessment was concentrated on authorized people to access data, the protection of room and backup of data in case of fire or sabotage. At CHUB, it has been found that the system offers less security as a large portion of the respondents was neutral. However, some of them indicated that the system lacks a backup and a protection against the physical threats like fire.

At Hopital de Nemba, it has been found that the room where data are stored, the access is not enough restricted, the

hospital seems not to do any backup and in case of any destruction or theft or fire, all patients' data can be lost.

The researcher has assessed the privacy of data in the current used system and at CHUB; it has been found that the privacy is much enforced in the paper-based record. Only restricted and allowed staff have access to the patients' data. Data are not available on any public platform like Internet or public shared storage media. Hopital de Nemba also enforces privacy of patients' data, as does the CHUB.

The aspect of interoperability of the system currently used, i.e. the paper based record, has been tackled in this research. At CHUB, it has been found that the pharmacists can get patients' medical prescriptions easily, however, finance officers or managers cannot have access to patients' data and this can constitute a barrier to the billing system, which can take a long time. At Hopital de Nemba, the researcher found that their system is less interoperable with other services including pharmacy, finances, and procurement.

The researcher can state that the paper-based record can be leveraged by the EHR and both work temporarily together whereby the EHR can improve the work process and the quality of care rendered to patients especially at CHUB. In addition, the EHR can help the CHUB and Hopital de Nemba to utilize its human resource by reducing the number of persons involved in the retrieval of patients' data files. In addition, the EHR can ameliorate the security of data by providing back up facilities to CHUB as well as Hopital de Nemba, to avoid the discontinuation of patients' information in case of loss or destruction. If well implemented and configured, the EHR system can be linked to different systems like finance or work beyond organizational boundary to allow full interoperability. The coming section will elaborate on the findings of the EHR acceptance and its features.

B. EHR System Acceptance and Its Features

Assessing the Security of the EHR System, at CHUB, though some of them did not express their opinion on the matter, but lot of them expressed that they want an EHR system which can allow only authorized access to the system, installed in well-protected room to prevent damages and with different permissions and levels of loggings to enforce privacy. The same concerns were expressed at Hopital de Nemba. The privacy, as a major concern in most of the EHR systems, has been tackled and respondents from both CHUB and Hopital de Nemba have strongly stated that the EHR System should not allow anyone to disclose the patient's information and other services within these institutions should have access to data related to their department only. But this possibility requires a very advanced design or data structure during the design phase of the software.

Concerning the interoperability, the researcher found that at CHUB, they seem not to understand the benefits of having an EHR System which is interoperable at a nationwide scale. They want a system which can work with other systems within CHUB but not beyond their organizational boundary. This is the big challenge for EHR today even in advanced countries whereby EHRs are vendor driven and lack interoperability

with other healthcare institutions systems [3]. However, at Hopital de Nemba, they seem to want an EHR System which is fully interoperable even beyond the hospital boundary. To achieve this, it requires also a coordination at country level, whereby standards and other measures for protocols, data format, etc., should be set to allow an inter enterprises health communication [2].

Assessing the acceptance of EHR System using the TAM, the researcher found that both CHUB and Hopital de Nemba have expressed that the EHR System will be a system easy to use in their work. Coming to the usefulness of EHR, all respondents from both hospitals said the system will be very useful. Even, their attitude to use the system has been found positive. The respondents also have been asked if they plan to use the system in near future but most of them at CHUB were still skeptic about the time they can start use the EHR System but at Hopital de Nemba, they said they want to use the EHR System in very near future time.

The researcher can say that the CHUB and Hopital de Nemba are ready to implement the EHR System and they want a system which enforces the security of patients' data and keeps the privacy of the patients. They also expressed that the system will be interoperable, however at CHUB they are still reluctant about the interoperability of the system.

VIII. LIMITATIONS

As said previously, the results of this research may be slightly biased by the fact that the respondents are not enough knowledgeable about the IS or merely not willing to state what is not favorable to their respective hospitals. This may be explained by the high percentage of people who were neutral on issues about the security or quality of information.

Due to limited time for the research, the data collection was limited to staff of hospitals, CHUB and Hopital de Nemba, although the research intended to survey into health insurances, Ministry of Health and other hospitals.

IX. CONCLUSION

The purpose of this research was to find what the EHR can improve to the services rendered to patients in Rwanda healthcare organization and to find if the healthcare institutions and various stakeholders can adopt or implement the EHR, considering also its challenges like interoperability and privacy of data. The objectives of the research were to analyze the existing patients' data record system whether paper based record system or EHR system and to assess attitudes of stakeholders regarding acceptance of EHR. The case study methodology was used and the TAM has been used as a theoretical framework to design the questionnaire which helped to collect data. The sampling method used was a judgmental sampling and the sample size targeted for this study was 40 respondents i.e. 25 from CHUB and 15 from Hopital de Nemba. The TAM helped to reach a general conclusion.

The findings are based on the qualitative analysis of data gathered through the survey after a distribution of

questionnaires among staff of CHUB and Hopital de Nemba. The questions were directed to understand the weaknesses and strengths of the existing system, the features of EHR and its acceptance.

For the CHUB, concerning the usefulness of the paper based record system currently in use, it has been found that the system does not improve the work process or quality of care delivered, which is not the case for Hopital de Nemba. The system has been found to be interoperable with the pharmacists at CHUB as the later can easily get medical prescriptions from physicians. However, finances and other departments cannot have access to patients' data at both CHUB and Hopital de Nemba.

Concerning the security, the rooms where the patient's data are stored, were found not protected against fire or other physical threats and no backup of data is done to prevent loss of data, at CHUB and Hopital de Nemba. Respondents of both hospitals said that the paper based record system gives complete information about the patient's historical health or clinical information when they were asked about the quality of information.

The system has been found to enforce the privacy of patients' data as anybody cannot have access to patients' data except allowed persons and this stands for CHUB and Hopital de Nemba. The access to data seemed to take considerable time span for CHUB and patient's data retrieval includes more than one staff at time whereas at Hopital de Nemba, the time seemed to be not long even many people are involved in data retrieval.

The perceptions of a new proposed system have been assessed and respondents showed positive attitudes for EHR System acceptance and usage. They emphasized on the fact that it will be very secure, protecting the privacy of data but for the matter of interoperability, CHUB respondents were still reluctant whereas at Hopital de Nemba they seemed to accept the interoperability of the EHR System. The EHR System can improve the paper based system as it can reduce the number of staff involved in the retrieval of patients' data files; improve the work process and quality of care at CHUB and enforcing the security of data because it can provide facilities for regular backups. For Hopital de Nemba, the EHR can improve the security of their system and interoperability.

X. RECOMMENDATIONS

This study shows that CHUB and Hopital de Nemba are ready to adopt the EHR System, however before implementation, the computer literacy of the users should be considered to avoid a failure of the system once it is installed.

The choice of the EHR System should be tailored to the organizational structure of each hospital and not be vendor driven.

A National Body should be put in place to set the standards (data format, protocol) to allow interoperability of the EHR Systems and interchange of patients' data at nationwide level.

XI. FURTHER RESEARCH

The same research can be done again and take into consideration a very large sample size as Rwanda has around 500 medical facilities to improve the generalization of the findings.

Another research can study or focus on feasibility of EHR Systems interoperability at a nationwide level in Rwanda.

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