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Electronic Medical Record System user satisfaction and its implication on individual work performance: A case of a University Teaching Hospital in Rwanda

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Abstract

The Information system user satisfaction has been extensively documented as a key component and a surrogate of success, and a determinant of individual and organizational performance. However, most of researches focused on measuring user satisfaction and its impact through mathematical models which might not capture exhaustively the issues affecting user satisfaction and performance. This study was conducted at the “Centre Hospitalier Universtaire de Kigali” one of the two tertiary public and university teaching hospitals in Rwanda. This hospital has been implementing OpenClinic as an Electronic Medical Record system since 2007 and there has been few studies focused on its evaluation. In addition, there is no study yet conducted focused on understanding the implication of user satisfaction on his individual work performance. This study was cross-sectional mixed research using explanatory embedded design. The data was collected on a convenient sample of OpenClinic users through the questionnaires including closed and open ended questions in order to capture both quantitative and qualitative data. The OpenClinic user satisfaction was found to be high (91%) as well as the proportion of users who perceived it as having positive impact on their work performance (94%). The relationship between user satisfaction and perceived impact was statistically significant, and satisfied users were 20 times more likely to perceive it having positive impact than no satisfied users. Important concerns were expressed by users and the main ones are the poor functionality of the system due to unstable internet, the limited capacity of use and the scarcity of computers. Therefore, the Electronic Medical Record system implementation at the hospital has been successful and its user satisfaction led to perceived positive impact, but it needs further improvements for optimal success. The inclusion of qualitative component in future researches is recommended for a better understanding of IS success.

I. INTRODUCTION

1.1. Background

Many developing countries suffers from the lack of or poor healthcare Management Information Systems (MIS) [1]. The purpose of MIS in healthcare settings is to improve efficiency and service delivery to the patients in order to achieve positive outcomes, including saving lives [2]. However, achieving that purpose is not straight forward because many systems fails [3] [4] [5]. Successful implementation of information systems (IS) requires recurrent and rigorous evaluations that inform decision making and actions of organizations [6]. Many researchers have identified Information Systems (IS) user satisfaction as a key component of information systems’ success towards organizational goals [6].

In Rwanda, the “Centre Hospitalier de Kigali (CHUK)”, one of the two first level public university teaching hospitals in the country, is a tertiary hospital providing healthcare services to thousands of population annually including those that are self-referred and those that are transferred from different hospitals across the country. This hospital has been among the few pioneers in Rwanda for implementing Openclinic as a healthcare MIS since the year 2007 [1]. This system is currently used by more than 800

healthcare providers including physicians, nurses, allied health professionals, and finance department staff.

Nevertheless, there has been only one study identified focused on its evaluation [7]. In addition, there is no study yet conducted focused on understanding the implication of user satisfaction on his individual work performance for understand the extent of success or failure and inform the hospital leadership on necessary improvements that would eventually lead to increased outcomes of patient care. Therefore, this study intends to fill this gap by assessing user experience in terms of satisfaction on using OpenClinic and their appreciation of its impact on work performance. The results of the study inform the hospital on the interventions needed to ensure successful adoption of MISs and improve services provided to the patients.

1.2. Study context and relevance

Information systems (IS) user satisfaction has been documented as a key indicator of IS success and extensive quantitative researches have been conducted in many countries to understand the factors associated with it. However, such researches have been rarely conducted in Rwanda, especially in healthcare settings. In addition, few qualitative researches have been conducted in order to deepen understanding of the lessons learnt and issues associated with user satisfaction. Particularly, there is no assessment that has been conducted on user experience of OpenClinic at the CHUK for the past 7 years in order to inform its leadership on necessary improvements for increased patient benefits.

This study closes the explained gaps in the following way: First, it adds to the existing literature on issues affecting IS user satisfaction and work performance. Second, it enables the hospital leadership to know the level of satisfaction as a key component of successful implementation of its healthcare system. Thirdly, for staff who are dissatisfied or for which the system affects negatively their work performance, the leadership are informed on reasons of dissatisfaction, which might help in eventual planning for remedial.

1.2. Research objectives, hypothesis and questions

The aim of this study is to assess the level of user satisfaction with an electronic medical record system (OpenClinic) by healthcare service providers at the CHUK and its implication on their work performance.

The specific objectives are:

- To determine user satisfaction for OpenClinic in the hospital setting;
- To identify drivers and key issues that affect user satisfaction;
- To evaluate the perceived impact of OpenClinic on work performance of the users;
- To provide recommendations on improvements needed for increased satisfaction and performance.

Therefore, this study focus on the following research hypothesis and questions.

- *Research Hypothesis*

The OpenClinic user satisfaction has a positive relationship with individual work performance.

- *Research Questions*

1. What is the level of OpenClinic user satisfaction by healthcare providers in the CHUK?
2. What are the triggers and key issues which affect user satisfaction?
3. How does user satisfaction affect the individual work performance?
4. What are the improvements that need to be made in order to ensure successful implementation of the system and its impact on work performance?

II. Literature Review

Nowadays, information systems constitute an essential component of organizational management in order to improve efficiency and performance. However, many systems fail to achieve the expectations of its users, which negatively impact individual and organizational performance [3] [4] [5]. Therefore, the need for researches on successful operationalization of information systems emerged from these challenges and still continues to be an important subject of inquiry [6]. Thus, the evaluation of an IS being operationalized is a worthwhile undertaking to ensure its success and benefits [7]. One of the key aspects of IS success is the perceived satisfaction of its users [6].

2.1. IS user satisfaction as a measure of IS success

The IS user satisfaction reflects the degree at which a user feels an IS meets his needs and expectations [8]. The IS user satisfaction has been considered as an important element or even a surrogate of information system's success, especially when the use of MIS is mandatory for the work [9] [7]. This assertion lies in that users are the ones who interact with an IS and know its functionality strengths and weaknesses, thus playing the role of evaluators [6] [10]. Besides that intuitive assertion, extensive researches have been conducted and found a correlation between user satisfaction and IS success [10]. Therefore, as measuring IS success is asserted to be difficult, satisfaction is usually used as a proxy measurement of IS success [11] [12].

2.2. Factors affecting user satisfaction

A variety of models have been elaborated to understand the factors that affect user satisfaction towards an IS. Among these, the most widely used are the DeLone and McLean (D&M) original and revised multi-dimensional and interdependent construct models [13] [7] [14]. According to the updated D&M model, the user satisfaction has been theorized as being associated to System quality, Information quality and Service quality [14] [15]. The model stipulates that the quality dimension of an IS has a positive effect on its use or intention to use and on its user satisfaction, which on their turn bring to IS benefits as shown in the Fig. 1 below [14].

According to D&M model, the system quality reflects the aspects of usability, availability, reliability, adaptability and response time; the information quality relates to the interface content issues, including personalization, completeness, relevance, ease of understanding and security; the service quality is concerned with support provided to the users whether coming from internally or externally to the organization; the use measures the aspects of navigation, retrieval of information and execution of operations; the user satisfaction captures user' opinions through his experience while interacting with the system; and finally, net benefits direct to impacts realized whether positives or negatives [14] [15].

The model suggests that the results of IS quality are iteratively interrelated [14]. In fact, the system use must precede user satisfaction, but also a good experience of use (user satisfaction) would lead to the intention to and use of the system[7] [14] [15]. On the other hand, the system use and user satisfaction would result in net benefits, but the net benefits would also result in intention to use and user satisfaction [14]. A variety of empirical studies have been conducted and validated the D&M IS model. Most of these studies used quantitative design and found significant relationships between quality of IS and user satisfaction as well as a positive relationship between user satisfaction and IS benefits [16] [17] [18] [19] [20] [21] [22].

D&M IS model was criticized for its difficulties of application due to different contexts of IS researches, modelling processes with causal explanations resulting in confusing meanings, and limited coverage of dependent variables as there are many other possible categories of measures varying from users to users [23][14] [15] [10] [24] [25]. Thus, a variety of other IS success models were referred on and others surged including technology acceptance model, human-organizational-technology and fit model, technology-organization-environment model, and innovation dissemination theory [13] [7] [26].

2.3. Other main models of IS success

a. Technology Acceptance Model (TAM)

According to this model, the IS success is characterized by the extent of user acceptance measured through the actual use, while the underlying factors of that acceptance are the perceived usefulness and the perceived ease of use [27] [28]. The mode defines perceived usefulness as the extent to which users believe the information system is important in helping them for completing their job requirements, while perceived ease of use is defined as the extent to which users believe the system is used without efforts [27]. The model recognizes that these two factors are influenced by external factors which can include social, cultural and political factors [27] [29]. As illustrated in the Fig. 2 below, the model stipulates that the perceived usefulness and ease of use influence the attitudes towards the use of technology, and those attitudes influence intention to use the technology, whereas that intention leads to the actual use of technology [27].

Many studies have been conducted and validated the TAM, highlighting the significance of the relationship between perceived usefulness and perceived ease of use on technology acceptance [28]

[29]. However, there have also been a high number of studies where the findings did not fit to the TAM model [30].

b. The Human-Organizational-Technology (HOT) fit model

The HOT fit model assumes that the effectiveness of an IS depends on the alignment of human factors, organizational structures and technology, with perspective of understanding IS success through a complex interplay between people, organizations and technology [31]. The human attributes reflect individual characteristics and interaction such as knowledge, skills, capabilities, motivation, position, tasks, collaboration, communication, competition and supervision; the organizational structures encompass internal and external organizational management environment and traits such as organizational size, culture, policies and strategy, practices and government regulations; while technology relates to the IS characteristics and requirements such as software, hardware, network tools, professional skills, systems quality, information quality, service quality and social presence [31].

Numerous studies have been conducted with hypothetical assumptions based on the fact that, when an information system is well aligned with the individual attributes, the organizational management practices as well as the technological equipment and tools in place, that system leads to higher user satisfaction, increased productivity, and improved system performance [32] [33]. Thus, the underlying technology adoption factors highlighted in these studies include: (i) training, perception, roles, skills, clarity of system purpose and user involvement as human attributes: (ii) leadership and support, process, participation or user involvement, internal communication and inter-organizational system as Organization factors; and (iii) ease of use, system usefulness, system flexibility, time efficiency, information accessibility and relevancy as technology factors [32] [33].

However, the literature emphases on the necessity for constant re-alignment of HOT components [31]. In fact, the alignment has to be dynamically adapted due to constant technological changes and evolving needs of the organization [31]. The literature also points out the nuances and complex interactions between HOT components and recommends further researches for exploring those interactions as well as their implications for emerging technologies and workplace dynamics [31] [34].

c. The Technology-Organization-Environment (TOE) model

The TOE model focuses on technological, organizational and environmental factors for modeling the technology adoption and innovation within organizations [35]. Technological factors capture the key characteristics of the technology under consideration, including the complexity of the technology and its compatibility with existing systems [36] [37]. The technological factors cover the internal characteristics and capabilities of an organization such as organization's absorptive capacity, leadership and innovation culture [36]. The environmental factors include the elements that are external to the organization, but crucial in shaping technology adoption in an organization such as industry regulations, pressure from competitors and market trends [36]. Studies have shown the relevance of the TOE model, highlighting

specific elements that influence the technology adoption such as connectivity, IT capabilities and management support [36] [37].

d. *Innovation dissemination theory (IDT)*

The IDT theory explains the success of an information system in terms of gradual technology adoption. According to this theory, the extent of technology adoption pass through a diffusion process and communicated overtime throughout members of an organization [38]. In the context of an IS, an innovation is defined as a technology that is perceived as new by its users, even if it has been long on the market, and it is manifested through their knowledge, persuasion and decisions [38]. Thus, the key point of IDT model is one of achieving convergence in understanding and adopting the technology through a framework of information sharing where change agents and opinion leaders can play significant influence towards desired practices [38] [39]. This state of adoption depends on five main factors: perceived attributes of innovation, type of innovation-decision, communication channels, nature of the social system, and extent of promotion agents' efforts [39].

2.4. User satisfaction and individual performance

The measurement of net benefits in terms of individual or organization impact, as results of system's qualities, use and user satisfaction, has been advocated. For instance, D&M have advocated for this measurement, cautioning researchers not to limit their investigations on use and user satisfaction as measures of IS success, but also extending them towards benefits realized in terms of performance [14]. Therefore, measuring the impact of user satisfaction on individual work performance is essential and add value to the existing literature on IS success.

IS impact to individual performance is defined as the extent to which the individual perceives the level of productivity due to the use of IS [40]. While many studies found positive impact through increased quantities and quality of productivity, some studies indicated that IS use had negative or neutral impact on individual performance and social life of its users [8] [40] [18] [41].

2.5. Critical analysis and conclusion

The D&M and subsequent models intended to associate IS qualities with user satisfaction or technology adoption in terms of causal relationship of dependent and independent variables. However, the intuitive nature of the relationship is internal rather than external. When a user appreciates positively or expresses difficulties with an aspect of an IS quality or use such as ease of use or usefulness of the information generated by an IS, it is a means of expressing his satisfaction or dissatisfaction with the IS use or usefulness. Therefore, this study will focus on understanding the reasons, issues and challenges as characteristics underlying a certain level of satisfaction rather than understanding it in terms of correlation and causality.

Most of researches conducted are quantitative, exploring the relationship between user satisfaction and the IS qualities through a number of dependent and independent variables [15]. However, understanding

challenges and issues with user satisfaction might not be limited to parametric models and pre-defined variables [14] [24]. In addition, there is a divergence on how IS quality variables are measured and critics on their reliability [8]. This implies that researches must give the flow to the users to express their concerns as measures of IS qualities. Thus, this study will integrate a qualitative component that will further the understanding of the issues of healthcare providers while using the system. Therefore, the D&M and other models that subsequently emerged were adapted in the conceptual framework of this study as shown in the Fig. 3 below:

D&M recommended researchers to select a small number of measurements while using their model [14] [15]. However, many of the quantitative studies conducted generally used long questionnaires and many questions had similarities, which raise confusions in distinguishing variables [13] [14] [15] [19] [20] [42]. This study used a concise questionnaire with a single question addressing user satisfaction and another one addressing its perceived impact on work performance of the users. In this study, the aspects of IS qualities and other issues characterizing user satisfaction and how they affect the individual work performance were obtained through qualitative questions. This enables discerning user judgments, avoiding a blurt in expressing their experience and letting the flow of the expression for the qualitative component of the questionnaire.

2.6. Summary and gap in the literature

The D&M model has been essential in explaining IS success through user satisfaction and quality characteristics of an IS. Following the critics on the D&M model, further researches have been conducted through a variety of other models and elaborated other factors that affect IS success including perceived ease of use and usefulness of IS, trustworthiness, top management support, design of user requirement, having been trained, computer literacy, organizational structure and management style [26] [27] [28] [29] [30]. Despite a multitude of those models, no one is claimed to exhaustively explain all the elements of an IS success. However, qualitative studies can effectively capture a wide range of IS characteristics underlying the status of IS success taking into account the specificity of organizations, but this approach remains under-explored. Thus, this study uses a mixed research approach in order to take advantage of benefits of both quantitative and qualitative approaches for analyzing the extent of an IS success as well as the underlying issues in the context of a specific hospital.

Iii. Methodology

3.1. Study design

This study was a cross-sectional mixed research method using explanatory embedded design in order to get a deep understanding of key issues affecting OpenClinic user satisfaction and individual performance. The quantitative studies have been useful and extensively used in studies exploring information systems success, but criticized for their underlying assumptions [43]. However, qualitative

studies have been in shortage, yet they have been advocated for due to their strengths in identifying virtues in their natural state with less or without assumptions [43].

The combination of qualitative and quantitative approaches is necessary for studying information systems success. Some of the key benefits of that combination are: the value of combining qualitative and quantitative methods is superior than using one of them, it enables accounting for context-specific nature and practices in organizations rather than relying on standard context-independent variables and assumptions, it takes into account of the natural process experienced by users while evaluating information systems, it can capture the multi-dimensional relationships between an IS and user perceptions rather than unidirectional assumption, and enrich the knowledge by bringing in diversification in system researches [44] [43].

As consequence, this study opted to integrate the two approaches in order to take advantage of each. The purpose of quantitative component was to enable measuring the level of OpenClinic user satisfaction, the level of its perceived impact on individual work performance, and the relationship between user satisfaction and perceived work performance [45] [46]. On the other hand, the qualitative component was aimed at providing more explanations on issues affecting user satisfaction and its impact on individual work performance [43].

3.2. Sample selection

The sampling frame of this study was the list of staff who use OpenClining at the CHUK. A convenient sample was used for this study and spread across service departments of the hospital covering the main categories of healthcare professionals administered by the hospital including physicians, nurses, allied health professionals and administration staff. This sampling has proved to be effective in exploring information systems success [47].

3.3. Data collector and collection procedure

The data was collected personally by the principle investigator. Prior to data collection, an appointment was requested during the departmental staff meetings and the data was collected during those meetings with flexibility to submit the questionnaire later after the meeting. During the data collection, the investigator provided questionnaire and explained the study to the participants, ensuring that they understand its importance and agree to participate voluntarily. Thereafter, the participants who accepted to participate in the study signed a hard copy of the concert form and responded to self-registered questionnaire.

3.4. Data collection, entry and analysis tools

A self-registered questionnaire was used to collect data from the participants (Ref. Appendix 2 and Appendix 3). This questionnaire has been designed specifically for this study based on research questions. The first section of the questionnaire consisted of closed questions inspired by Likert

measurement framework and was focused on collecting quantitative data [49]. The second section of the questionnaire consisted of open ended questions and was focused on qualitative data.

An electronic Epi-Info data entry platform was used for data entry of quantitative data, while MS-Excel was used for transcription of qualitative data. The quantitative data was analysed using “R” software whereas qualitative data was analysed using “NVivo 12” software.

3.5. Data analysis technics

The quantitative data were analyzed using descriptive statistics and statistical tests including Chi-square, Fisher exact and Wald tests. The descriptive statistics provides the proportions of user satisfaction and perceived impact of the system by its users. The Chi-square test provides the significance of the relationship between user satisfaction and perceived impact of the system. Fisher exact test was used for reconfirmation of Chi-square findings due to presence of low absolute numbers of dissatisfied users, but also for providing the magnitude of the relationship. In addition, the Wald test was used for providing the magnitude and significance of the relationship between user satisfaction and perceived impact of the system and evaluating the consistence of previous results. The analysis of user satisfaction and perceived impact through the demographic variables was not done due to presents of empty or very low numbers of dissatisfaction cross-tabulated cells.

The qualitative data was analyzed using content analysis. The participants’ expressions were grouped and coded into themes and sub-themes over the process of analysis using NVivo12. Where the expressions were not clear for matching or elaborating the related theme, clarifications were sought from the participants.

IV. DEMOGRAPHIC FINDINGS

4.1. Sample distribution by major categories of participants

The sample frame obtained from the Human Resource office of the CHUK consisted of 832 OpenClinic users, including 529 nurses, 80 physicians, 157 allied health professionals and 66 administrative staff. The data collection was conducted during the month of August and September 2023 targeting the representativeness of users from all the four professional categories and all departments of the hospital. The self-registered responses were obtained from 217 participants subdivided as follow (ref. Table 1):

Table 1
Distribution of users and sample by major categories of health professions

Categories of staff	# All users	Sample
Nurses	529	133
Physicians	80	41
AHPs	157	25
Administrative staff	66	18
Total	**832**	**217**

4.2. Sample distribution by age categories of participants

The majority of the sample participants was between 30 and 39 years representing 46%, followed by the age range of 40 to 49 years representing 35%.

Sample distribution by age categories

Age category	Number	Percentage
20–29 years	20	9%
30–39 years	99	46%
40–49 years	77	35%
50–59 years	18	8%
60 + years	1	0%
Missing	2	1%
Total	217	100%

4.2. Sample distribution by age years of job experience and years of experience using OpenClinic

Most of the sample participants had many years of job experience, including 78% who had more than 5 years of experience. On the other hand, the majority had between 1 to years of experience using OpenClinic (41%). The proportion of participants with age ranges of use experience between “6 to 10 years” and “11 to 15 years” was also high, representing 29% and 23% respectively.

Sample distribution by years of professional experience and years of experience using OpenClinic

Category of years	Job experience	Experience with OpenClinic
< 1 year	1%	7%
1 to 5 years	21%	41%
6 to 10 years	22%	29%
11 to 15 years	27%	23%
16 to 20 years	13%	0%
> 20 years	16%	0%
Total	**100%**	**100%**

V. ANALYSIS AND RESULTS

5.1. Overall user satisfaction

Most users (91%) were satisfied by the electronic medical record system (OpenClinic) in their service delivery including 28% who indicated their satisfaction as “very satisfied” and 63% as just “satisfied”. Nine percent (9%) were not satisfied, including 5% who were neutral (neither satisfied or dissatisfied), 2% who were dissatisfied and 2% who were very dissatisfied.

Number and percentage of respondents per their level of satisfaction through a Likert scale

Likert scale satisfaction level	Number	Percentage
Very satisfied	61	28%
Satisfied	136	63%
Neutral	11	5%
Dissatisfied	4	2%
Very dissatisfied	5	2%
Total	**217**	**100%**

5.2. Sources of satisfaction:

A high proportion of respondents (95%) expressed at least one cause of satisfaction. The sources of satisfaction expressed and percentages of respondents who expressed that satisfaction are the following:

- The importance of its functionalities (83%): respondents expressed being satisfied by the system functionalities which help them for storing, archiving, easy access and retrieval of patient data, billing care services provided to patients, generating codes for patients file useful for their

classification, quick access to diagnostic results including laboratory and imagery results, ensuring security and long lasting of data and providing reliable and accurate information.

- Facilitation and simplification the work (32%): the system facilitated and simplified the work including communication and information sharing which has become easier, reduction of movements between departments and to the archive looking for patients' information and diagnostic results, reduction of written work, easing workload by reducing the amount of time that one would spend performing operations such as billing calculations and facilitating requests of supplies.
- Time management (22%): the system allowed users to manage their time efficiently by saving their time while looking for information and caring patients.
- Ease to use (14%): participants described the system as user friendly or not complicated and not requiring special skills.
- Services digitalization (13%): this satisfaction was due to the fact that the healthcare services were digitalized and service procedures have been shifted from traditional paper work towards modern paperless work environment. Some of the users also sees the system as an opportunity to familiarize and to increase their skills with the use of technology.
- Quick performance (11%): The system was described as having a high speed in performance and not taking much time to respond to user requests.
- Data protection and confidentiality (5%): These users were confident that records are safely kept and archived electronically within the system that is protected by username and password, and that those records cannot be changed.

5.3. Sources of dissatisfaction

Despite the high percentage of users who expressed their satisfaction, a high percentage (98%) also expressed one or more issues resulting to their dissatisfaction. The main issues for dissatisfaction and the percentage of respondents that addressed those issues are:

- Poor functionality or dysfunctionality due to unstable network or electricity (57%)
- Limited capacity of use due to lack or insufficient trainings (44%)
- Insufficient computers (22%)
- Impossibility or difficult to edit and correct errors (17%)
- Time consuming system, adding more workload to their already usual high workload (17%)
- Partial digitalization which results in double work, using both paper files and the system (16%)
- Exposure of patients' information, where all users can access to patients' confidential data (9%)
- Incomplete or incorrect diagnosis service coding (8%)
- Missing of some information in the system (7%)
- Frequent password expiration (6%)

- Inability to generate a performance report (6%)
- Errors in records (4%)
- Challenging management of patients' identification with patients having 2 or more identifications and patients' addresses section not well ordered (3%)
- The system allowing changing information entered by others (2%)
- Lack of extension to and interoperability with the systems at district hospitals (2%)
- Ineffective use where some staff don't comply with standard use procedure and leave uncompleted data (2%)
- Loss or mismatch of data (2%)
- No access to some information (2%)
- Use of desktops fixed at designated place and care givers are obliged to make frequent movements in order to access the system (2%)
- Denied functionalities where for example the system refuse to output supplies already available in the stock or refusal of other operations which would simplify the work (1%)
- Inability to work with multiple files at a time on the computer (1%)
- Lack of some search options for example when performing investigation procedures or during the validation of laboratory results (1%):
- Sometimes the system crushes (1%)
- Over reliance on automation which raise sceptics (1%)
- Scattered and unintegrated registers which cause multiple entry of similar information on the same patient, especially in the laboratory department (1%)
- Health risks such as problems of eyes due to longer exposure to computer (1%)
- Not respecting guide in attributing credentials (1%), and
- Poor communication between clinicians and cashiers (1%).

5.4. Perceived impact of OpenClinic on work performance

a. Overall perceived impact: Most users (94%) perceived positive impact of the system to their work performance including 25% who rated the impact as "very positive" and 69% as just "positive". Six percent (6%) were not satisfied, including 4% who were neutral (seeing the impact as neither positive or negative), 1% who considered its impact to be negative and 1% who considered it to be very negative.

Number and percentage of respondents per level of their perceived impact through a Likert scale

Likert scale satisfaction level	Number	%
Strongly positive	53	24%
Positive	150	69%
Neutral	8	4%
Negative	3	1%
Strongly negative	3	1%
Total	**217**	**100%**

b. Perceived positive impact: The improved efficiency and effectiveness of service delivery were seen as a positive impact induced by the use of the system. Specifically, the main benefits expressed by the users and the percentages of respondents who expressed that benefit were that the system:

- Enhances quick service performance and delivery (22%);
- Helps in providing good (quality) services, especially reducing patient waiting time (9%)
- Improves quantity of work delivered by serving more clients (7%);
- Improves income generation through the increased number of clients served and revenues recovery (4%);
- Improves efficiency in the use of resources such as minimizing paper files and archive space, abolishing printings of patients' results, better control of healthcare supplies' requests and use, and human resources management though evaluation of clients served (2%); and
- Helps to ensure continuity of care based on the history of the patient that is kept for a long time and easily accessible (2%).

c. Perceived negative impact: The negative side of the impact was expressed at limited extend (18% of the respondents) as delays in service delivery mainly due to the interruption of work caused by the loss of internet connection, limited capacity of use, insufficiency of equipment and high workload.

1. • *5.5. User satisfaction and individual work performance*

In order to analyze the relationship between "user satisfaction" and "perceived work performance", the original variables were transformed as follow:

- For user satisfaction, those who scored "Very satisfied" and "Satisfied" were assumed both to be "Satisfied", while those who scored "Neutral, Dissatisfied and Very dissatisfied" were assumed to be "Not satisfied;
- For the impact on work performance, the "Very positive and Positive" scores were rescored as "Positive", while the "Neutral, Negative and Very negative" scores were rescored as "Not positive".

Thus, the results of this transformation provided the contingent table presented below with the numbers of respondents per new categories of user satisfaction and perceived work performance.

Number of respondents per user satisfaction and perceived work performance

User satisfaction	Impact on individual work performance		
	Positive	Not positive	Total
Satisfied	191	6	197
Not satisfied	12	8	20
Total	203	14	217

The Chi-square, Fisher exact and Wald tests were performed to analyze the significance as well as the strength of association between user satisfaction and perceived work performance (ref. Appendix 1). Both Chi-square and Fisher tests confirmed the significance of the association with p-values less than 0.001, whereas the Fisher and Wald tests indicated a high strength of association through odds ratio values.

The Fisher's test odds ration value was 20.5 (CI: 5.3 85.1), while the Wald test odd ratio value was 21.2 (CI: 6.3, 71.1). Thus, the respondents who were satisfied were 20 times more likely to have a positive perception of the EMR (OpenClinic) on their work performance than those who were not satisfied.

5.5. Recommended improvements for review and actions

Based on the sources of dissatisfaction and expressed needs of the system users, the following are the recommendations for consideration by the hospital leadership in order to improve their satisfaction and increase their productivity:

- Provide sufficient and continuous trainings on OpenClinic in order to increase knowledge and skills on the use of the system;
- Ensure strong, stable and permanent internet connection;
- Increase progressively the number of computers until users can have timely access without any waiting time;
- Fully digitalize healthcare services and remove a double workload of using both computers and paper based files during the process of patient care;
- Ensure a complete and correct coding of services based on standard coding procedure;
- Assess the possibility of enabling the system to work offline or through intranet and avoid disruption of care once the internet and the electricity are lost;
- Integrate functionality to enable editing or deleting errors within a reasonable time;
- Integrate functionalities for ensuring patients' data protection and confidentiality by tightening access to the relevant content by authorized users;

- Review the system and ensure constant recovery of data once the internet or electricity are lost, or once the system crushes;
- Include performance reporting functionality in the system so that users can get summary reports, including the performance report of the work completed, retrieval of information registered during a given period of time, and the consolidated and detailed bills of the patients.
- Integrate other necessary process functionalities such as providing additional search options especially while reviewing ordered investigation procedures; increasing number of words in space where text is necessary; adding images for some diagnostics such as histopathology; complete the list of all necessary elements required on the forms for results validations including the date, time and person who performed validation; and improving calculation of turnaround time of samples;
- Integrate the advanced functionalities such as associating diagnostic devices' results to patient ID in order to enter data into the system immediately through those devices, which would prevent or reduce errors such as interchanging results; inputting the electronic signature and stamps into the system; introducing payment system such as VISA and MasterCard; and including SMS functionality that inform the patients when their laboratory or radiology results are available by sending them a message;
- Review the management procedures of passwords and avoid frequent password expiration or devise a strategy for helping staff to manage their periodic changing passwords;
- Merge and integrate scattered registers such as consultation and radio image results, and avoid multiple entry of similar patients' data on different registers;
- Individualize services delivered in the system in a such a way only users who have put the data in the system and the authorizers such as heads of departments and system administrators can make changes on the information entered. The system should trace the changes by indicating the person who made those changes and they should be time stamped.
- Upgrading the system to mobile devices so that patient records can immediately be entered in the system during the time of patient care provision;
- Review the patient data accessibility policy with a view to enable remote access, particularly for insufficient specialist doctors who can be contacted beyond their working hours;
- Ensure constant availability of the information needed by healthcare providers;
- Increase the number of staff in order to ease the high workload of users;
- Increase the number of support staff and ensure regular and timely support to the users;
- Segregate the responsibilities by assigning dedicated users of the system and avoiding the combination of entering data and providing patient care; and
- Raise dialogues with the Government in order to extend the use of OpenClinic to all district hospitals and proceed with their interoperability in order to improve the continuity of informed patient care.

VI. RESULTS DISCUSSION

Overall, the implementation of Open Clinic for healthcare provision in the CHUK has been successful. In fact, this study found out that a high proportion of employed (91%) were satisfied with the use of OpenClinic. According to D&M and many other models, this is an indication of information system success [9] [7] [10]. In addition, these findings serve as an evaluation feedback to the hospital leadership being on track in implementing the EMR. On the other hand, in general and especially in developing counties, the literature shows that many systems fail [1] [3] [4] [5]. Thus, the operationalization of OpenClinic in the CHUK can serve as a lesson to interested parties for successful implementation of IS in healthcare settings.

The level of satisfaction identified though a Likert-scale scores of success is not sufficient in characterizing user satisfaction and success [48]. In fact, although 91% were ranked as very or just satisfied through a 5 point Likert-scale in this study, there were even more employees (98%) who expressed dissatisfactions through qualitative open-ended questions. Therefore, an IS user who provides an overall score of good satisfaction can still have specific concerns as dissatisfaction which should need to be addressed in order to optimize success in IS implementation.

The key drivers of OpenClinic success in the CHUK can arguably reflect the main causes of user satisfaction stipulated by D&M and other IS success models, but the self-expressed appraisals are more specific and clear for understanding success in the context of the hospital. Thus, the reliability of system functionalities, its ease of use, its quick performance, its role in patient data protection and confidentiality, the shifts from paper-based to digital system, and its appreciation in time management and facilitating as well as simplifying employees work can reflect the system, information and service qualities as well as its usefulness, acceptability and trustworthiness. However, the self-expressed appraisals identified by the employees are more self-explanatory for understand the reason behind their user satisfaction and IS benefits.

Although the identified triggers of satisfaction might be implicitly multi-matched with suggested models of IS success, especially the D&M model, they are also mitigated by self-expressed dissatisfactions equally identifiable with those models. Thus, the factors such as expressed poor functionality or dysfunctionality due to unstable network or electricity, limited capacity of use due to lack or insufficient trainings, insufficiency of computers, inflexibility due difficulties in correcting errors, incomplete digitalization, the felt high workload, exposure of patients' info, inconsistent diagnosis coding and many other issues addressed by users can equally be negatively multi-paired with the key components of IS success models though user satisfaction including system quality, information quality, service quality and usefulness of the system, its acceptability and trustworthiness. This suggest that user satisfaction would be evaluated holistically, discerning both positive and negative aspects of satisfaction.

The perceived impact of OpenClinic was expressed by users in terms of efficiency and effectiveness in work performance, which is the purpose of an information system [2]. The positive side of this impact was specifically explained as higher speed of services, improved service quality, increased number (volume) of beneficiaries who receive healthcare services, increased revenues recovery, efficient

management and use of resources and continuity of patient care. The negative side of the impact was expressed at limited extend as delays in service delivery manly due to the interruption of work caused by the loss of internet connection, limited capacity of use, insufficiency of equipment and high workload. Thus, the success of OpenClinic has been achieved beyond satisfaction, but would be more improved if the causes of expressed delays in services delivery are addressed.

The inter-relationship between the components of IS success stipulated in the D&M model was even observed through the interchangeable responses of participants between user satisfaction components and perceived impact. For instance, according to D&M model, the user satisfaction would result in net benefits, but the net benefits would also result in user satisfaction [14]. Through this analogy, some of the participants expressed interchangeably the reasons for their satisfaction as the impact that the system has on their work such as being satisfied by increased speed or efficiency of services, while others expressed the perceived impact as sources of their satisfaction such as the appraisal of its functionalities and its role in their work performance.

Some of dissatisfaction addressed by users might not have been real challenges, but would have been due to limited capacity of knowledge and use. For instance, according to the system administrators at CHUK, some issues such as the inability to work simultaneously with multiple files and missing of some information in the system would due to limited capacity of users. In addition, addressing some of the functionalities according to the wishes of the users might cause other challenges which are difficult to address. This is for example the case for frequent password expiration, difficulties for editing and correcting errors and limitation of access to some information which, if addressed differently, would expose data security and confidentiality. Furthermore, some challenges are beyond the feasibility by the hospital such as the interoperability with the systems of district hospitals which would require the establishment of the system in those hospitals, while others are difficult to address due to financial constraints and management capacity such as finding sufficient computers for every user.

The results of this study highlighted the positive relationship between user satisfaction and individual work performance. Consequently, the satisfied users were much more likely to have a positive perception of the system on their work performance than unsatisfied users. This adds to the many existing literatures on IS user satisfaction and individual performance [16] [17] [18] [19] [20] [21]. This study also adds to few existing studies that used mixed method research design and this enabled a deeper understanding of the relationship by identifying key aspects of user satisfaction as well as acquired benefits throughout their opinions.

VII. CONCLUSION

This study reviewed the extent of success in the implementation of electronic medical record (EMR) at the “Centre Hospitalier Universitaire de Kigali (CHUK)”. The implementation was found to be successful due to high level of overall user satisfaction (91%) and the high proportion of users who felt it to be beneficial (94%) through its perceived positive impact. However, the users also addressed important

points of concerns as dissatisfaction which need to be reviewed and addressed appropriately by the hospital leadership for further improvements in services delivery and increased patient outcomes. This study also provides insights relevant to the wide audience interested in healthcare information systems management by taking advantage of using both quantitative and qualitative approaches for analyzing IS success and issues in the context of healthcare facilities, thus adding on a few existing literatures of this kind.

VIII. LIMITATIONS AND RECOMMENDATIONS FOR FURTHER STUDIES

The findings from this study suggest the need for using mixed research methods for evaluating information systems' success. In fact, it is necessary to quantify the overall satisfaction and benefits, but also necessary to understand challenges and issues addressed by users. The key aspect in favor of mixed research is the fact that a high level of user satisfaction and perceived benefits does not preclude the existence of many challenges and issues experienced by users which constitute dissatisfaction and hindrance to their performance. Therefore, the inclusion of qualitative component in evaluating information systems' success would bring in a holistic review of both positive and negative aspects of user satisfaction and IS benefits.

This study used a convenient sample of healthcare providers which is prone to selection bias and limits the generalizability of results. This sampling method was used due to difficult availability and accessibility of the participants who have a busy schedule and work on different shifts of the day. In order to mitigate the selection bias, the sample was enlarged with 217 participants selected from different departmental services of the hospital.

This study assessed the impact of OpenClinic usage to the work performance of healthcare providers. However, the assessment was only limited to the identification of what the healthcare providers believe to be the positive and negative impact of the system on their work performance and not a strict experimental impact assessment, which limit the degree of reliability of the expressed impact.

Although this study highlighted important aspects of dissatisfaction and improvements needed, it did not intend to make an objective evaluation of system dysfunctionalities. Thus, the findings elaborated the sources of dissatisfaction and the actions that might be taken for improvements based on user opinions and some of the suggestions might not be relevant or easily applicable. Therefore, the hospital is recommended to conduct a deep review of the sources of dissatisfaction expressed as well as recommended improvements, analyze the feasibility of suggested improvements and take appropriate measures to ensure the optimal operationalization of its electronic medical record system.

Declarations

9.1. Ethics approval and consent to participate

The ethical approval was obtained from Wrexham University and from Research committee of the CHUK (ref. the copies of approvals attached in the appendix). The essential component of this study that needed special attention during the data collection was the voluntary participation. This was explained to the participants and the data collectors signed a consent form prior to responding to the data collection questionnaire. Another key element that needed attention was to make sure that the study does not interrupt participants for the provision of services to the patients. The participants were cautioned on this aspect and provided with a flexible schedule for filling and submitting the questionnaire.

Participants' data protection and confidentiality is also an aspect that was paid on attention by de-identification of their data: before stating data collection, participants were briefed on confidentiality of their data. Personal identifiable data such as names was not collected from participants through the questionnaire and were assigned with new identification codes.

9.2. Consent for publication

Not applicable

9.3. Availability of data and materials

The datasets used and analyzed during the current study are available from the main author and may be provided on reasonable request.

9.4. Competing interests

The authors declare that they have no competing interests.

9.5. Funding

There is no any funder associated with this study.

9.6. Authors' contributions

The main author conceptualized and initiated the study. Other authors discussed with and advised the main author on approaches and methodology. They reviewed and revised the manuscript, and provided comments. They also guided and facilitated the main author to obtain ethical approval. A.M. and E.M. facilitated the main author to reach the participants.

9.7. Acknowledgements

Not applicable

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Figures

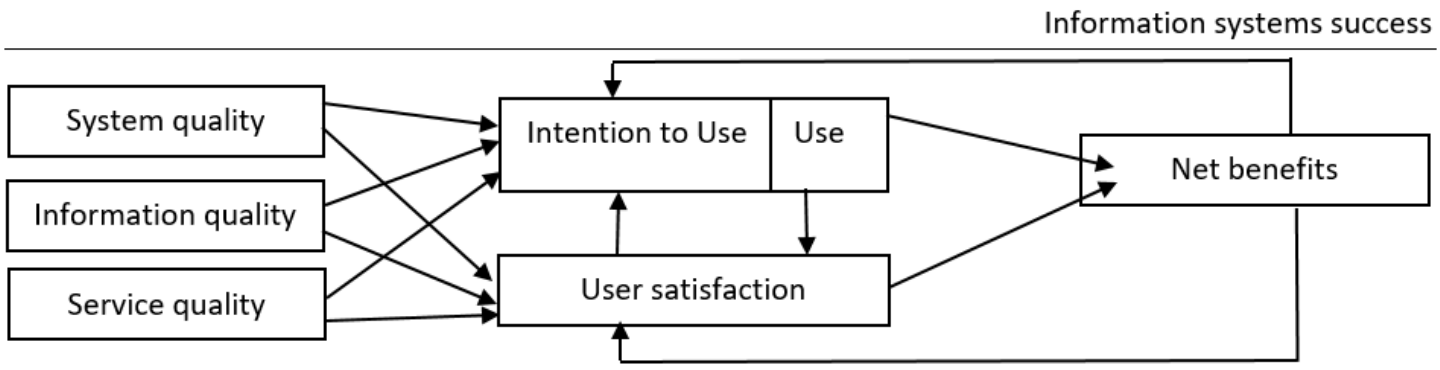

Figure 1

Updated DeLone and McLean IS model [14].

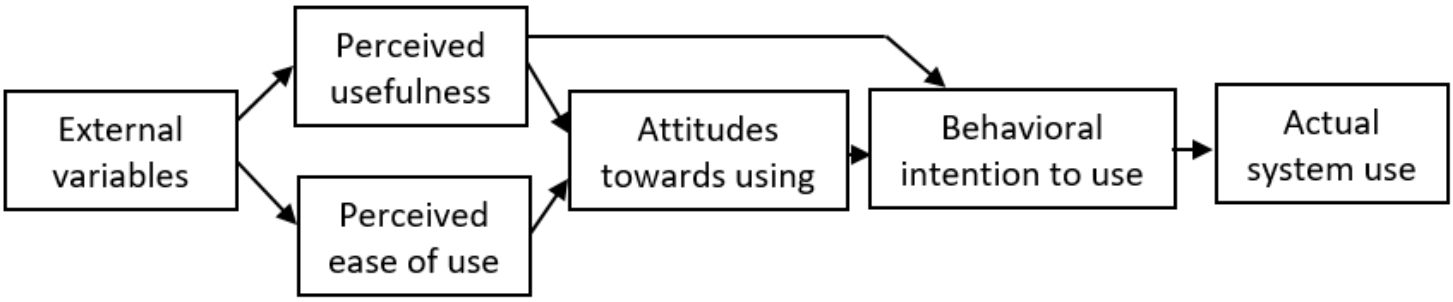

Figure 2

The technology acceptance model [27]

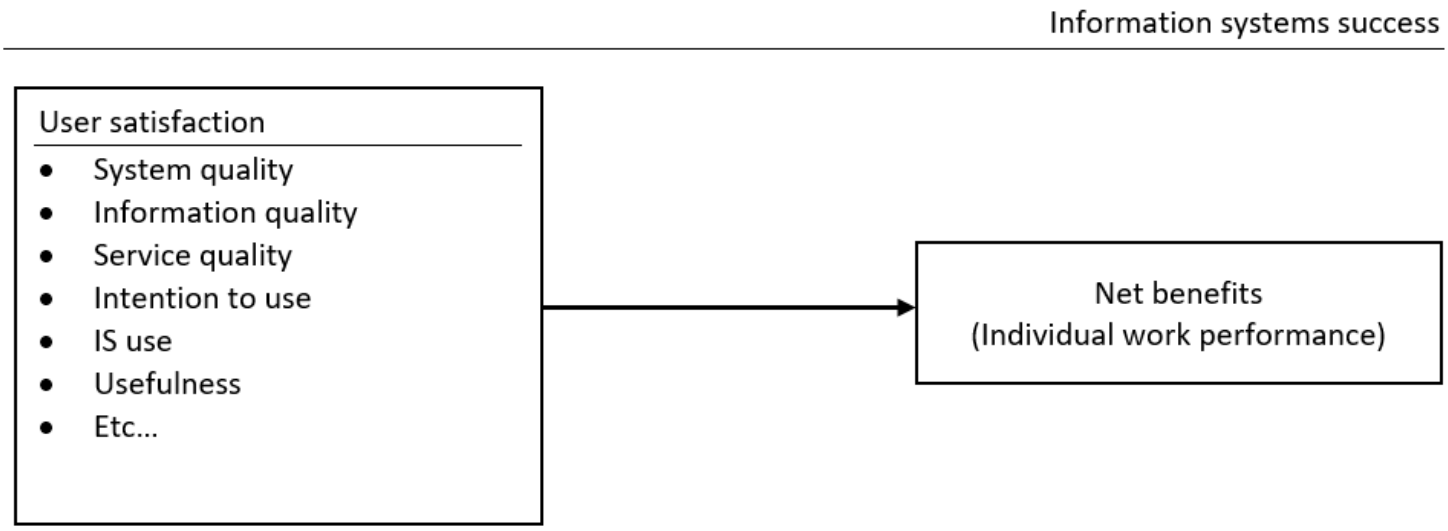

Figure 3

Conceptual model adapted from DeLone and McLean and subsequent IS models.

Supplementary Files

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- Appendix1.ResultsofChisquareFisherandWaldtestsstthroughRstudio.jpg
- Appendix2.QuantitativeQuestionnaire.png
- Appendix3.QualitativeQuestionnaire.png
- Appendix4.InstitutionalReviewBoardApprovalfromtheCHUK.png