Implementation of a National Electronic Health Information System in Gabon: A Survey of Healthcare Providers’ Perceptions.

CURRENT STATUS: UNDER REVIEW

BMC Medical Informatics and Decision Making

C.O. Bagayoko
Universite de Bamako

Email: cobagayoko@certesmali.org Corresponding Author
ORCID: https://orcid.org/0000-0002-7270-4854

Jack Tcheente
Research Center in Primary Care and Social Services

Diakaridia Traoré
CERTES

Gaetan Moukoumbi
Mistère en Charge de la santé, eGabon

Raymond Ondzigue
Mistère en Charge de la Santé, eGabon

Aimé Patrice Koumamba
Ministère en charge de la santé, eGabon

Myriam Corille Ondjani
Ministère en Charge de la Santé, eGabon

Olive Lea Ndjeli
Ministère en charge de la santé, eGabon

Marie-Pierre Gagnon
Faculty of Nursing Sciences, Université Laval

DOI: 10.21203/rs.2.14725/v1

SUBJECT AREAS

Medical Informatics
KEYWORDS

Health Information System, Information System Success, User Acceptance, Healthcare Providers, Gabon
Abstract
Background: Health information systems bring several benefits for the health system, healthcare providers, and the population. As a set of tools for the collection, storage, management and transmission of health data, their role to support the modernization of health systems, improve access to quality health care and reduce costs in developing countries is unquestionable. However, HIS implementation in low-income countries face several challenges. In Gabon, a unique initiative called eGabon has been launched in order to modernize the country’s infrastructures, notably through the deployment of a unique national electronic HIS that will connect health care institutions and providers at all levels in the whole country.
Objective: This study aims to identify the factors influencing the optimal use of the national electronic HIS by healthcare providers in Gabon.
Methods: We used an adaptation of the Information System Success Model (and developed a questionnaire that was distributed to 2600 healthcare providers across the country). Reliability and validity of the instrument were tested, and we performed a logistic regression to identify the factors influencing healthcare providers’ perceptions towards the national electronic HIS.
Results: A total of 2327 questionnaires were received from healthcare providers, of which 1930 were usable in the analyses. The reliability and validity of the questionnaire were supported. The logistic regression identified five constructs that significantly influence perceived system impact: System quality, Information quality, Support quality, Actual use and Useful functions. The model explains 30% of the variance in providers’ perception that the HIS leads to positive impacts.
Discussion: This study provides support to the use of an adapted ISSM in the context of HIS implementation in a low-income setting. The results show that health care providers’ perceptions regarding the positive impact of the HIS are influenced by their previous use of a HIS, the extent of their use, their perceptions of system quality, information quality and quality of the support provided to users. These results could inform the development of strategies to ensure adequate change management and user experience for the implementation of the national electronic HIS, and eventually in other low-resources settings.
Background
Health information systems (HIS) allow the collection, storage, management and transmission of data related to activities of healthcare providers, health organizations, patients and health consumers [1]. HIS include electronic health record (EHR) systems, clinical and hospital management systems, epidemiological and public health information systems, clinical decision support systems, patient portals and remote monitoring systems.
HIS are now implemented, at least partially, in several developed countries [2]. One of the major benefits of HIS is the capacity of generating timely information about patient and population health to support health care provision and management at all levels [3]. Improved coordination of care is also achieved through health information exchange that allow information sharing between all health care providers [4]. It is also expected that HIS could contribute to improve population health by processing large sets of epidemiological data to identify trends and adjust public health interventions [5].
In developing countries, governments are also investing in national HIS and expect it will contribute to improve access to quality health care and reduce costs [6]. However, many previous initiatives of HIS implementation in developing countries have not been successful due to poor planning [7]. The first obstacle to the implementation of HIS in developing countries is the current state of health systems that often lack the basic infrastructure [8].
In order to ensure that the conditions are in place for successful implementation of HIS in developing countries, it is necessary to investigate providers’ acceptance of these technologies, as well as the potential facilitators and threats to their adoption and integration [2].
Studies focusing on the adoption of HIS in developing countries are scarce [3, 9] and to the best of our knowledge, such study are inexistent in Gabon. In Gabon, a national initiative called “eGabon” has been put forward by the government in order to modernize the country’s infrastructure based on the rapid advances in information technologies. The uniqueness of this initiative lies in the fact that it encompasses several sectors of activities, notably healthcare. A national electronic health information system is thus being developed, adopting a systemic vision that will allow the deployment of an integrated HIS that will connect health care institutions and providers at all levels in the whole
country. An external evaluation has been mandated in order to accompany the development of the project and one of its first task has been to assess the conditions for success of such large-scale project, taking into account the perspectives of end-users, including health organisations, professionals and patients.

This study is part of the larger evaluation strategy of the Gabon national HIS initiative and aims to identify the individual determinants of healthcare providers’ perceptions of the impact of implementing a national electronic health information system in Gabon. The perspective of healthcare providers is particularly important to consider since they are those who will have to integrate the new system into their practice, which supposes important changes[10–12].

**Theoretical Models of HIT Acceptance**

Technology acceptance is considered as an essential condition for technology adoption and use[13].

In developed countries, acceptance of health information technology has been the focus of research since the 1990’s. Over the last decade, rapid technological advances, notably with the expansion of mobile telecommunication networks, have stimulated the application of information and communication technologies (ICT) for health purposes in developing countries.

There is generally a variety of models used in evaluating the implementation of health ICT in developing countries. The Technology Acceptance Model (TAM), developed by Davis and collaborators [14], and its several extensions, such as the Unified Theory of Acceptance and Use of Technology (UTAUT)[15] have been extensively applied for assessing technology acceptance. However, the adequacy of these models to study technology acceptance in the context of developing countries has been criticized or showed mixed results[16]. For instance, the fact that technologies such as EHR are not widespread in the daily life of the population limits the relevance of some variable of the UTAUT[9].

According to many authors, those models should be adapted to context of developing countries[2, 3, 16, 17]. Thus, researchers often decide to adapt these acceptance models either by adding new variables[3, 9, 16] or by deleting variables [8, 16]. The addition of variables is done to facilitate the consideration of cultural specificities or technical issues specific to developing countries[3, 8, 16]. For
instance, an adaptation of the UTAUT has proved conclusive in the case of a study on HIS acceptance conducted in Cameroon [16]: the percentage of explained variance increased from 12% to 46% when the moderating effect of age was considered in the model.

Other models have also been used to study technology acceptance in developing countries. For instance, several authors used the DeLone and McLean Information System Success Model (ISSM) [18] to measure the success of implementing a HIS [19–23]. These studies generally support the use of this model when it comes to evaluating the success of an implantation in a developing or resource-limited country. In Ethiopia, for instance, the study by Tilahun and Fritz [20] provided satisfactory results to support the relevance of this model in a low-resource system.

Methods
Study population and setting
The target population of this study was healthcare providers, including health professionals (physicians, nurses, midwives, etc.) or people working in health care services (managers, administrators) employed in different health structures of the 10 health regions of Gabon. A convenience sample of 2600 participants was selected reflecting the proportion of healthcare providers within each region.

Theoretical model
The theoretical background of this study is inspired by the DeLone and McLean ISSM [18, 24]. This model recommends taking into account five variables to measure the success of the implementation of an information system: system quality, service quality, information quality, actual use, satisfaction and net benefits (impact).

In this study, we extended the ISSM by adding sociodemographic variables (age, sex, profession, experience, organization, and ICT skills) and psychosocial factors (useful functions, overload, and compatibility). Figure 1 presents the adapted conceptual model.

A questionnaire was developed based on previous studies and validated among experts of the project team (see Additional file 1). The questionnaire comprised 14 questions, totalising 44 items. Theoretical constructs were assessed by 5-point Likert scales, and a “not applicable” option was available for participants without previous experience of using a HIS.
Figure 1 Theoretical model adapted from DeLone & McLean

Data analysis

All responses were encoded into numerical values and questionnaires with too many missing values were eliminated. First, we used Cronbach alpha and congeneric reliability (CR) coefficients to assess the internal consistency of each theoretical construct. Confirmatory factor analysis (CFA) was then used to evaluate construct validity. Observations with “not applicable” answers were eliminated for the validation analyses. However, they were kept for construct computation if at least half of the items for the associated construct were valid responses.

Due to the non-normality of the dependant variable, logistic regression was used in order to test the study hypotheses and identify the variables associated with perceived system impact (Impact) by healthcare providers. Ordinal variables with more than two modalities and Impact, the dependant variable, were dichotomized in order to perform the logistic regression. Age was dichotomized (“less than 40 years old” and “40 years old and above”). Work experience was also divided in two categories (“less than 10 years” and “10 years and more”). With respect to ICT skills, the average category was chosen as the cut-off point. For nominal variables (organization and profession), we also performed a dichotomization considering the mode of the series. Impact was dichotomized at the median while the other theoretical variables were considered as continuous variables.

An alpha level of 0.05 was set for testing the statistical significance for both correlation and regression analyses. All statistics were performed with SAS 9.4.

Results

Characteristics of participants

Figure 2 presents the flow diagram of the study. A total of 2327 participants returned their questionnaires, for a global response rate of 89.5%. There were 397 unusable questionnaires due to a high number of missing values, notably on socio-demographic questions. Of the 1930 questionnaires with usable observations, many included “not applicable” responses for some items, but they were kept for the reliability tests if there was at least 50% of the items with a valid response for a given construct. Finally, 781 questionnaires with complete observations were retained to test the theoretical model after eliminating those that were not eligible due to “not applicable” answers (Figure 2).
Table 1 presents the profile of respondents with a description of their socio-demographic characteristics. Among the 1930 usable questionnaires, 1275 were completed by women (66.1%) and 655 by men (33.9%). The majority of participants (47.5%) were between 40–49 years old. Regarding ICT skills, a majority reported an average level (36.6%). However, more people (51.8%) reported having a low level (null or elementary) than a high level (advanced or expert) (11.6%). With respect to occupational characteristics, there was a majority of nurses (55.5%), and professionals from a regional hospital (HR) with 29%. A majority of respondents had a long tenure in their profession: most of them have been in this profession for more than 10 years (60.8%).

Figure 2 Study flow diagram

Reliability and validity
Pearson correlations were performed between the different items as a first consistency check (Additional file 2). The coefficients were generally significant, high (>0.4) and positive for items belonging to the same construct. The values obtained with the Cronbach alpha (Table 2) and with the CR (Table 3) were all above the minimally accepted value (0.7) used to support a consistency of the constructs [25, 26]. To test the construct validity, 385 observations with absolutely no “not applicable” value were used. All factor loadings were higher than 0.7 (Table 3). Fit indices were also in the recommend threshold, except for RMSEA which was slightly above [27] (Table 4).

Normality and multicollinearity
Two assumptions have to be examined before performing a logistic regression. There should not be high multicollinearity between independent variables, and the dependant variable should not have a normal distribution. Correlations between variables are generally inferior to 0.3 (Additional File 3). However, some variables have a higher correlation score. For instance, SQ has high correlation (>0.5) with many variables such as Impact, IQ or SupQual. As high correlation may indicate multicollinearity, we performed a variance inflation factor (VIF) test. The VIFs obtained are all below 5, which is the maximum value proposed by several authors [28–30] (Additional File 3). To test the normality, the Shapiro-Wilk test was performed on the dependant variable. The null hypothesis was rejected, which implied a non-normal distribution of Impact.

Logistic regression
The logistic regression model was first tested with all independent variables (Table 5). Of these, four variables showed a significant odds ratio (p < 0.05): SQ, IQ, SupQual, and UF. All these variables had a positive coefficient, which means that the higher their values, the more likely the individual will evaluate the impact of the HIS as strong. IQ had the highest standardized estimate, which implies it has the highest importance in this model.

We performed a stepwise regression by testing a model in which only the significant variables were kept (Table 6). Consequently, one additional variable was retained in the model, namely AU. People who have already used an HIS were about 1.5 more likely to consider that HIS has a high impact.

The final model was able to explain 30% of the variance in the dependant variable. Using a cross-validate method (leave one out) we calculated the area under the curve (AUC). The model was able to predict correctly 78% of the cases (AUC = 0.78).

The final model is represented by the following equation:

\[
\text{logit}(p) = -5.7 + 0.32\text{SupQual} + 0.53\text{SQ} + 0.52\text{IQ} + 0.34\text{AU} + 0.13\text{UF}
\]

Where \( p \) is the probability that Impact = 1.

Figure 3 Final theoretical model with estimates

Discussion
This study aimed to identify the individual determinants of healthcare providers’ perceptions regarding the national electronic HIS in Gabon. We used a model adapted from the Information System Success Model [18, 24] that showed very good measurement properties and acceptable predictive power. In fact, a total of 30% of the variance in providers’ perceptions of the positive impact resulting from the use of the HIS was explained by five variables of our adapted model, namely Support Quality, Information Quality, System Quality, Actual Use and Useful Functions. This latter variable was added to the initial ISSM in order to consider not only the actual use of a HIS, but also the extent of its use by asking respondents to indicate which specific functions of the HIS they use. The more functions they use, the higher is their score. This variable could be related to the concept of ‘meaningful use’ of an information system by health care providers which implies that
providers optimally use the core functionalities of an information system[31].

There are very limited data from similar studies in low-income countries. A study in Ethiopia[20] applied an adaptation of the ISSM and found that system quality, information quality and service quality had a significant influence on EMR use and user satisfaction. Both actual use and usersatisfaction were significantly associated with perceived benefit of EMRuse. Surprisingly, our results do not support the influence of user satisfaction on perceived benefits since this construct is not significantly associated with Impact in the final model. A plausible explanation could be that the ISSM variables are seen as interdependent, meaning that other constructs, such as useful functions and actual use might capture the influence of user satisfaction on perceived benefits [32].

A recent study conducted in Tanzania has tested a model that combines constructs from the ISSM and the TAM to understand user satisfaction and use of an EMR system [19]. The final model suggests that attitude and system quality are the only significant predictors of user satisfaction and system use. Another study from Tanzania applied a modified ISSM to identify the factors influencing user satisfaction with an electronic logistic management information system[22]. The model includes perceived usefulness, a variable from the TAM, as well as facilitating conditions from the UTAUT. These two variables, together with system quality, information quality, and system support, contributed significantly to the model, explaining 59.1% of the variance in user satisfaction.

Our adapted model allowed us to verify whether variables that are external to the ISSM could influence healthcare providers’ perceptions towards the HIS. Thus, we included several sociodemographic (age, sex, profession, experience, region, organization, and computer skills) and psychosocial variables (useful functions, work overload, and compatibility). However, none of the added variables but useful functions did significantly contribute to the model.

Some authors have suggested that inadequate computer literacy could hinder the success of EMR implementation in low-income countries[33, 34] but this effect has not been rigorously tested[20]. In our study, we measured computer skills but we found no significant influence of this variable on healthcare providers’ perceptions towards the HIS.

Strengths and Limitations
This study is one of the few focusing on the acceptance of a large-scale HIS in a low-income country and that considers the perceptions of various groups of end users, including nurses, physicians, midwives, and health administrators. The fact that the survey was completed by more than 2,300 participants is also noteworthy. Although we used an adaptation of a well-known theoretical model, the DeLone and McLean ISSM[18], the percentage of variance explained by this model is modest. Other models, such as the TAM and the UTAUT, are often applied to study user acceptance of HIS. However, some authors have questioned the appropriateness of such models to the context of low-income countries[16]. In future studies, it could be interesting to compare different models in order to assess their applicability to the context of resource-limited countries.

Our survey instrument showed very good psychometric properties and we are confident that it could be adapted and used in other similar settings. Our theoretical model adapted from the ISSM is also promising, but still needs improvement. Even though the scores obtained for the VIFs were relatively low, we cannot exclude the possibility of multicollinearity. Furthermore, the interdependence between the ISSM variables, particularly the mutual influence between use and user satisfaction, has been acknowledged previously and could constitute a limitation to this model[32, 35]. Nonetheless, based on our results and on those from other studies in similar contexts [19–22], we are confident that theoretical models such as the ISSM and the UTAUT could be adapted to low-resources settings and provide a useful framework to orient change management strategies when implementing HIS.

**Conclusion**

The implementation of a national electronic HIS in Gabon represents a unique opportunity to modernize the health system and improve the provision of health care and services to the population. The perceptions of healthcare providers are essential to consider in order to ensure their acceptance and use of this system in a low resource setting. Using an adaptation of the Information System Success Model, this study found that information quality, system quality, support quality, actual use and useful functions influenced the perception of positive impacts of the HIS by healthcare providers. These findings should be considered by decision makers and managers involved in the
implementation of the national electronic HIS in Gabon in order to ensure the quality of the system in terms of usability, the quality of information and the support provided to end users. Potential users should also be trained to the various functionalities of this system in order to witness its benefits and increase the likelihood of success of this HIS.

Abbreviations
Actual use: AU
Confirmatory Factor Analysis: CFA
Congeneric Reliability: CR
Electronic Health Record: EMR
Electronic Medical Record: EMR
Health Information System: HIS
Information and Communication Technology: ICT
Information Quality: IQ
Support quality: SupQual
System quality: SQ
Useful functions: UF

Declarations
Ethics approval and consent to participate
This study received approval from the "Commission des Lois et Textes" of the Ministry of Health of Gabon during the second Steering Committee of the Project.
All study participants signed an informed consent form.

Consent for publication
The publication of this work was authorized by "Commission des Lois et Textes" of the Ministry of Health of Gabon during the second Steering Committee of the Project.

Availability of data and materials
All data is available from the corresponding author (COB).

Competing interests
The authors declare that they have no competing interests.

Funding
This project is funded by the Government of Gabon through a program of the World Bank.

The funder (the Government of Gabon) has no role in this study. This publication is the initiative and the responsibility of the researchers of this study.

Authors’ contributions
COB, MPG, DT, GML, APK, RO, MCO and OLD designed the study. COB and DT draft the first report. MPG and COB carried out the first draft of the manuscript. JT and DT did the statistical analysis. COB, MPG, DT and JT revised the manuscript. MPG draft the final version of the manuscript. All authors checked and approved the submitted manuscript.

Acknowledgements
We are most grateful to the Government of Gabon and its partner, the World Bank. We also thank all the eGabon project team. A special thanks to the study participants who committed their time to the project.

Authors’ information

Bibliography
1. Haux R: Health information systems—past, present, future. International Journal of Medical Informatics 2006, 75(3):268–281.

2. Shehu I, Shamsudeen AS, Amaal KN: Acceptance of electronic health record for improving quality of health service delivery: case study of aminu kano teaching hospital, Nigeria. KIU Journal of Humanities 2017:15.

3. Karuri J, Waiganjo P, Orwa D: Determinants of Acceptance and Use of DHIS2 in Kenya UTAUT-Based Model. Journal of Health Informatics in Developing Countries 2017, 11.

4. Bates DW: Health Information Technology and Care Coordination: The Next Big Opportunity for Informatics? Yearb Med Inform 2015, 10(1):11–14.

5. Birkhead GS, Klompas M, Shah NR: Uses of Electronic Health Records for Public Health Surveillance to Advance Public Health. Annual Review of Public Health 2015, 36(1):345–359.

6. Hoque MR, Bao Y, Sorwar G: Investigating factors influencing the adoption of e-Health in developing countries: A patient’s perspective. Inform Health Soc Care 2017, 42(1):1–17.

7. Anwar F, Shamim A: Barriers in Adoption of Health Information Technology in Developing Societies,
8. Mukred A, Singh D, Safie N: *Investigating the impact of information culture on the adoption of information system in public health sector of developing countries*. International Journal of Business Information Systems 2017, 24(3):261.

9. Hossain A, Quaresma R, Rahman H: *Investigating factors influencing the physicians’ adoption of electronic health record (EHR) in healthcare system of Bangladesh: An empirical study*. International Journal of Information Management 2019, 44:76–87.

10. Lorenzi N, T. Riley R, A. Dewan N: *Barriers and resistance to informatics in behavioral health*, vol. 84; 2001.

11. Lorenzi NM, Riley RT, Blyth AJC, Southon G, Dixon BJ: *Antecedents of the People and Organizational Aspects of Medical Informatics: Review of the Literature*. Journal of the American Medical Informatics Association 1997, 4(2):79–93.

12. Venkatesh V, Sykes TA, Zhang X: ‘*Just What the Doctor Ordered*: A Revised UTAUT for EMR System Adoption and Use by Doctors*. In: 2011 44th Hawaii International Conference on System Sciences: 4–7 Jan. 2011 2011; 2011: 1-10.

13. Lee YK, Kenneth A.; and Larsen, Kai R. T.: *The Technology Acceptance Model: Past, Present, and Future*. Communications of the Association for Information Systems 2003, 12.

14. Davis F, Bagozzi R, R. Warshaw P: *User Acceptance of Computer Technology: A Comparison of Two Theoretical Models*, vol. 35; 1989.

15. Venkatesh V, Morris MG, Davis GB, Davis FD: *User Acceptance of Information Technology: Toward a Unified View*. MIS Quarterly 2003, 27(3):425–478.

16. Bawack RE, Kala Kamdjoug JR: *Adequacy of UTAUT in clinician adoption of health information systems in developing countries: The case of Cameroon*. Int J Med Inform 2018, 109:15–22.

17. Alsharo M, Alnsour Y, Alabdallah M: *How habit affects continuous use: evidence from Jordan’s national health information system*. Inform Health Soc Care 2018:1-14.

18. Delone W, McLean E: *The DeLone and McLean Model of Information Systems Success: A Ten-Year Update*, vol. 19; 2003.
19. Ayebazibwe I, Kimaro HC, Kaasbøll JJ: System Use and User Satisfaction in the Adoption of Electronic Medical Records Systems: A Case of DHIS2 Tracker Implementation in Tanzania. 2019, 551:63–75.

20. Tilahun B, Fritz F: Modeling antecedents of electronic medical record system implementation success in low-resource setting hospitals. BMC Med Inform Decis Mak 2015, 15:61.

21. Tubaishat A: Evaluation of Electronic Health Record Implementation in Hospitals. Comput Inform Nurs 2017, 35(7):364–372.

22. Zuhura D Omary, Kalinga EA: Assessing Users’ Satisfaction with Tanzanians’ Public Health Supply Chain Electronic Logistic Management Information System. 2017.

23. Hossein Monem, Mohammad Afrasiabi, Pouyan Rezvan, Dehkordi SA: The Impact of User Quality and Information Quality on the IS Success in Healthcare Context. Journal of Basic and Applied Scientific Research 2013.

24. McLean ER, DeLone WH: Information Systems Success Measurement. Foundations and Trends® in Information Systems 2016, 2(1):1–116.

25. Hair JF, Black WC, Babin BJ, Anderson RE: Multivariate Data Analysis: Pearson Education Limited; 2013.

26. Hoque R, Sorwar G: Understanding factors influencing the adoption of mHealth by the elderly: An extension of the UTAUT model. Int J Med Inform 2017, 101:75–84.

27. Hu Lt, Bentler PM: Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling: A Multidisciplinary Journal 1999, 6(1):1–55.

28. Abdelhamid M: Greater patient health information control to improve the sustainability of health information exchanges. J Biomed Inform 2018, 83:150–158.

29. Cilliers L, Viljoen KL, Chinyamurindi WT: A study on students’ acceptance of mobile phone use to seek health information in South Africa. Health Inf Manag 2018, 47(2):59–69.

30. Studenmund AH: Using econometrics: a practical guide, 6th ed., International ed edn. Harlow: Pearson Education Limited; 2013.
31. Blumenthal D, Tavenner M: *The “Meaningful Use” Regulation for Electronic Health Records*. *New England Journal of Medicine* 2010, 363(6):501–504.

32. Petter S, DeLone W, McLean E: *Measuring information systems success: models, dimensions, measures, and interrelationships*. *European Journal of Information Systems* 2008, 17(3):236–263.

33. Alwan K, Awoke T, Tilahun B: *Knowledge and Utilization of Computers Among Health Professionals in a Developing Country: A Cross-Sectional Study*. *JMIR Human Factors* 2015, 2(1):e4.

34. Miranda FJ, N. Gadelha S: *Hospital Information System Satisfaction in Brazil: Background and Moderating Effects*, vol. 2; 2014.

35. Petter S, DeLone W, McLean ER: *Information Systems Success: The Quest for the Independent Variables*. *Journal of Management Information Systems* 2013, 29(4):7–62.

### Tables

**Table 1. Characteristics of participants**

| Variables   | Categories               | n (%)* |
|-------------|--------------------------|--------|
| **Age**     | 0-29                     | 101 (5.2) |
|             | 30-39                    | 583 (30.2) |
|             | 40-49                    | 917 (47.5) |
|             | 50-59                    | 301 (15.6) |
|             | 60+                      | 28 (1.5) |
| **Experience** | 0-5 years              | 323 (16.7) |
|             | 6-9 years                | 434 (22.5) |
|             | 10+                      | 1173 (60.8) |
| **ICT Skill** | None                   | 564 (29.2) |
|             | Elementary               | 436 (22.6) |
|             | Average                  | 706 (36.6) |
|             | Advanced                 | 209 (10.8) |
|             | Expert                   | 15 (0.8) |
| **Organization** | Regional hospital      | 559 (29) |
|             | Medical center           | 348 (18) |
|             | Other structure          | 316 (16.4) |
|             | CHU                      | 303 (15.7) |
|             | Health center            | 196 (10.2) |
| Profession                      | Count (Percentage) |
|---------------------------------|--------------------|
| Private structure               | 145 (7.5)          |
| Dispensary                      | 63 (3.3)           |
| Nurse                           | 1072 (55.5)        |
| Other health profession         | 412 (21.3)         |
| Midwife                         | 140 (7.3)          |
| General practitioner            | 115 (6)            |
| Administrator                   | 105 (5.4)          |
| Specialist practitioner         | 86 (4.5)           |

| Healthregion                    | Count (Percentage) |
|---------------------------------|--------------------|
| Estuaire (Libreville Owendo)    | 669 (34.7)         |
| WoleuNtem                       | 296 (15.3)         |
| Ngounié                         | 271 (14)           |
| Estuaire (Ouest)                | 182 (9.4)          |
| Haut Ogooué                     | 146 (7.6)          |
| Ogooué Lolo                     | 92 (4.8)           |
| Ogooué Ivindo                   | 81 (4.2)           |
| Moyen Ogooué                    | 75 (3.9)           |
| Ogooué Maritime                 | 68 (3.5)           |
| Nyanga                          | 50 (2.6)           |

| Sex                              | Count (Percentage) |
|----------------------------------|--------------------|
| Female                           | 1275 (66.1)        |
| Male                             | 655 (33.9)         |

*N=1930

Table 2. Internal consistency of theoretical constructs (Cronbach alpha)
| Construct             | Cronbach coefficient (n) | Nb. Items | n     |
|----------------------|--------------------------|-----------|-------|
| Satisfaction         | 0.85                     | 4         | 1104  |
| Support Quality (SupQual) | 0.85                   | 4         | 889   |
| System Quality (SQ)  | 0.90                     | 7         | 663   |
| Impact               | 0.90                     | 10        | 1036  |
| Information Quality (IQ) | 0.91                   | 5         | 1009  |

Table 3. Construct reliability of the model

| Construct             | Items | Label                                           |
|----------------------|-------|------------------------------------------------|
| Satisfaction         | q1a   | HIS performance                                |
|                      | q1b   | HIS ease of use                                |
|                      | q1c   | HIS quality of information                      |
|                      | q1d   | HIS support services quality                    |
| SupQual              | q2a   | The process of implementing HIS was adequate    |
|                      | q2b   | The level of training in the use of HIS is adequate |
|                      | q2c   | The level of support offered for the use of HIS is adequate |
|                      | q2d   | Accessing the HIS at your workplace is easy     |
| SQ                   | q3a   | The response time of the HIS against a request is acceptable |
|                      | q3b   | The HIS is easy to use                          |
|                      | q3c   | The required effort to use the HIS is acceptable |
|                      | q3d   | The HIS ensures adequate privacy and security of patients' personal data |
q3e  Access to the HIS is acceptable
q3f  The HIS has a reliable performance
q3g  The HIS allows you to enter all the information you want

Impact
q4a  The HIS increases your productivity
q4b  The HIS facilitates information exchange between different users of the system
q4c  The HIS improves real time management of health care and services
q4d  The HIS improves patient information management in real time
q4e  The HIS provides easy access to the desired information
q4f  The HIS makes it possible to visualize the information related to a patient
q4g  The HIS allows to be informed about the care and services received by a patient
q4h  The HIS allows for better planning of your clinical activities
q4i  The HIS avoids unnecessary investigations and examinations
q4j  The HIS facilitates access to information about a patient's results

IQ
q5a  The information provided by the HIS is complete
q5b  The information provided by the HIS is accurate
q5c  The HIS provides information quickly
q5d  Information is available in the HIS when you need it
q5e  The presentation and layout of information in the HIS are adequate

| Model fit | Indicator value |
|-----------|-----------------|
| RMSEA     | 0.071           |
| CFI       | 0.925           |
| IFI       | 0.925           |
| TLI       | 0.918           |

Table 4. Fit indices of the CFA

Table 5. Logistic regression of the full model
| Variables                          | Estimate | Estimate confidence interval | Odds ratio | p-values | Standardized estimate |
|-----------------------------------|----------|------------------------------|------------|----------|-----------------------|
| Intercept                         | -5.68    | -6.8 to -4.51                | 1.08       | 0        | 0                     |
| Satisfaction                      | 0.07     | -0.1 to 0.26                | 1.34       | 0.44     | 0.05                  |
| SupQual                           | 0.29     | 0.0 to 0.53                 | 1.37       | 0.02     | 0.16                  |
| SQ                                | 0.51     | 0.2 to 0.77                 | 1.66       | 0        | 0.28                  |
| IQ                                | 0.51     | 0.3 to 0.72                 | 1.67       | 0        | 0.3                   |
| AU                                | 0.19     | -0.3 to 0.78                | 1.21       | 0.52     | 0.05                  |
| Compatibility                     | 0.18     | -0.3 to 0.71                | 1.2        | 0.51     | 0.05                  |
| Overload                          | 0.14     | -0.3 to 0.59                | 1.15       | 0.53     | 0.03                  |
| UF                                | 0.12     | 0.0 to 0.21                 | 1.13       | 0.01     | 0.12                  |
| Age (0-39)                        | -0.14    | -0.5 to 0.24                | 0.87       | 0.47     | -0.04                 |
| Sex (Male)                        | -0.08    | -0.4 to 0.26                | 0.92       | 0.64     | -0.02                 |
| Experience (0-9)                  | -0.11    | -0.5 to 0.29                | 0.9        | 0.6      | -0.03                 |
| Low ICT skill                     | 0.19     | -0.1 to 0.54                | 1.2        | 0.3      | 0.05                  |
| Profession (Nurse)                | -0.01    | -0.3 to 0.35                | 0.99       | 0.95     | 0                     |
| Organization (RegionalHospital)   | 0.22     | -0.1 to 0.56                | 1.24       | 0.23     | 0.06                  |

AUC: 0.77; Nagelkerke r-square: 0.31; n=781

Table 6. Stepwise logistic regression of the final model

| Variables                          | Estimate | Estimate confidence interval | Odds ratio | P-Values | Standardized estimate |
|-----------------------------------|----------|------------------------------|------------|----------|-----------------------|
| Intercept                         | -5.7     | -6.67 to -4.74               | 1.37       | 0.01     | 0.18                  |
| SupQual                           | 0.32     | 0.1 to 0.54                  | 1.37       | 0.01     | 0.29                  |
| SQ                                | 0.53     | 0.28 to 0.78                 | 1.7        | 0        | 0.3                   |
| IQ                                | 0.52     | 0.32 to 0.73                 | 1.69       | 0        | 0.3                   |
| AU                                | 0.34     | 0.01 to 0.68                 | 1.41       | 0.04     | 0.09                  |
| UF                                | 0.13     | 0.04 to 0.22                 | 1.14       | 0.01     | 0.13                  |

AUC: 0.78; Nagelkerke R-squared: 0.3; n=781

Figures
Figure 1

Theoretical model adapted from DeLone & McLean. The theoretical model is based on the DeLone and McLean Information System Success Model. This model proposes five variables to measure the success of an information system: system quality, service quality, information quality, actual use, satisfaction and net benefits (impact).
Study flow diagram. From the 2600 potential participants, 2327 returned their questionnaires. There were 1930 usable questionnaires, and 781 questionnaires with complete observations were retained to test the theoretical model.
Final theoretical model with estimates. The final theoretical model explains 30% of the variance in providers’ perception of the positive impact resulting from the use of the HIS. Five variables of the adapted model are significative, namely Support Quality, Information Quality, System Quality, Actual Use and Useful Functions.

Supplementary Files
This is a list of supplementary files associated with this preprint. Click to download.

- Additional file 1.doc
- Additional file 2.xlsx
- Additional file 3.xlsx