ON THE DEVELOPMENT OF AN ONLINE BASED QUALITY ASSURANCE SYSTEM FOR MATERNAL AND CHILD HEALTH CARE PROVIDERS.

Nzeribe, S.O.[1] and Ugwunna, C.O[2]

[1]Department of Computer Science, Faculty of Physical Sciences, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria [2]Department of Computer Science, Federal University of Agriculture Abeokuta, Ogun State, Nigeria.

[1]*obystel12@gmail.com* / [2]*charles4monia@gmail.com*

Abstract

Despite considerable efforts made to ensure skilled birth attendance with the aim of reducing morbidity and mortality among mothers and newborns, there is absence of quality check and monitoring of services rendered by healthcare providers. This absence has in turn increased the level of maternal, child death and morbidity. Based on this, there is a need to create a system that can check the quality of medical treatment and amenities of the healthcare providers for the purpose of achieving desired outcome that are both consistent with current professional knowledge and basic healthcare rights. The research focuses on designing an online based quality assurance system for maternal and child healthcare providers. Object Oriented Analysis and Design Methodology (OOADM) was adopted for both analysis and design of the system. Hypertext Preprocessor (PHP) Cascading style sheet (CSS) and Javascript were used for the interface while APACHE server and MySQL were for the database analysis. The result is an online-based quality assurance system that assesses and evaluates the services rendered by healthcare providers to mothers and children using an agreed upon standards according to World Health Organization (WHO) specifications. The system either grants or denies license code to the hospital based on the outcome of performance. Mean was used to calculate the performance standard based on the universal bench mark provided by WHO. The values of the performance standard are x_1, x_2, x_3……x_n and the grading inputs are; evidence-based practices for routine care and management of complication, actionable information system, functional referral system, effective communication, respect and preservation of dignity, emotional support, competence, motivated human resource and essential physical resource. The quality assurance standard performance is the percentage value of the mean.

Keywords*: Maternal and child mortality, healthcare providers, online quality assurance model, standard performance, WHO.*

Introduction

Since 1990, considerable efforts have been made to ensure skilled birth attendance, with the aim of reducing morbidity and mortality among mothers and newborns. These efforts have substantially improved the number of births in health facilities. The proportion of deliveries attended by skilled health personnel in developing countries having increased from 56% in 1990 to 68% in 2012. Despite this increased coverage, 800 women and 7700 newborns still die each day from complications during pregnancy and childbirth and in the postnatal period; an additional 7300 women experience a stillbirth [5]. The outcome of the healthcare for women and newborns around the time of birth in health facilities reflects the evidence-based practices used and the overall quality of services provided by healthcare providers. The quality assurance of healthcare depends on the physical infrastructure, human resources, knowledge, skills and

capacity to deal with both normal pregnancies and complications that require prompt and life-saving interventions. Quality assurance of healthcare requires appropriate use of effective clinical and non-clinical interventions, strengthened health infrastructure, optimum skills and a positive attitude of health providers. These will improve health outcomes and give women, their families and the healthcare providers a positive experience.

Defining quality assurance of maternal and child healthcare poses some extra challenges with specific dimensions related to maternal and child healthcare, which need to be considered. In the context of maternal healthcare, Hulton and Mathews [7] incorporated the concept of both effective and timely access and of basic healthcare rights in quality assurance. The researchers defined quality assurance of healthcare as the degree to which maternal healthcare services for individuals and populations increase the likelihood of timely and appropriate treatment for the purpose of achieving desired outcomes that are both consistent with current professional knowledge and uphold basic healthcare rights. In this definition, two important components of healthcare were taken into consideration: the quality of the provision of healthcare and quality of healthcare as experienced by the users. The use of services and outcomes are the result not only of the provision of healthcare but also of women's experience of that the healthcare. Provision of healthcare may be deemed of high quality against recognized standards of healthcare but unacceptable to the woman and her family. Conversely, some aspects of healthcare may be popular with women but may be ineffective or harmful to healthcare. Taking into account these specific aspects of maternal healthcare, Pittrof and Campbell [15] developed a definition of quality assurance in maternal and child healthcare. It included an appreciation that as women and their babies have different needs, the health systems need to respond to these needs. Clinical outcomes as well as satisfaction for both users and healthcare providers are valued. It also includes a consideration of the costs of healthcare for the health services and how this healthcare can be sustained over time.

The United Nations Millennium Development Goals (MDGs) numbers 4 and 5 aimed at reducing child mortality and maternal mortality by two-third and three-quarters respectively till 2015. However, several developing regions, including Pakistan, were unable to meet the international targets and the efforts to achieve MDGs were marked as insufficient [3]. For instance, by the year 2015, Pakistan's less than 5 mortality rate was 81.1 and the maternal mortality ratio per 100,000 live births was 178. Situation is not very different in many other developing countries such as Saudi Arabia. The need for improvement resulted as a new set of Sustainable Development Goals (SDGs), which also define targets to deal with global healthcare issues including a reduction in maternal, neonatal, and child mortality in the next 15 years. Achieving maternal and child health (MCH) targets in underdeveloped or developing parts of the world requires significant investment in the infrastructure, improvement in the service delivery, and quality of healthcare, as well as the availability of reliable healthcare data [17]. In Pakistan, however, immature e-health solutions are deployed in a limited number of healthcare facilities [12]. The existing nonstandardized record-keeping techniques result in missing records, inconsistencies, poor data quality, and inaccuracies and hence undermine evidence-based decision making in healthcare service delivery [2]. Most of the local hospitals and clinics only have a primitive patient registration system to record billing information, and electronic records of clinical and medical data are ignored for the most part. In the absence of reliable data, country-level statistics are based on estimates from a selected sample.

Peoples-Sheps et al. [14] suggested that higher level ranking indicators in MCH domain are very well established. Developed countries use more granular data models. Japan, for instance, initiated the Maternal and Child Health Handbook in 1942 (referred as MCHHJ), to create awareness and log necessary information related to pregnancy and delivery, child development, and healthcare education. This handbook greatly contributed in decreasing maternal mortality rate (MMR) and infant mortality rate (IMR) in Japan [16]. Later on, customized handbooks were implemented in many countries such as Bangladesh, Indonesia, Thailand, Cambodia, and Mongolia. However, MCHHJ is a record book that does not offer some of the features of a computerized information system. Improving the quality assurance of healthcare in health facilities is thus, increasingly recognized as an important focus in the quest to end preventable mortality and morbidity among mothers and newborns. In order to address the barriers and challenges of providing quality assurance maternal and child healthcare (MCH) at hospitals, a comprehensive quality assurance system for maternal and child healthcare providers is essential. Maternal mortality has been on the increase in recent time with detrimental effects on the socioeconomic development of the nation. According to the World Health Organization, approximately 830 women die every day from preventable causes related to pregnancy and childbirth. More worrisome is the fact that 99% of all maternal deaths occur in developing countries [12]. Maternal mortality refers to deaths due to complications from pregnancy or childbirth. Even though, the United Nations International Children Emergency Funds reported that from 1990 to 2015, the global maternal mortality ratio declined by 44 percent from 385 deaths to 216 deaths per 100,000 live births, according to UN inter-agency estimates. This translates into an average annual rate of reduction of 2.3 per cent. While impressive, this is less than half the 5.5 per cent annual rate needed to achieve the three-quarters reduction in maternal mortality targeted for 2015 in Millennium Development Goal 5. Maternal and infant mortality rates are social indicators used to measure the development of any country, and the situation in Nigeria is of great concern [13]. Maternal and child mortality is a serious concern to the government and all interested stakeholder, and as such, it has become a vital issue for research. This research therefore, aimed to unravel the concept of maternal mortality within the Nigerian context, unpack it precipitating factors and bring to the fore the debilitating effects especially in areas of socioeconomic development. The improvement of the maternal healthcare system in Nigeria cannot be overstretched, and it is a vital aspect of sustainable development.

Related Works

Global efforts have increased facility-based childbirth, but substantial barriers remain in some settings. In Nigeria, women report that poor healthcare providers' attitudes influence their use of maternal healthcare services. Bohren et al. [4] suggested that women in Nigeria may experience mistreatment during childbirth; however, there is limited understanding of how and why mistreatment occurs. This study uses qualitative methods to explore women and healthcare providers' experiences and perceptions of mistreatment during childbirth in two health facilities and catchment areas in Abuja, Nigeria. In-depth interviews (IDIs) and focus group discussions (FGDs) were used with a purposive sample of women of reproductive age, midwives, doctors and facility administrations. Instruments were semi-structured discussion guides. Participants were asked about their experiences and perceptions of, and perceived factors influencing mistreatment during childbirth. Thematic analysis was used to synthesize findings into meaningful sub-themes, narrative text and illustrative quotations, which were interpreted within the context of the study and an existing typology of mistreatment during childbirth. Women and providers reported experiencing or witnessing physical abuse including slapping, physical restraint to a delivery bed and detainment in the hospital and verbal abuse,

such as shouting and threatening women with physical abuse. Women sometimes overcame tremendous barriers to reach a hospital, only to give birth on the floor, unattended by healthcare providers. Participants identified three main factors contributing to mistreatment: poor healthcare providers' attitudes, women's behavior and healthcare system constraints. Moving forward, findings from this study must be communicated to key stakeholders at the study facilities. Measurement tools to assess how often mistreatment occurs and in what manner must be developed for monitoring and evaluation. Any intervention to prevent mistreatment will need to be multifaceted and implementers should consider lessons learned from related interventions, such as increasing audit and feedback including from women, promoting labor companionship and encouraging stress-coping training for healthcare providers.

An efficient health management information system (HMIS) improves health care delivery and outcomes. However, in most rural settings in Uganda, paper-based HMIS are widely used to monitor public health care services [6]. Moreover, there are limited capabilities and capacity for quality HMIS in remote settings such as Kayunga district. The quality assurance practices of HMIS in health centres (HCs) in Kayunga district were evaluated. A cross-sectional descriptive study design was used to assess the quality of HMIS at 21 HCs in Kayunga district. Data were collected through in-depth interviews of HMIS focal persons as well as document analysis of HMIS records and guidelines between 15 June 2010 and 15 July 2010. The main outcomes were quality assurance practices, the HMIS programmatic challenges and opportunities. The practice of HMIS was assessed against a scale for good quality assurance practices. Qualitative data were coded and thematically analyzed, whereas quantitative data were analyzed by descriptive statistics using SPSS v22 software. Results: All the 21 HCs had manual paper-based HMIS. Less than 25% of HCs practiced quality assurance measures during collection, compilation, analysis and dissemination of HMIS data. More than 50% of HCs were not practicing any type of quality assurance during analysis and dissemination of data. The main challenges of the HMIS were the laborious and tedious manual system, the difficulty to archive and retrieve records, insufficient HMIS forms and difficulty in delivering hard copies of reports to relevant stakeholders influenced quality of data. Human resource challenges included understaffing where 43% of participating HCs did not have a designated HMIS staff. Conclusion: The HMIS quality assurance practices in Kayunga were suboptimal. Training and support supervision of HMIS focal persons is required to strengthen quality assurance of HMIS. Implementation of electronic HMIS dashboards with data quality checks should be integrated alongside the manual system.

Lamadrid [9] came up with an analysis of the distribution of time after delivery of maternal deaths in Mexico, 2010-2013. Progress towards the Millennium Development Goal No. 5 was measured by an indicator that excluded women who died due to pregnancy and childbirth after 42 days from the date of delivery. These women suffered from what are defined as late deaths and sequelae-related deaths (O96 and O97 respectively, according to the International Classification of Diseases, 10th revision). Such deaths end up not being part of the numerator in the calculation of the Maternal Mortality Ratio (MMR), the indicator that governments and international agencies use for reporting. The issue is not trivial since these deaths account for a sizeable fraction of all maternal deaths in the world and show an upward trend over time in many countries. The aim of this study was to analyze empirical data on maternal deaths that occurred between 2010 and 2013 in Mexico, linking databases of the Deliberate Search and Reclassification of Maternal Deaths (BIRMM) and the Birth Information Subsystem (SINAC) of the Ministry of Health. Data were analyzed by negative binomial regression, survival

analysis and multiple cause analysis. While the reported MMR decreased by 5% per year between 2010 and 2013, the MMR due to late and sequelae-related deaths doubled from 3.5 to 7 per 100,000 live-births in 2013 ($p < 0.01$). A survival analysis of all maternal deaths revealed nothing particular around the 42-day threshold, other than the exclusion of 18% of women who died due to childbirth in 2013. The multiple cause analysis showed a strong association between the excluded deaths and obstetric causes. It is suggested to review the construction of the MMR to make it a more inclusive and dignified measurement of maternal mortality by including all deaths due to pregnancy and childbirth into the Maternal Death definition.

Zohra et al. [18] examined a broad consensus and evidence that shows qualifies, accessible and responsive human resources for health (HRH) can make a major impact on the health of the populations. At the same time, there is widespread recognition that HRH crises particularly in low- and middle-income countries (LMICs) impede the achievement of better outcomes/targets. In order to achieve the Sustainable Development Goals (SDGs), equitable access to a skilled and motivated health worker within a performing health system is needed to be ensured. This review contributes to the vast pool of literature towards the assessment of HRH for maternal health and is focused on interventions delivered by skilled birth attendants (SBAs). Studies were included if (a) any HRH interventions in management system, policy, finance, education, partnership and leadership were implemented; (b) there were related to SBA; (c) reported outcomes related to maternal health; (d) the studies were conducted in LMICs' and (e) studies were in English. Studies were excluded if traditional birth attendants and/or community healthcare workers were trained. The review identified 25 studies which revealed reasons for maternal health outcomes in LMICs despite the efforts and policies implemented throughout these years; this review suggests an urgent and immediate need for formative evidence-based research on effective HRH interventions for improved maternal health outcomes. Other initiatives such as education and empowerment of women, alleviating poverty, establishing gender equality, and provision of infrastructure, equipment, drugs and supplies are all integral components that are required to achieve SDGs by reducing maternal mortality and improving maternal health.

Kyalo & Odhiambo-Otieno [8] evaluate the District Health Management Information Systems (DHMISs) were established by the Ministry of Health (MoH) in Kenya more than two decades ago. Since then, no comprehensive evaluation has been undertaken. This can partly be attributed to lack of defined criteria for evaluating them. The objective was to propose evaluation criteria for assessing the design, implementation and impact of DHMIS in the management of the District Health system (DHS) in Kenya. A descriptive cross-sectional study conducted in three DHSs in Kenya: Bungoma, Murang'a and Uasin Gishu districts. Data was collected through focus group discussions, key informant interviews, and documents' review. The respondents purposely selected from the Ministry of Health headquarters and the three DHS districts, included designers, managers and end-users of the system. A set of evaluation criteria for DHMISs was identified for each of the three phases of implementation: pre-implementation evaluation criteria (categorized as policy and objectives, technical feasibility, financial viability, political viability and administrative operability) to be applied at the design stage; concurrent implementation evaluation criteria to be applied during implementation of the new system; and post-implementation evaluation criteria (classified as internal – quality of information; external – resources and managerial support; ultimate – systems impact) to be applied after implementation of the system for at least three years. In designing a DHMIS model there is need to have built-in these three sets of evaluation criteria which should be used

in a phased manner. Pre-implementation evaluation criteria should be used to evaluate the system's viability before more resources are committed to it; concurrent (operational) – implementation evaluation criteria should be used to monitor the process; and post-implementation evaluation criteria should be applied to assess the system's effectiveness.

Information about utilization of health services and associated factors are useful for improving service delivery to achieve universal health coverage [10]. Data on a sample of ever-married women from India Demographic and Health survey 2005–06 was used. Mothers of children aged 0–59 months were asked about child's illnesses and type of health facilities where treatment was given during 15 days prior to the survey date. Type of health facilities were grouped as informal provider, public provider and private provider. Factors associated with utilization of health services for diarrhea and fever/cough was assessed according to Andersen's health behavior model. Multinomial logistic regression analyses were done considering sampling weights for complex sampling design. A total of 48,679 of ever-married women reported that 9.1% 14.8% and 17.67% of their children had diarrhea, fever and cough respectively. Nearly one-third of the children with diarrhea and fever/cough did not receive any treatment. Two-thirds of children who received treatment were from private health care providers (HCPs). Among predisposing factors, children aged 1–2 years and those born at health facility (public/private) were more likely to be taken to any type of HCP during illness. Among enabling factors, as compared to poorer household, wealthier households were 2.5 times more likely to choose private HCPs for any illness. Children in rural areas were likely to be taken to any type of HCP for diarrhea but rural children were less likely to utilize private HCP for fever/cough. 'Need' factors i.e. children having severe symptoms were 2–3 times more likely to be taken to any type of HCP. Private HCPs were preferred for treatment of childhood illnesses. Involvement of private HCPs may be considered while planning child health programs. Health insurance scheme for childhood illnesses may to protect economically weaker sections from out-of-pocket health expenditure during child illness.

Materials and Methods

We developed and implemented an online-based quality assurance system using MySQL Database Engine Version 5.6; Hypertext Preprocessor (PHP) Scripts Version 5.4 and Cascading Style Sheet (CSS) Version 3.0. The methodology adopted was Object Oriented Analysis and Design Methodology (OOADM) for easy implementation. It was chosen to break a complex system into smaller module, back together to form a complete and consistent system. The information obtained necessitated the definition of a high-level model (HLM) for the system as shown in Figure 1. Using this HLM, a dataflow diagram of the new system (Figure 2) and the class diagram of the system (Figure 3) were designed. The use of case diagram and sequence diagram were also used to represent processes within the system as shown in Figure 4 and 5. Online-based quality assurance system displays whether the hospital passed or failed the assessment and evaluation process. Mean was used to calculate the performance standard based on the universal bench mark provided by World Health Organization (WHO).

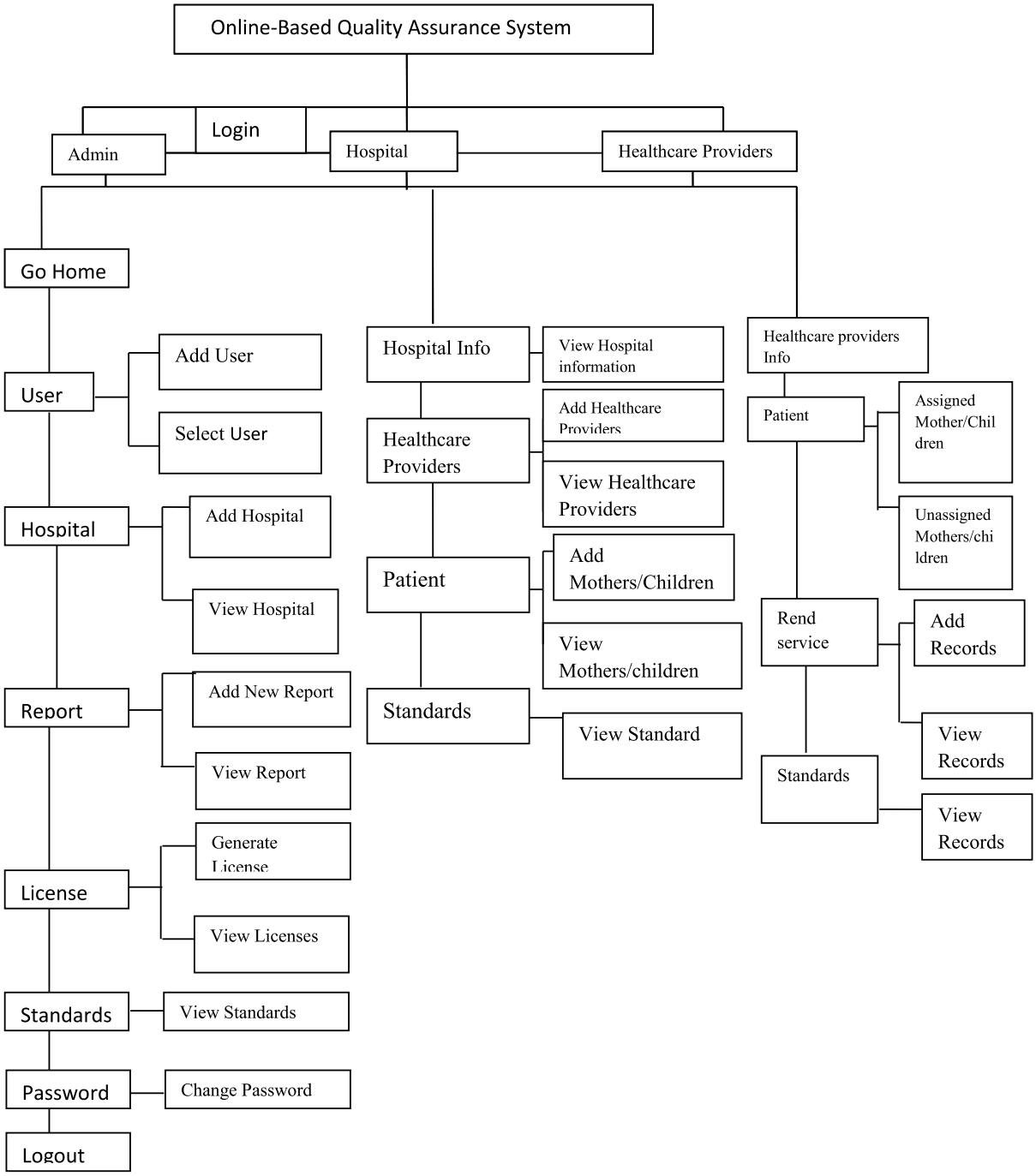


Figure 1: High level model (HLM) of online-based quality assurance system

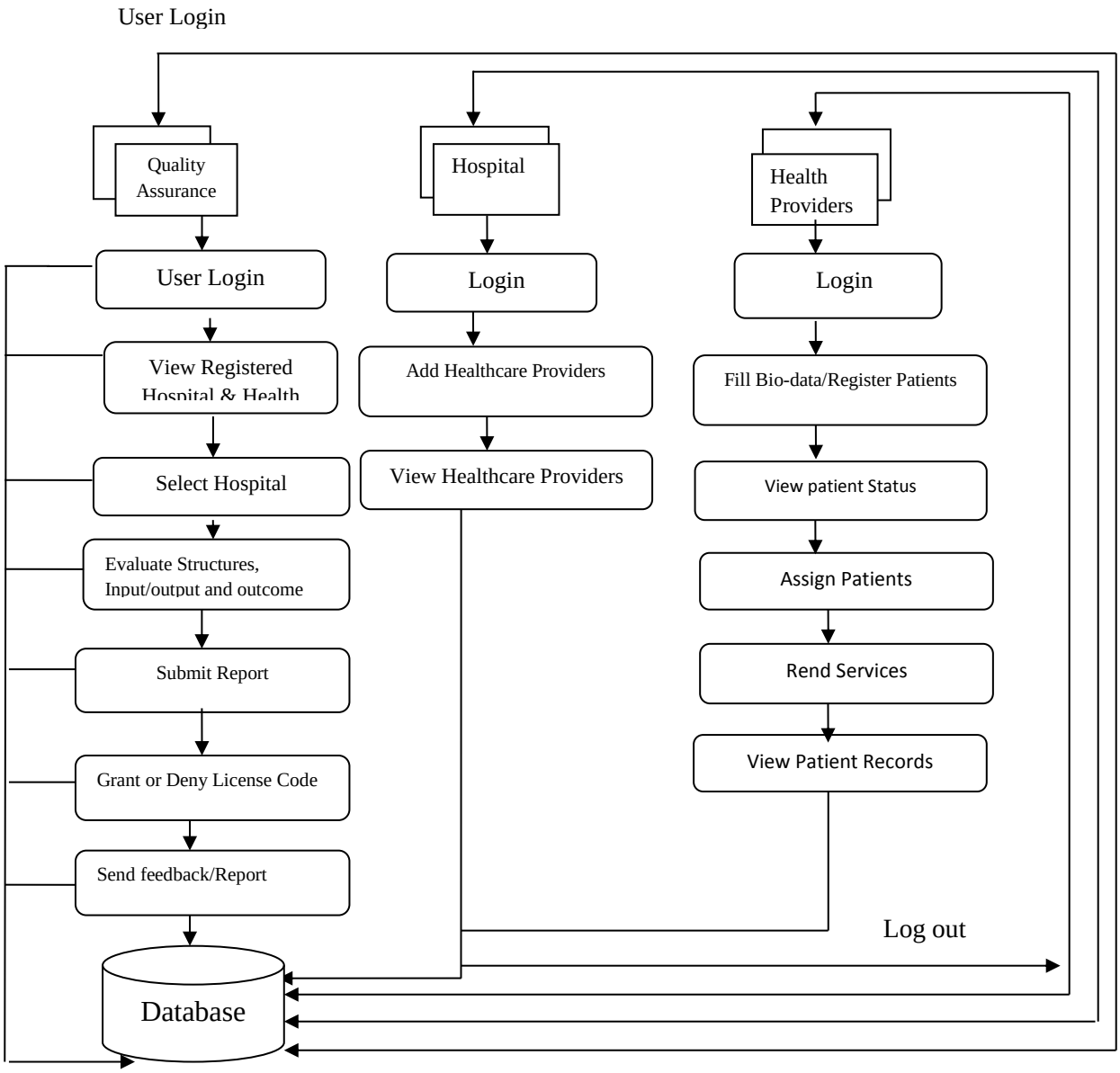


Figure 2: Dataflow Diagram of the New System (OBQAS)

System Design

Design principles are necessary for efficient software design. Top down and bottom up strategies help to implement these principles and achieve the objectives [1]. The top down approach which was adopted in this work, starts from the highest-level module of the hierarchy and proceeds through to lower level. On the contrary, bottom up approach starts with lower level modules and proceeds through higher levels to the top-level module. The HLM of the online-based quality assurance system is represented by Figure 1. This figure shows several modules in the system. These modules are Go Home, User, hospital, Report, license, standards, healthcare providers, patients, password, Logout from the administration dashboard. Some of these modules have sub modules.

Add User- In Add User module, regulatory control agency, hospital and healthcare providers this can be added through module.
Report- The report of the performance standard should be evaluated and assessed on this module.
License- The generation of license code can be done on the module.
View Standard- performance standards according WHO specification are shown on this module.

Password-Users can be able to change their password from this module.

Figure 2 shows the dataflow diagram of the new system, the system is made online where both governmental and non-government hospitals are allowed to register and give detailed information of their hospital and their healthcare providers. The performance standards are used to assess and evaluate the services being rendered by healthcare providers, putting in place the structures (the number of care providers, functioning equipment, number of worthy vehicle etc.), processes (waiting time, laboratory test, diagnosis, treatment etc.) and outcome (mortality rate, patient satisfaction, attendance level etc.) into considerations as the criteria for evaluation performance standards. The hospital is scored based on the listed quality statements and submitted to the system to evaluate and display the feedback immediately.

The class diagram of the system (Figure 3) shows the building blocks of the online-based quality assurance system. The class diagram depicts the static view of the model, describing the attribute and behavior. Each class contains various attributes and methods which call other class attributes to share data. The regulatory control agency registers hospital to create username and password the hospital should use to register their healthcare providers to also get their identity number and password. The healthcare providers assess the system with an identity number to render their services to either mothers or children assigned to them for medical care.

On the other hand, the regulatory control agency selects hospital and assesses their service using the performance standards according world health organization (WHO) specifications. The quality assurance standard performance is the percentage value of the mean. License code which serves as symbol of power or authority to practice is granted to the hospital that meets up to performance standards.

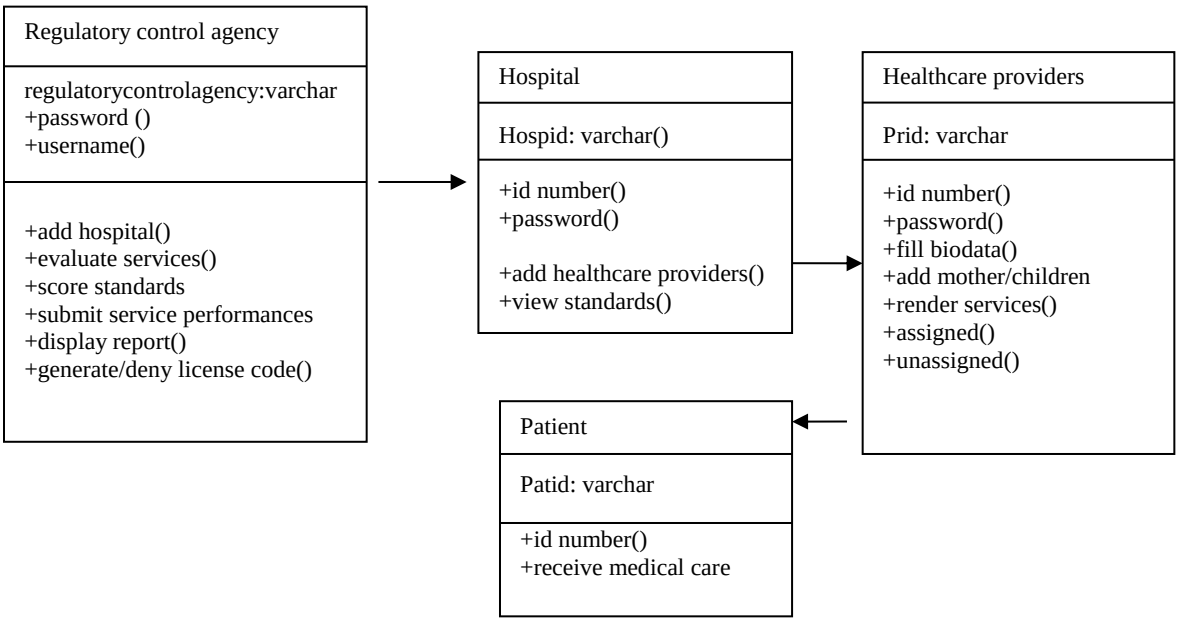


Figure 3: Class diagram of the online-based quality assurance system (OBQAS)

Figure 4 shows the use of case diagram of an online-based quality assurance system. Here, the regulatory control agency login with their username and password, register hospitals to get them identity number and password, select and evaluate hospital performance standards, score and submit report, display result and license code is granted or denied based on the outcome of the performance standards. The healthcare providers fill biodata using hospital identity number to create account, add, assignor unassigned mothers and children, then render services that are to be assessed and evaluated. The output depends on whether license code can be granted or denied.

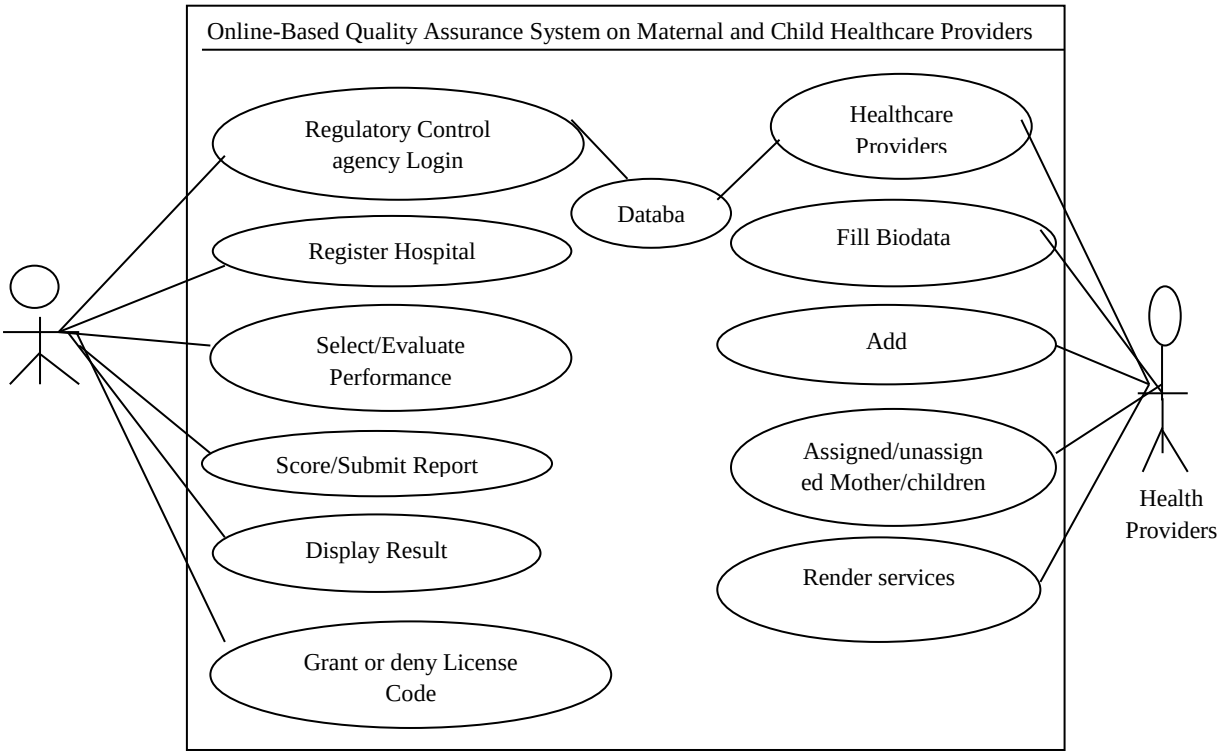


Figure 4 Use Case Diagram for Online-based quality assurance system

Figure 5 depict the sequence diagram of an online-based quality assurance system. It shows object as lifelines running down the page and with their interactions over time represented as messages drawn as arrows from the source lifeline to the target lifeline. Here, the administrator (regulatory control agency) starts by logging in into the system. The administrator has the option of adding or viewing all registered hospital with their username and password. The administrator also has the ability to assess and evaluate hospital performance. Once the hospital passed the evaluation process, license code is generated, otherwise license code should not be issued. Registered hospital login and add healthcare providers, view and add healthcare providers of the hospital. Healthcare providers login to add and assign mothers and children, render services and view records. The whole information is stored in the database for future reference.

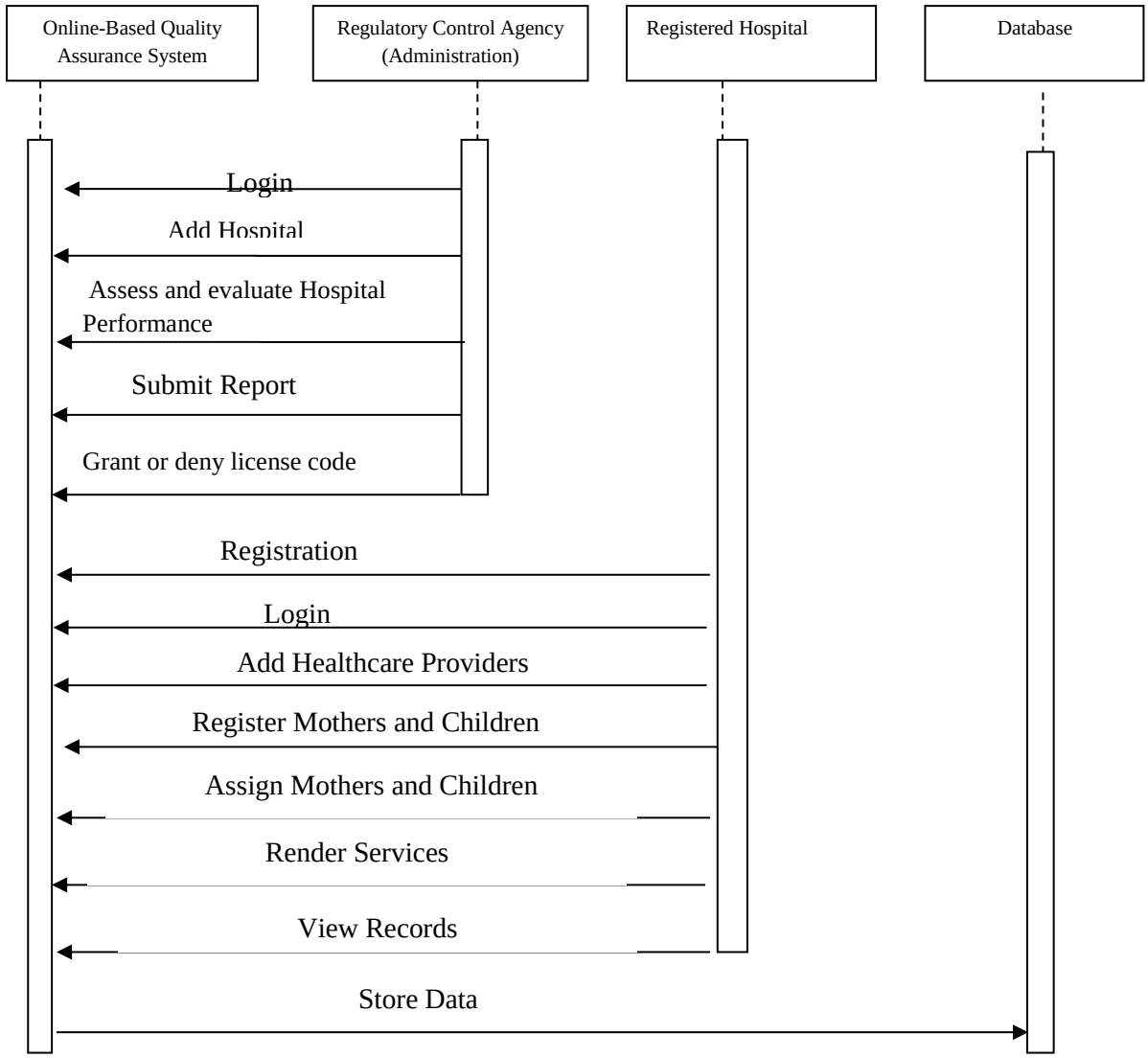


Figure 5: Sequence Diagram of online-based quality assurance System

Results and Discussion

The results of the online-based quality assurance system are shown in Figure 6 to Figure 9.

A. ***Online-Based Quality Assurance System***

It is important to remember that the objectives of this research were to produce an online platform for quality check in healthcare services delivered to mothers and children in health facilities through the use of information technology which will also provide governments with a picture of evidence-based approaches that can ensure and improve quality of healthcare services. This will reduce the level of maternal and child death and morbidity due to complications and childbirth. MySQL is a Relational Database Management System (RDBMS) that can be used to develop database applications both locally and on the internet. The Version used in this work is Version 5.5.24. MySQL storage engine provides good flexibility and

performance. It can host millions of databases simultaneously. This application contains a form for registering hospitals' information and other forms that display different lists of information from the database. When data is entered, the system communicates with the user through the messages displayed in the screen, the system processes and returns a message to inform the user whether the operation is successful or not.

i. Login Interface

Figure 6 is the login user interface. It is the validation page and it gives access to the users. The user is prompted to enter a USERNAME and a PASSWORD, the system verifies the correctness of the information entered and either grants or denies access to the user. Note that the user in this case is the regulatory control agency, hospital and healthcare providers.

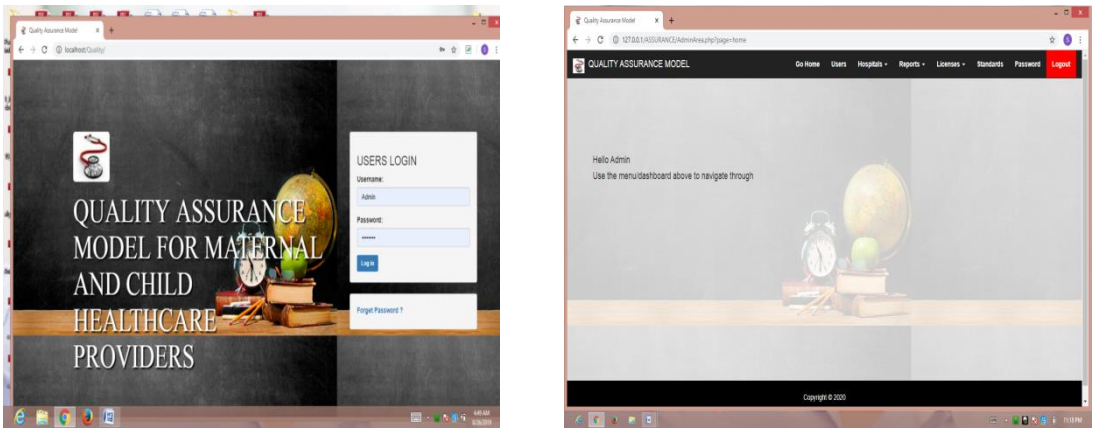


Figure 6: Login User Interface

ii. Add Hospital Form

In order for the system to be useful to the healthcare sector, hospitals' information have to be added and viewed to the database via the Hospital information page as shown in figure 7 below. This page has a form which needs to be completed with valid hospital information and then submitted. This system ensures that no two hospitals have same hospital id number.

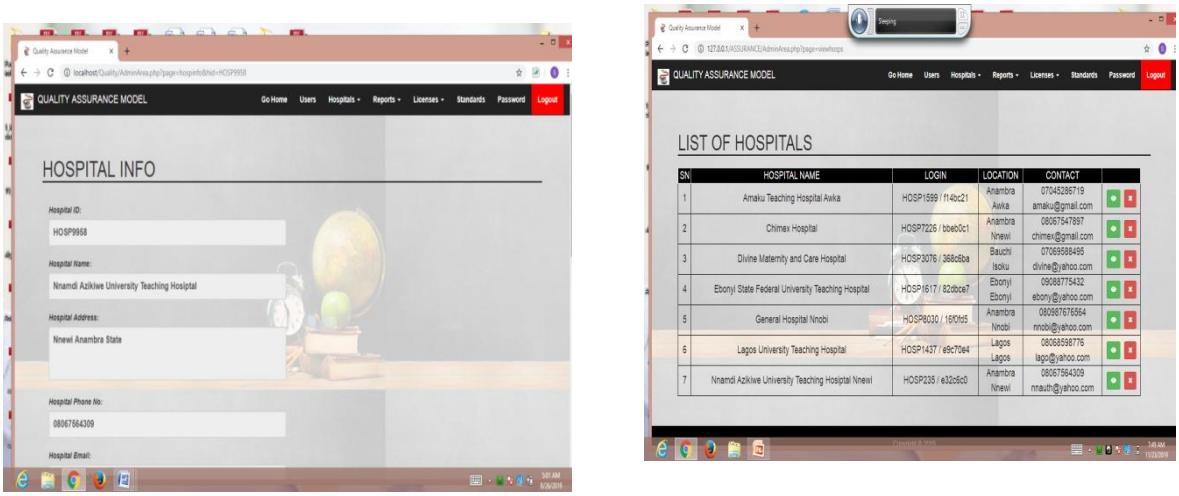
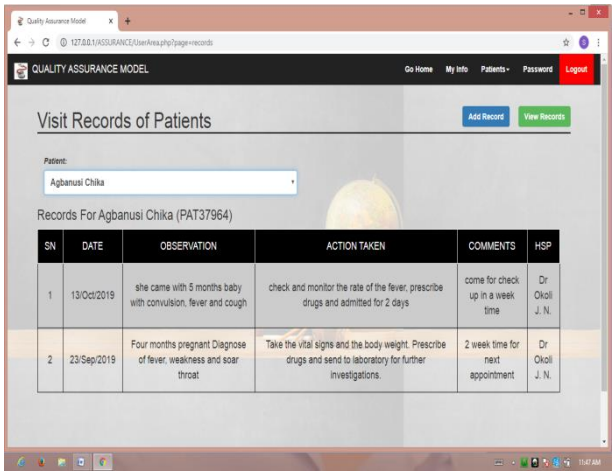


Figure 7: Add Hospital Interface

iii. Services Rendered Interface

This is module that shows the services being rendered by a particular healthcare provider showing detailed information of the medical personnel that takes care of the patients. The regulatory control agency clicks on view records to view the services made by healthcare providers to make their observation for the evaluation and assessment process.



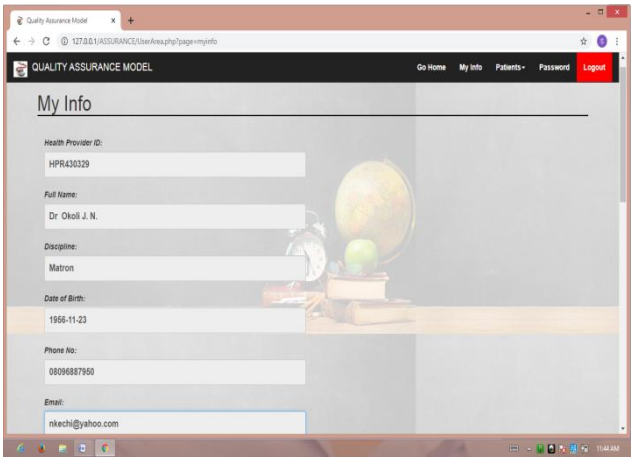


Figure 8: Services Rendered Interface

iv. Create New Maintenance Report Form

Figure 9 is New Maintenance Report Interface. This is the form that gives the reports of the evaluation and assessment process using the standards as the universal benchmark. Here, the scores that determine whether the health facility passed or failed the evaluation process.

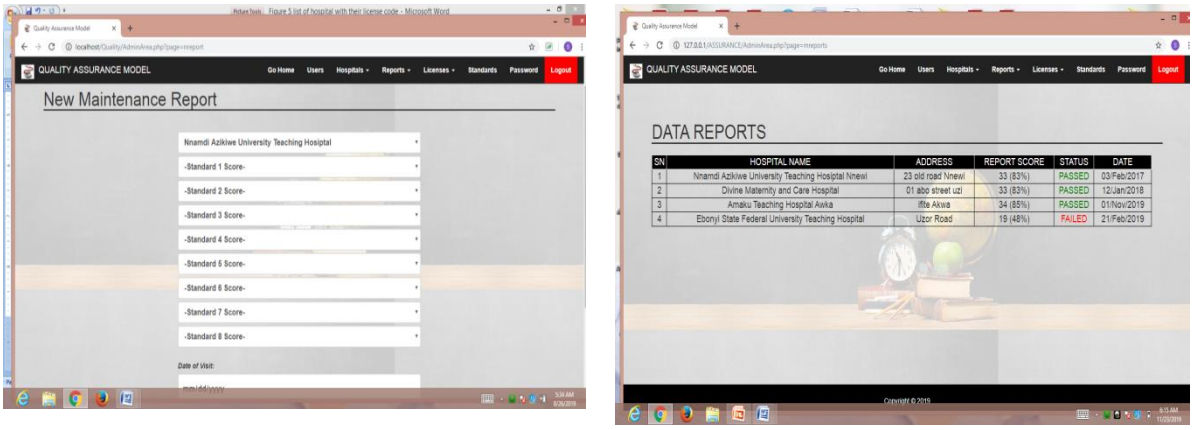


Figure 9: Submit Performance Report Interface

v. Generate License Code Form

In Figure 10 here, license code is granted to any health facility that meet up with the performance standards while the license code is denied the hospital that could not meet with performance standards.

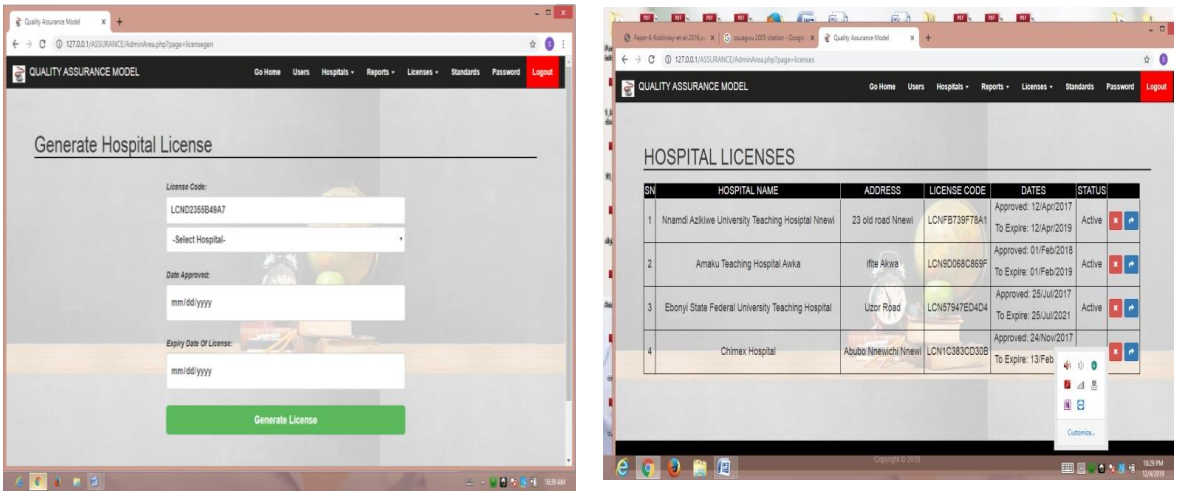


Figure 10: Generate License Code Interface

Conclusion

Online based quality assurance system will contribute to improvements in healthcare providers' performance on maternal and child service delivery. The methodology facilitates rapid action to correct service gaps and promote a culture of standardization, measurement and recognition of achievements with the agreed upon standards according to WHO specifications. The large number of health facilities that will start now and successfully applying this system must show its potential as a method that can be used to optimize quality at scale. As with other quality assurance approaches, methods, the system will benefit the growing trends toward more robust implementation research and evaluation.

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