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An Improved Model for Birth Rate Monitoring Information System in Nigeria

Ubani Tochukwu Iheajuru[1]; Onuodu Friday Eleonu[2]
[1]Department of Computer Science, Ignatius Ajuru University of Education, Rivers State, Nigeria
[2]Department of Computer Science, University of Port Harcourt, Nigeria
[1] dontocy@yahoo.com; [2] gonuodu@gmail.com

Abstract— Child birth registration and monitoring is a vital first step towards guaranteeing lifelong protection and securing an identity. It's a step towards promoting children's right to birth registration which clearly falls within UNICEF's mandate. The benefits of child registration is not only limited to the childhood period of a child, in adulthood, birth certificates gotten from birth registration may be needed for many purposes, such as: to obtain social security or a job in the formal sector; to buy or prove the right to inherit property; to obtain identity cards; to vote; and to obtain a passport, especially in Nigeria. Due to this fact, the lack of a birth certificate can have a grave, cumulative, negative effect on people's life opportunities. Several researchers have developed systems that carry out birth registration, but none of them were able to develop a system that monitors the rate of increase or decrease of the rate of birth in a particular region. In this work, an improved model for birth rate monitoring information system in Nigeria that eliminate the inefficiencies of the existing systems have been developed, and produced accurate monitoring results. Tools such as homogenous database, automated Centralized system, were used and the result of the records search was displayed in a user-friendly interface for the users to access. We adopted the Structured System Analysis and Design Methodology (SSADM) for this approach. The system was implemented using Hypertext Preprocessor (PHP), JavaScript and MySQL as the Backend. The result shows accurate birth rate monitoring with a performance evaluation of 86% as superior to the existing system with an accuracy of 66%. This system will be beneficial to: The Federal Bureau of Statistics (FBS), to Federal Government of Nigeria, to NIMC, to Educational bodies such as WAEC, NECO, JAMB, to tertiary institutions and Security Forces and to any other organization that deals on child registration.

Keywords— Birth Certificate, Birth Information, Impersonation, Civil Registration, Birth Rate

I. INTRODUCTION

The population of the world continues to grow, though at a slower rate than at any time since 1950, this is due to reduced levels of fertility. From an estimated population of 7.7 billion people worldwide in 2019, the medium-variant projection indicates that the global population could grow to around 8.5 billion in 2030, 9.7 billion in 2050, and 10.9 billion in 2100 (United Nations 2019).

The growth in the population of a region or country is to a large extent dependent on the birth rate of the citizens of that country or region. As a consequence, most developing countries have coined a law that puts the birth rate of its citizens to check, in order to maximize the use of available resources to satisfy the already existing populace.

However, for a country as populated as Nigeria, the need for a birth rate monitoring system is long overdue, and its importance cannot be overemphasized. Sufficient data to track the direction of fertility and other demographic indices is scarce. There is need for mathematical modeling to track the fertility outcomes, but unfortunately such models are scarce in Nigeria.

Child birth registration and monitoring is a vital first step towards guarantying lifelong protection. It's a step towards promoting children's right to birth registration which clearly falls within UNICEF's mandate. The idea of child Birth registration and monitoring dates back to the Catholic Church, Despite existing previous cases, the obligation to maintain registers in all churches only appears in 11 November 1563 session XXIV of Trento Council that decreed that "The priest shall have a book in which he shall write the names of the spouses, and of the witnesses, and the day and place where the marriage contracts, whose book he shall keep in his power with care" [1].

Due to the herculean task involved in birthrate monitoring, it cannot be manually achieved. Therefore, an automated software system is needed to facilitate direct monitoring of birth rate. This is only possible with the aid of a web based or online information system to register births. The system will then use the information or statistics gotten from the registration of births across the country to plot a graphical representation of the rates in certain regions of the country, thereby indicating their rise and fall over time, due to factors which can be man-made or natural. An information system will make the process easy with minimal stress, great speed and a high level of accuracy.

A. Aim and Objectives

The aim of this work is to develop an improved model for monitoring birthrate using an information system. The specific objectives are to:

- Design a secure e-birth registration system for registration of all births in the hospitals, clinics, recognized religious centers and legal institutions and generate birth certificates.
- Develop a birthrate monitoring system that uses the data gotten from the e-birth registration to analyze the birthrates in particular regions and make it available to the public in the form of a chart.
- Implement with Hypertext Pre-processor (PHP), JavaScript (JS), Hypertext Markup Language and MySQL as backend.
- Compare result with the existing system performance.

II. RELATED WORK

Hamilton et al [2] in their research titled "Births: Provisional Data for 2018", presented provisional 2018 data on U.S. births. Their work illustrated the statics of births and birth rates in the U.S over the period of 1 year i.e., between 2017 and 2018, however, there was implementation of the system that was used to capture and monitor these rates, and the statistics were totally dependent on refined data.

Philips et al [3], in their work titled "How useful are registered birth statistics for health and social policy? A global systematic assessment of the availability and quality of birth registration data" assembled publicly available birth registration records for as many countries as possible into a novel global birth registration database, and they presented a systematic assessment of available data. They compared these to existing estimates of total births to assess completeness of public data and adapted existing methods to evaluate the quality and timeliness of the data. From their analysis they discovered that since 1980, approximately one billion births were registered and shared in public databases. Compared to estimates of fertility, this represents only 40.0% of total births in the peak year, 2011. However, a birth rate monitoring system was not developed in the course of their research.

Seidu et al [4] in their work titled "Not just numbers: beyond counting caesarean deliveries to understanding their determinants in Ghana using a population based cross-sectional study", carried out a study with data from the 2014 Ghana Demographic and Health Survey. Their analysis was limited to mothers (n = 2742) aged 15–49, who had given birth in health facilities 5 years preceding the survey.

However, their research was carried out using a stale data set which had some lapses and could have resulted in inaccurate analysis; also a birth rate monitoring system was not developed.

Saturno-Hernández et al [5], in their research titled "Indicators for monitoring maternal and neonatal quality care: a systematic review" conducted a search using international repositories, national and international indicator sets, scientific articles published between 2012 and 2016, and grey literature. The eligibility criteria were documents in Spanish or English with indicators to monitor aspects of the continuum of care phases of interest. The identified indicators were characterized as follows: formula, justification, evidence level, pilot study, indicator type, phase of the continuum, intended organizational level of application, level of care, and income level of the countries. Selection was based on the characteristics associated with scientific soundness (formula, evidence level, and reliability). However, most indicators lack demonstrated scientific soundness and refer to particular continuum phases and levels within the healthcare system.

Fagbamigbe and Adebowale [6] in their work titled "Current and Predicted Fertility using Poisson Regression Model: Evidence from 2008 Nigerian Demographic Health Survey" proposed a non-linear model to identify fertility determinants and predict fertility using women's background characteristics. They used 2008 Nigeria Demography and Health Survey dataset consisting of 33,385 women with 31.4% from urban area. Fertility was measured using children ever born (CEB) and fitted into multi-factors additive Poisson regression models. Respondents mean age was 28.64±9.59years, average CEB of 3.13±3.07 but higher among rural women than urban women (3.42±3.16 vs 2.53±2.79). Women aged 20-24years were about twice as likely to have higher CEB as those aged 15-19years (IRR=2.06, 95% CI: 1.95-2.18).

However, their work gained a high level of inaccuracy due to the manual method for data collection and storage.

Ajayi et al [7] implemented a Mobile-Based Child-Birth Registration System in Nigeria. His design was in response to the problems associated with manual child-birth registration is complex and impractical for large increase in population of new born babies and also the cost of registering a child, risk and stress of commuting at the registration centre, loss of registration certificate by the parent and child, inaccurate population statistics are possible problems which inaccurate birth registration records can cause. His study was able to provide an effective, efficient and globally accessible platform for child-birth registration. The mobile-based technique enhances fast execution of child-birth registration procedures. The robust security measures adopted ensures adequate security of gen key and avoids its duplicity. However, his study was limited to the use of mobile phones for birth registration and there was no room for other birth monitoring processes in his design.

Nunes et al [8] in their work titled "An overview of central fetal monitoring systems in labour" reviewed several fetal monitoring systems currently in use in several hospitals in the developed countries, to check the progress of the foetus in the womb, and take charge immediately if any abnormality is noticed. However, they were unable to develop a monitoring system from their several reviews.

Hartnett [9] her work titled "Fertility Rates" reviewed several measures of the fertility rate of a region such as the Crude fertility rate, Age-specific fertility rate, General fertility rate, Cohort completed fertility, Total fertility rate. She proposed the use of these measures to determine the rate of fertility a particular region has recorded due to some prevalent factors in such regions and over a period of time. However, she was unable to develop an automated system that will calculate these fertility rates more accurately.

Nargund [10] in their work titled "Declining birth rate in Developed Countries: A radical policy re-think is required" proposed policies such as urgent need to initiate strategies at local/national and international level to prevent infertility and protect human fertility, Early and cost-effective assessment of fertility problems and assisted reproduction should be provided as part of public health care. However, he was unable to implement these policies using an information technology based system.

Waziri et al [11] in their work titled "Design and Implementation of Secured Online Census Information Management System Based on B/S Structure" proposed a system that was aimed at upgrading and integrating the efficiency of census data collection management system. Traditionally, census data collection demands an authorized enumerator, who collects the census data manually which is time consuming and waste of resource. A secure online census system based on B/S structure can overcome these problems. MyEclipse was used as an integrated environment for development of web-based system and JSP, were served as the programming language. SQL server (2005) served as a relational data base. By adopting the idea of differential equation and exponential function the system can predict the future population of the country that will encourage cooperation

and collaboration among federal agencies. However, their system could not accurately determine birth rates in a region over a period [11].

Awad and Yussof [12] in their work titled "Factors Affecting Fertility – New Evidence from Malaysia" proposed a research that investigates long and short term determinants of fertility rates in Malaysia based on basic macroeconomic variables for the period 1980-2014 using Auto Regressive Distributed Lag (ARDL) method. The study revealed that over a long term period, all the selected variables (GDP, infant mortality rate, females' education and employment) have had significant and negative impact on total fertility rates. Whilst during the short term period, only the infant mortality rate has had a positive impact. Since population growth is partly determined by fertility rates, efforts to increase population in Malaysia should consider factors that affect those rates. However, they were unable to develop a monitoring system.

III. METHODOLOGY

We successfully reviewed a good number of related works on the issue under discuss. However, we developed a special interest on the related work carried out by [13] titled "An Electronic Birth Record Management System For Nigeria". In their work, they proposed and developed an electronic system for birth registration and record management. They adopted the system analysis and design (SAD) methodology suitably for the design and implementation of their system. They used dataflow diagram (DFD) for its design while its implementation involved several client and server side development tools: Hypertext Markup Language (HTML), Java Script and Cascading Style Sheet (CSS), Hypertext Pre-Processor (PHP) and My Structured Query Language (MySQL). The resultant prototype system was tested and evaluated entirely, and it demonstrated the capability of birth registration, records management, and also checking the problems associated with data storage such as verification, retrieval, duplications, etc. However their model and design was unable to solve the problem of Difficulty in determining the rate of births in some regions over a period of, difficulty in monitoring birth rate records that are manually obtained, lack of user friendly interfaces for registration of births and generation of birth certificates for various approved institutions. I hope to improve on the work done by [13], by solving all the problems stated above, by implementing an improved model that curbs the deficiencies of the existing system.

A. Existing System

The existing system is an electronic birth record management system for Nigeria developed by [13]. The framework depicted in Figure 1 is an abstraction of a cybernated system with a digital repository of birth related records in distributed data servers to aid availability and reliability of services. It consists of two dashboards to handle both the managerial activities and the technological services. The client dashboard consists of the user's entity, processes and activities while the server dashboard are the maintenance panel and disparate database servers. The framework is a two-tier architecture where processes and functions of the system can be accessed by users (Registrar, Deputy Registrar (DR), Deputy Chief Registrar (DCR) and the Vital Statistics Department (VSD)) through a web browser which gives user access to the client dashboard for interactions with the system. Information from such interactions are deposited and retrieved from the database server at the back end. This aids real time verification and retrieval of birth information by all and sundry.

The system was populated with 50 fictitious birth registration data. An interactive functional prototype of the Nigerian civil birth registration and records system that could address the aforementioned challenges of the present Nigerian CRVS system was realized. The system consisted of birth information repository and several modules collectively to meet users' need and NPC's objectives. Thus, the system's search module was specifically tested to verify birth information of some citizens using name or birth registration number as captured.

Any birth information could be checked to checkmate falsification irrespective of its registration centre. A reliable, secured and efficient processing and management of Nigerian civil birth information is also guaranteed. It was noted by Oliha et al that DFD is very useful for describing processes and information flow in systems. A brief description of DFD describes the proposed system, how it will be accessed and how its components are operationally organized.

The search process facilitates checks of record existence and allows verification of the claimed birth information. In the development of the prototype civil system, the Sublime Text Integrated Development Environment (IDE) was employed a text development environment for building scripts files such as PHP and markup files such as HTML. Sublime Text IDE also allows developers to design dynamic web pages and preview websites in locally installed web browsers.

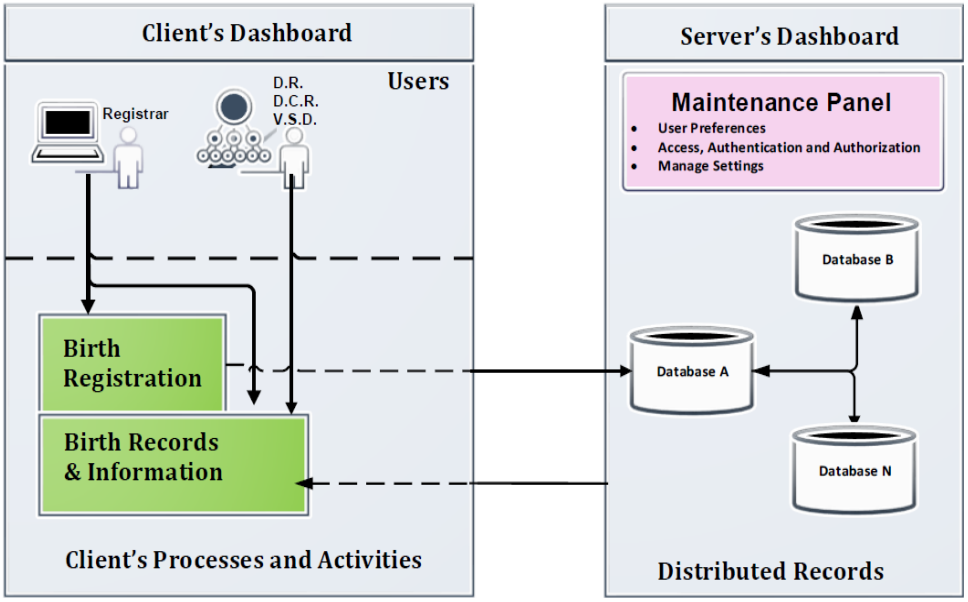

Fig. 1. Architecture of the existing System (Source: [13])

1) Disadvantages of the Existing System

- The system lacks a strong data security platform; hence the birth records data may be prone to alteration from hackers.
- The system contains several databases and therefore, the data can be manipulated and false records can be submitted.
- The system does not generate certificated after registration of births.

B. Proposed System

The proposed system is an electronic birth monitoring system that improves on the inefficiency of the existing system. The system carries out processes such as birth registration, data security of registered records, birth rate monitoring, birth certificate generation, and provides access to those documents online for stakeholders to access the information and use the data gotten from it to carry out informed decisions as denoted in Figure 2. The system contains several authorized registration system which are connected through the internet and are centrally connected to the centralized system through a Leginon (a system that connects several system to a centralized platform and acts as a security verification system). The sub-registration systems are dispersed throughout the country and are connected to the centralized system where the information it receives are validated.

Most registration systems are prone to manipulation of data, but the proposed system carries out verification of data, it ensures that the data it receives are from a valid source. The automated registration system automatically generates a birth certificate after registration of birth. The registration process also captures vital information about the new born which will be used for further verifications in the future. Information such as the age of the mother is very important in order to carry out accurate birth rate monitoring statistics. The proposed system skips the activities of the second dashboard of the architecture, because it leads to latency due to the several databases used to submit the records of the births gotten from registration. The proposed system executes the activities in the added functions instead (denoted in the red dotted text box). The system uses the information gotten from the birth registration (such as mother's age, local government of origin etc) to carry out monitoring, and uploads the results to the internet for viewers to access the information and use for further analysis or just to gain the information.

Verification of the system validity is carried out during the login of the registrar to the system. Before a registrar can be qualified to carry out birth registration, the registrar is properly registered and given a unique password that will be used to access the system and authenticate its identity. Any registrar who have not been previously registered and tries to access the system will be unable because of lack of authentication.

The Leginon is used to connect all the registration systems and then connect them to the centralized system. The centralized system is an intelligent system which carries automated authentication of the registrar's system once the login details are correct. It is also the centralized system that carries out the registration of all the registrars and generates their unique password.

The system can also be accessed by both mobile and windows platforms, provided there is an internet connection. The proposed system uses a homogenous database to store the data received from the registrar in a structured format. Statistical charts are used to demonstrate the birth rate of the region over a specified period.

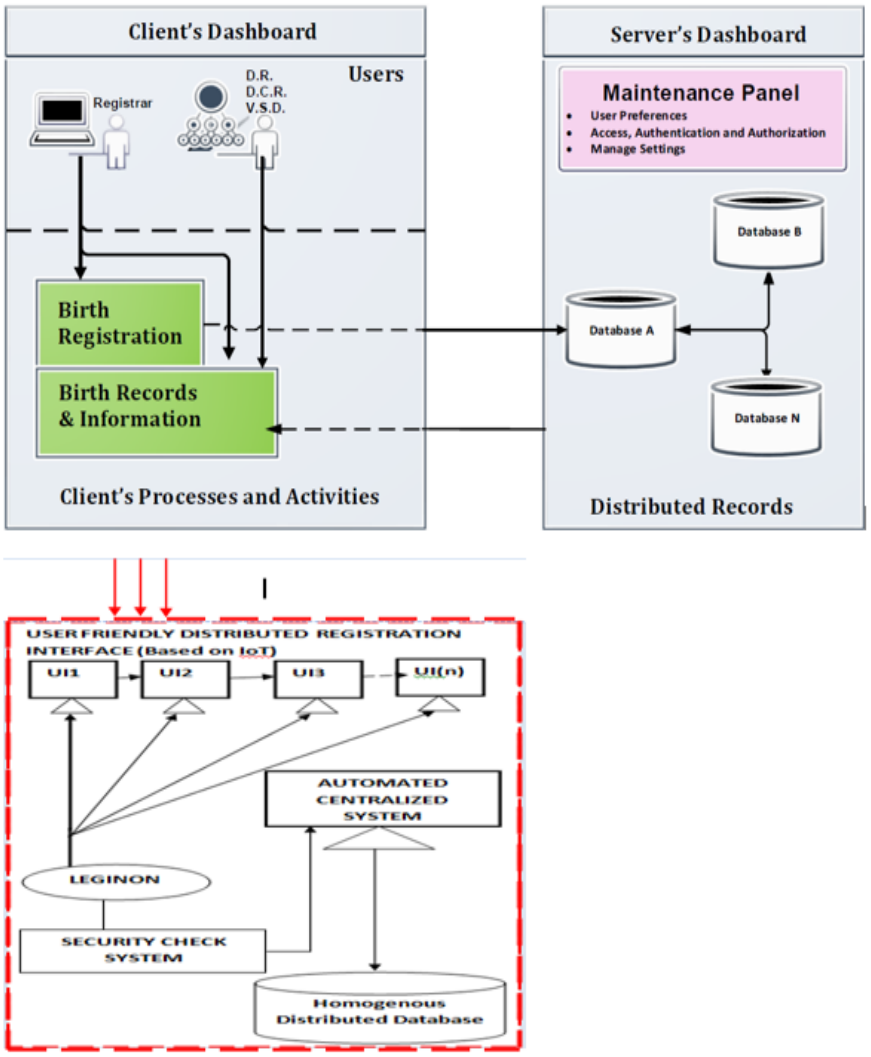

Fig. 2. An Improved Model for Birth Rate Monitoring (Proposed System)

C. Algorithm for the Proposed System

STEP 1:
START
STEP 2:
DECLARE VARIABLES
UN, PW, RSS, PTLF, QS, CG, UAV, RBS
STEP 3:

UN	=	USERNAME
PW	=	PASSWORD
DRS	=	DISTRIBUTED REGISTRAR SYSTEM
RSS	=	RECORDS SEARCH SYSTEM
QS	=	QUIT SYSTEM
GC	=	GENERATE CERTIFICATE
UAV	=	USER ACCESS VALIDATION
RBS	=	REGISTER BIRTHS
PBRC	=	PLOT BIRTH RATE CHART
BI	=	BIRTH INFORMATION


```
        CS          =       CENTRALIZED SYSTEM
        MYSQLDB     =       MY SQL DATABASE
STEP 4:
                            INITIALIZE RSS
STEP 5:
        UAV     =       UN + PW
STEP 6:
        IF PW =1, LAUNCH DRS
STEP 7:
        LAUNCH RBS
STEP 8:
        RBS = BI
STEP 9:
         LAUNCH GC
STEP 10:
        LAUNCH CS
STEP 11:
        EXECUTE PBRC
STEP11:
        STORE INFORMATION IN MYSQLDB
STEP 12:
        STOP
STEP 13:
        QS.
```

2) Advantages of the Existing System

- Removes difficulty in determining the rate of births in some regions over a period of time: the birth rate data of most regions with low or no routine counts or checks are carried out are carried out are now captured, this leads to an better birth rate monitoring and analysis report.
- The herculean task involved in carrying out citizen census, which may even be prone to serious errors, is removed by the use of the proposed system.
- Difficulty in monitoring birth rate records that are manually obtained is also solved by the use of this computerized registration system.
- Provides user friendly interfaces for registration of births and generation of birth certificates for various approved institutions.

IV. RESULT AND DISCUSSION

Figure 3 shows the welcome page of the proposed system. The welcome page was structured with hypertext markup language, styled with cascading style sheet and made dynamic with hypertext pre-processor. It contains a link to the login page. The Link is called the Register Birth Menu. The details entered in the login section will determine the authenticity of the page. Figure 5 contains the registration page was structured with hypertext mark-up language, styled with cascading style sheet and made dynamic with hypertext pre-processor.

After inputting the unique birth registration password, the centralized system verifies the authenticity of the inputted code to ensure that an authorized registrar is trying to access the system; this is shown in figure 4. If the validation is correct, the user is automatically navigated to the registration system. The birth registration page contains the following fields such as name of the new born, Name of the Mother, Mother's age, Date, time and place of birth etc. After inputting the registration details, the user clicks on submit in order to end the registration process. The next page selects a link to print the birth certificate which has been automatically generated by the information inputted. Pages such as the search page for the records by the other users, viewing of the birth rate chart generated by the centralized system are available for the users on line, and do not require any form of login.

After the birth registration has been successfully carried out, the system generates the birth certificate from the data submitted to the database. The User can now print the birth certificate and submit it for signing to the CMD of the Hospital or Clinic.

The climax of the birth monitoring system is the ability to automatically analyze the data from all the registrations made over a period and then represent it graphically in the form of a chart. The chart in fig. 6 illustrates the birth rate of Nigerian women from December 2019 to March 2020. From the curve, it can be noticed that there was a drastic fall in the rate of births in the month of January. This could have been caused by the agitation prevalent during that period of the year when people are still trying to recover from the large expense carried out during the Yuletide period. The rate however shot up in the second month of the year,

February (usually called the month of love), this may be as a result of the love associated with this month. As a result, people tend to engage more in sexual activities.

When compared to the existing system performance using certain parameters for evaluation, the proposed system proved more efficient an accuracy score of 86% as compared to the existing which has a score of 66% as illustrated in Table 1 and Figure 7.

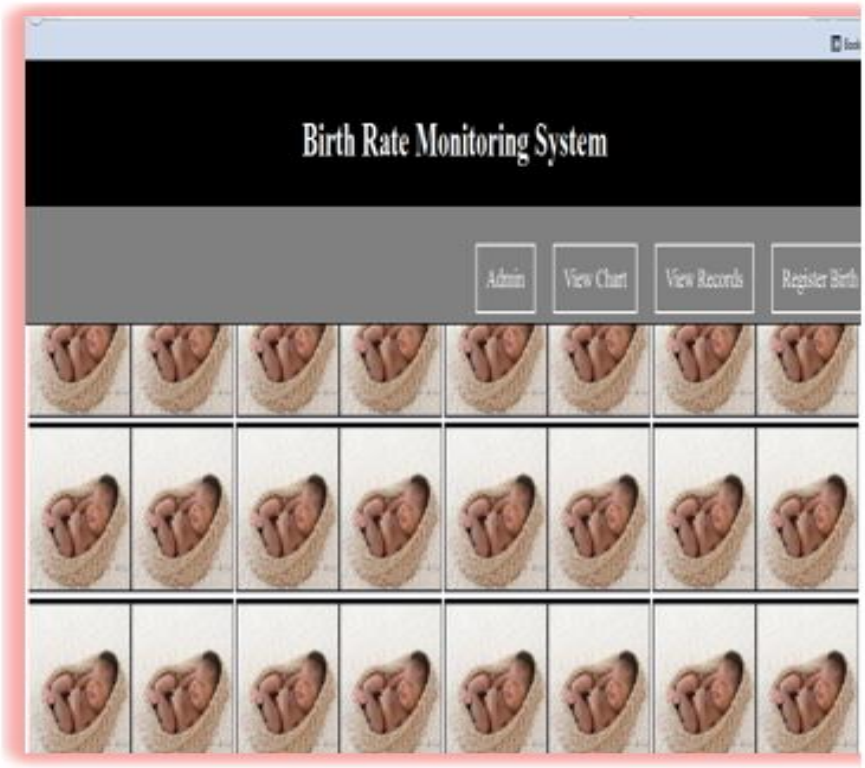

Fig. 3. Welcome Page

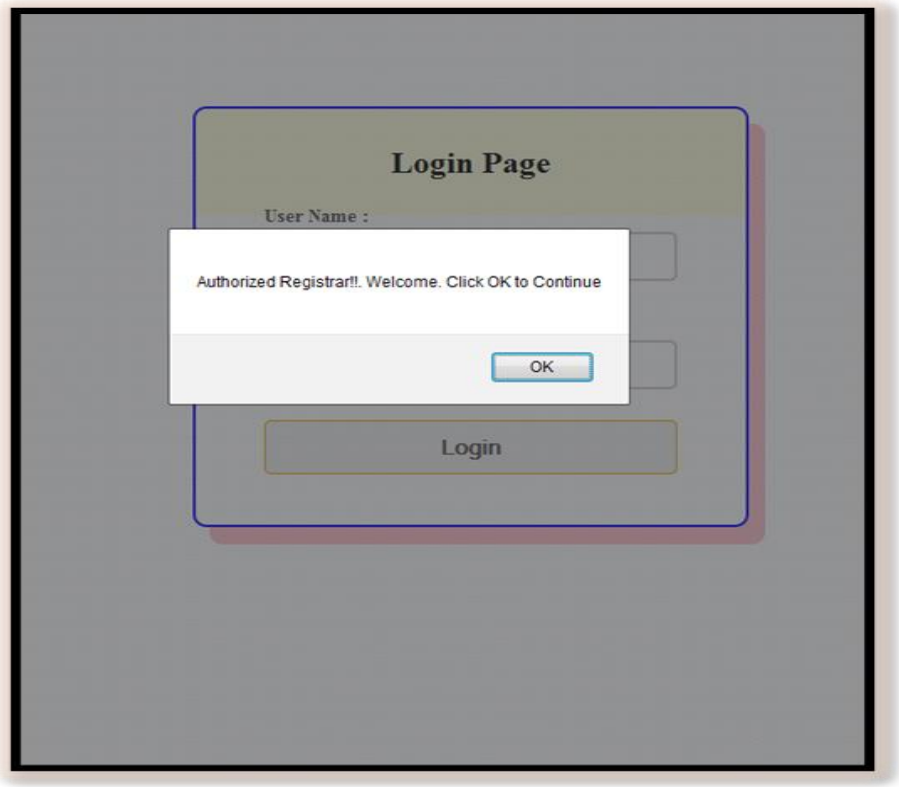

Fig. 4. Security verification of Registrar at Login

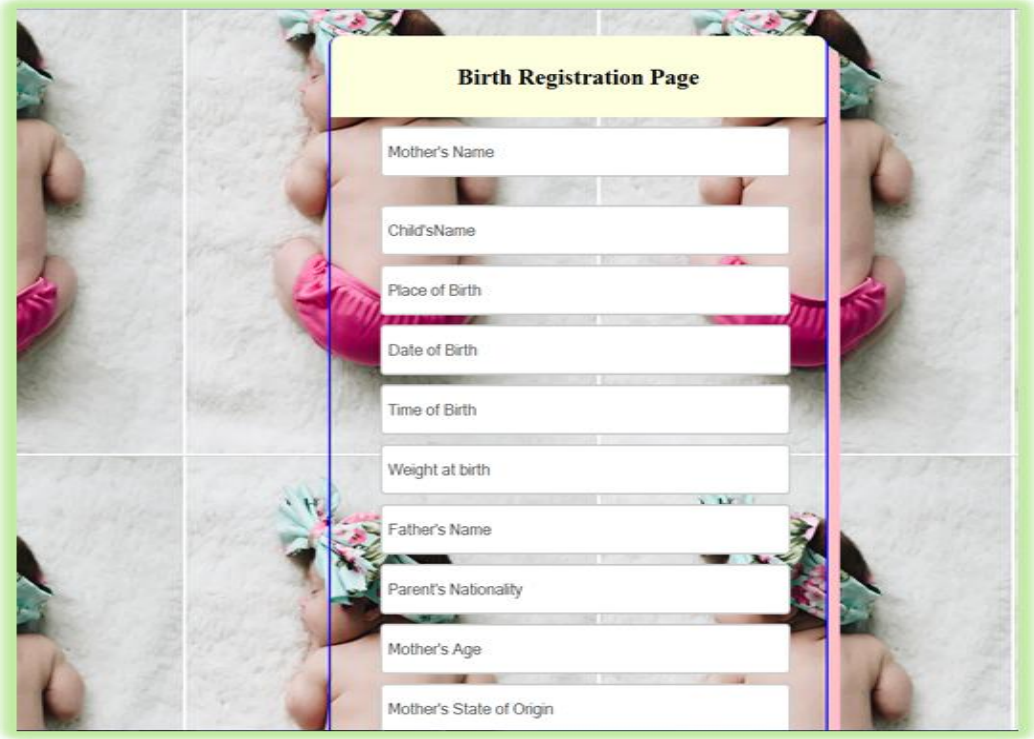

Fig. 5. Birth Registration Page

Table 1 and Figure 7 illustrate the comparison between the proposed system and the existing system. At the end of the comparison, using the same parameters, the proposed system had an accuracy score of 86% as opposed to the existing system with 66%. Thus, our system emerged to be 20% more accurate than the existing system.

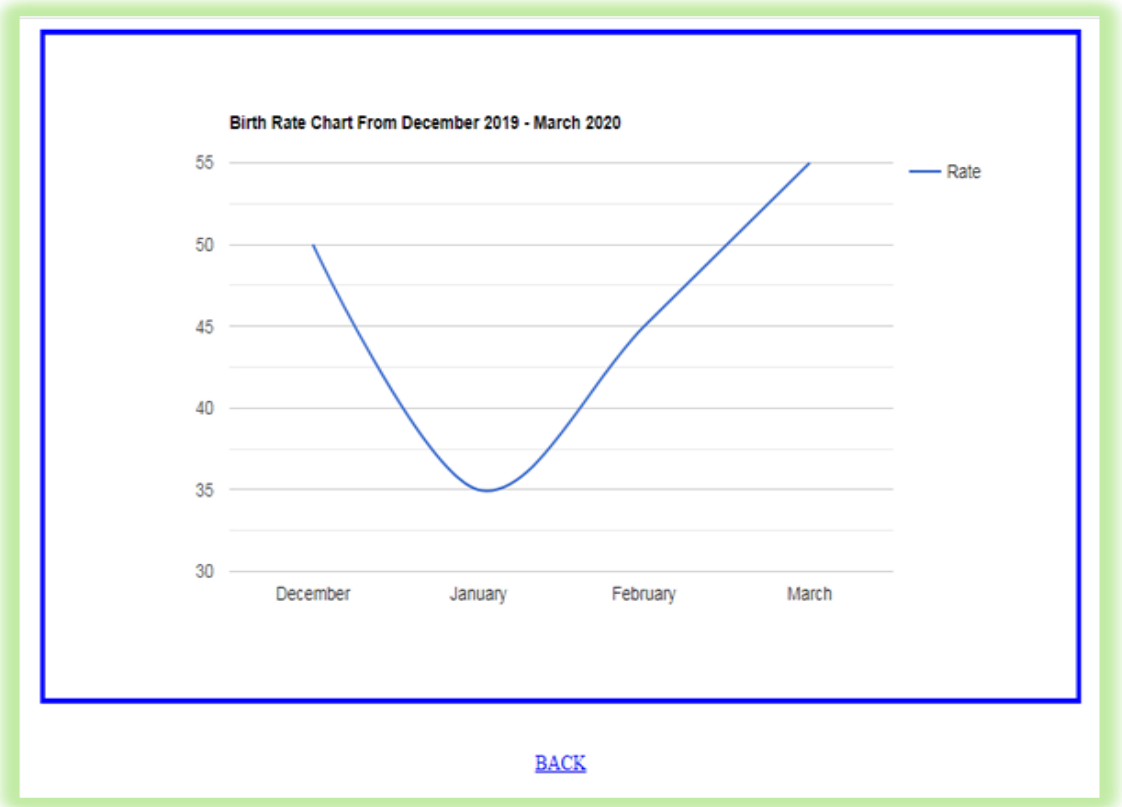

Fig. 6. Birth Rate Chart for a Given Period

TABLE I
COMPARATIVE ANALYSIS OF EXISTING AND PROPOSED SYSTEM

SN	EXISTING SYSTEM	Score	Score	PROPOSED SYSTEM
1.	Speed in Processing inputted validation details	20 (seconds)	12 (seconds)	Speed in Processing inputted validation details
2.	Speed in Registration Process	14 (seconds)	8 (seconds)	Speed in Registration Process
3.	Cross Platform Compatibility (CPA)	11	20	Cross Platform Compatibility (CPA)
4	Model Efficiency (ME)	10	23	Model Efficiency (ME)
5	Cost Benefit Analysis (CBA)	11	23	Cost Benefit Analysis (CBA)
Total		66%	86%	**Total**

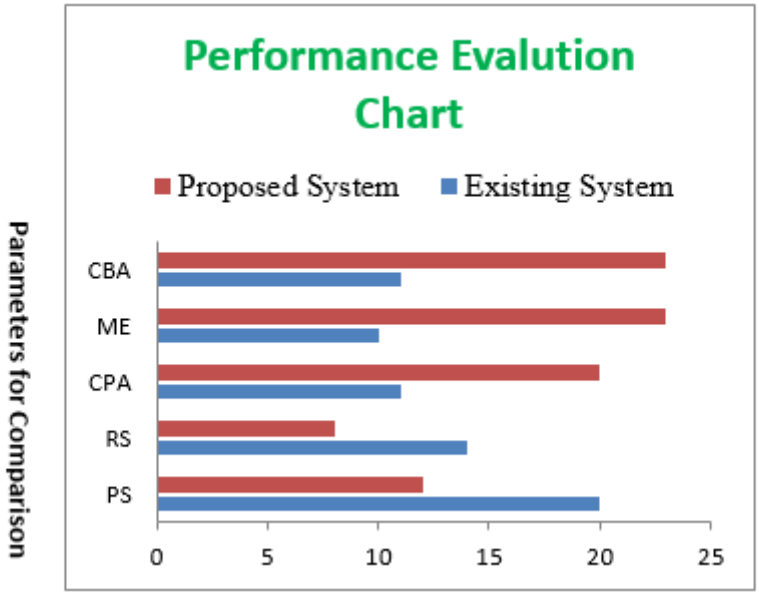

Fig. 7. Performance Evaluation Chart (Proposed and Existing System)

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