

DEVELOPMENT OF A PROTOTYPE FOR CENSUS AND ENUMERATION: A CASE STUDY OF NAMIBIA

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ABSTRACT

The most difficult and extensive task a national statistical office performs is a population census, which involves mapping a nation's population, enlisting and training a sizable number of enumerators, running a wide-ranging publicity campaign, encouraging every household to participate, gathering personal data, compiling a sizable amount of completed questionnaires, and analyzing and disseminating the results. According to the report, the traditional tablet-based census method utilized by the Namibia Statistic Agency has a number of drawbacks, including data loss and a protracted procedure. The goal of the study was to create a web-based application to support the Namibia Statistic Agency's (NSA) present system. The study employed a qualitative research methodology, and participants' issues and points of view were elicited using a descriptive research design. The research's findings showed that the web-based application for the census will cut down on the amount of time needed for data entry collecting and that the budget for the census will fall since the web-based system will cost less overall. The report concludes by recommending the NSA to consider employing the web-based application for its subsequent population count in order to do away with and simplify the manual data collection process.

KEYWORDS

Web-based application, Enumeration, Census, Namibia Statistics Agency, Prototype.

1. INTRODUCTION

Human-population census has been a very important exercise throughout Namibia's short history, and the government of Namibia depends on it for decision-making, administration, and national planning. The increasingly modern complex life means that there should have better plans for offloads, transportation, schools, social support structures, and economic requirements for the nation (Kanyuka, 2020). This effort will not be successful if there is no proper count of the population to give direction on how to address and distribute resources. In Namibia, the census is officially conducted by the Namibia Statistics Agency (NSA) which was established in 2011 by Act No. 9 of 2011 of the Namibian constitution. Due to omissions, inaccurate enumerations, and incorrectly answered questions, the Namibian census may contain coverage and substance errors. Not every person who needs to be counted is counted during the census period. The adoption of a web-based enumeration system in the NSA organization will help in many areas of information processing, storage, and efficient and accurate recording of data.

1.1. Background of the study

By conducting Population and Housing Censuses every ten years, Namibia has complied with international standards since gaining its independence in 1990. NSA was established under the Statistics Act, No. 9 of 2011, with the legal mandate and authority to collect a variety of data,

including population censuses (Namibia Statistics Agency, 2014). With the power vested in the agency, the NSA can count data and record that information as accurately as possible through census, sample surveys, and so on. Hence, an incoherent census result has several times been litigated by various state governments and regions, aimed at correcting the anomaly (Kanyuka, 2020). The process of conducting a census is difficult and cumbersome. Until now, the only available method of collection of census data was the use of paper questionnaires or forms (hardcopies), which is termed the canvasser method (Namibia Statistics Agency, 2014). Numerous registrations, printing of large paper forms, the laborious work of gathering data from the forms, and doing the requisite statistical analysis are only a few of the many problems and human errors that afflict this system. All of these factors contribute to the tardiness and excessive delay in the release of census data.

A majority of Namibian mobile phone owners do not have access to the internet, an Afrobarometer survey has found. Statistics show that while 87% of Namibians own a mobile phone, only 47% have access to the internet through their phones (Okano et al., 2022). To ensure the successful implementation of the census, more resources, additional time, and support from several organizations and individuals are needed. As the world of technology continues to grow, rapidly affecting every sphere of life, there is a need to adopt this technology in the area of census compilation. A web-based census enumeration platform with biometrics is proposed for the collection of census data to address these issues by replacing and simplifying the manual data collection procedure and enhancing system security and privacy while authenticating the user.

1.2. Statement of the Problem

The process of conducting a census is a complex, expensive, and time-consuming undertaking. This is shown as the NSA has tabled the budget for the August 2022 census to be N\$ 1.1 billion and is estimated to recruit around 11,500 unemployed persons to conduct a census statistical collection (Namibia Statistics Agency, 2022). This higher budget and a large number of recruits indicate there are numerous problems affecting the NSA from keeping steady reliable figures and conducting a valid analysis. We identified the major problems faced by NSA as follows: lack of a well-educated workforce, manual bulk collection of data that leads to time consumption, data Synchronization with database issues.

1.3. Objective of the Study

The research project was mainly aimed at developing a Web-based Census and Enumeration prototype for recording and storing census data in Namibia which allows users to register their own data and also allows enumerators to edit and update user data, at the same time provide an authentication process to authenticate its users for security reasons.

2. LITERATURE REVIEW

This chapter presents the literature review on the development of a prototype for census and enumeration in Namibia. This chapter gives an overview of what is prototyping, and an overview of a prototype for census and enumeration. The chapter further discusses the advantages of using a computerized system to conduct census and enumeration. It further studies related work on the use of mobile, computerized, and web-based applications for conducting censuses in different countries.

2.1. Overview of a Prototype for Census and Enumeration

A comprehensive range of data on people and housing units is available from population and housing censuses. The Department of Economic and Social Affairs (2019) notes that conducting a population and housing census is one of the most expensive and difficult data collection operations since it involves a number of intricately intertwined tasks. Using paper questionnaires for the traditional census exposes data to a variety of human errors throughout the whole census process, particularly during mapping, enumeration, and data processing, as is commonly acknowledged. The use of technology has become an integral part of many censuses processes critical for improving the cost, quality (coverage, accuracy, timeliness), and efficiency of the census. An increasingly appealing alternative to employing paper questionnaires, administered by an interviewer or self-administered, is data collection with computer-assisted self-interview using the Internet and computer-assisted personal interviewing (CAPI) on tablets or laptops.

Authors	Origin	Purpose	Type of source	Summary Point
Otelemate Horsfall Ugochukwu A Kamalu NkolikaOgechukwuNwazor	Nigeria	It eliminates and eases the rigorous process of data collection in a census and helps to smartly generate census results and statistical analysis of the census data.	Research	This paper presents a computerized Electronic Census Enumeration Platform design. The collection of this data has been a herculean task for the government owing to the available manual paper forms method employed. This method, the canvasser method is flawed with many errors, intentionally or otherwise, and challenges, ranging from the delay in the release of results, manipulation and falsification, double registration, security and integrity of data as well as a huge financial cost in the employment of many ad hoc staff and in the printing of bulky paper forms. An improved method of census data collection and security as well as a quicker way of doing analysis which supports the timely release of results, a departure from the past.
Luis Alberto Romero Tuanama Juber Alfonso Quiroz Gutarra Laberiano Andrade-Arenas	Peru	To implement this by providing a tablet containing the census application	Research	This study shows that the traditional census process in Peru has many shortcomings, including the loss of data and the long duration of the process. To solve this problem, a mobile application was designed to

		to every enumerator authorized by government through which they can collect census data and update the collected data to the census database through mobile networks.		automate the census process in Peru. The result obtained is the proposal of a productive approach, optimizing the census process, through a mobile application, where each census taker will register the data of the families on the census in a faster way and this information will be taken directly to the database of the organization conducting the census, thus avoiding loss of data, saving time and money.
Bourezgue, T	Algeria		Research	The following research by Tarik in 2018 deals with the use of tablets for the 2018 Algerian census. Instead of using the conventional paper questionnaire, this study focuses on how tablets with mobile chips are used to collect information. The author's concept was to give each packer a tablet with the census application on it so they could collect census data and update it to the census database over mobile networks. This tool helps to ensure that the census data are presented with the least amount of difficulty and risk to have accurate data.
Omotunde, A., Adekola, O., Maitanmi, O., Abel, S., & Akande, O.	Nigeria	Web-Based Automated Census Management System to help in the National Census.	Research	This web application was designed to collect details of each and every citizen whenever requested by the government. It collects details of children, teens, or adults depending on which details are requested by the government. With the information gathered, this system will be able to estimate the total number of people.

The limitations of various proposed electronic census and enumeration systems published in the literature are vulnerable to fraud, personal data storage space, and cybersecurity attacks remain a challenge. Therefore, due to the aforementioned gaps in existing electronic systems, it is a need to design a secure and verifiable web-based system that can address the aforementioned security

issues by transmitting data securely, storing data in the cloud, and educating staff members and participants about phishing emails and clickbait schemes that are used to trick the recipient into revealing personal information is a highly effective way to stop fraud.

3. MATERIAL AND METHODS

3.1. Research Methods

A research design, according to Liamputtong (2019), is a master plan that outlines the procedures and methods for gathering and analyzing the required data. According to this study, the qualitative research approach was adequate for achieving the study's goals and providing insights into its questions. Qualitative data are open-ended without predetermined responses (Creswell, 2014). Qualitative research methods will be used because in this method the researcher relies on the views of participants, asks broad or general questions, describes and analyzes these words for themes, and conducts the inquiry in a subjective, biased manner. A descriptive research design will be used in this study in order to get an in-depth analysis of the challenges faced by the NSA in conducting the national census. Descriptive research, according to Ormord (2014), is one that highlights the complexity of a particular situation, environment, process, connection, system, or group of individuals.

3.2. Population

All the variables that the researcher is interested in are present in a population (Zhu, Sari, & Lee, 2018). Thus, the target population for this study is the employees (both ordinary staff member and senior staff members) at the Namibia Statistics Agency.

3.3. Sample

In conducting research, it is not always possible or practical to include the entire population of interest in the study. A sample is a subset of the population. It is a selected group of elements drawn from a defined population. This research will adopt a simple random probability sampling design to pick the sample. A total sample of 20 will be selected from the Namibia Statistics Agency.

3.4. Research Instruments

This study used the online questionnaire and oral interview as research instruments. To collect data that are more meaningful from different participants online questionnaire will consist of both open and closed questions. Interviews also will be conducted on certain things that will need clarity from the researcher.

3.5. Data Collection Procedure

In order to gather information from respondents about the hurdles and difficulties the NSA's present tablet data-gathering system faced, online questionnaires were created by composing questions that were distributed to respondents through emails. Interviews were mostly used in addressing questions that are hard for the respondents to figure out on their own, so to get best answers interviews were conducted. Interviews were also conducted with people that do not have enough time to seat and answer questionnaires.

3.6. Data Analysis

The data analysis will follow approaches used in data collection for the qualitative method. The researcher used descriptive statistics and thematic text analysis of data. Descriptive statistics were used to summarize data in an organized manner by describing the relationship between variables in a sample or population (Kaur, Stoltzfus & Yellapu, 2018). Both the data from the open questions and the data from the closed questions were examined using descriptive analysis.

3.7. Software Development Method

3.7.1. System Development Method

The researcher has used Incremental development model to develop the prototype. The system requirements derived from the data analysis was divided into module/Increments of which every increment would go through the requirement, design, code and test phase. Every subsequent module added a new function to the system until the development was complete. The incremental model is a process of software development where requirements are divided into many individual components of the software development cycle. In this model, each component goes through the requirements, design, implementation, and testing phases. Every succeeding release of the component adds purpose to the previous release. Up till the full system has been achieved, the process is repeated. This was adapted because we had been going back to our requirements several times. We had to do that with another reason being that requirements were not all available at once.

3.7.2. Hardware and Software Requirements

This section gives details of the required software and hardware required to develop the system. Hardware required includes a computer with at least a dual-core processor and 4 Gigabytes of Random-Access Memory (RAM) running on at least Windows 10 Operating system (OS). Other required software includes XAMPP server, Visual Studio, React Work-frame, and MySQL database.

3.7.3. System Architecture

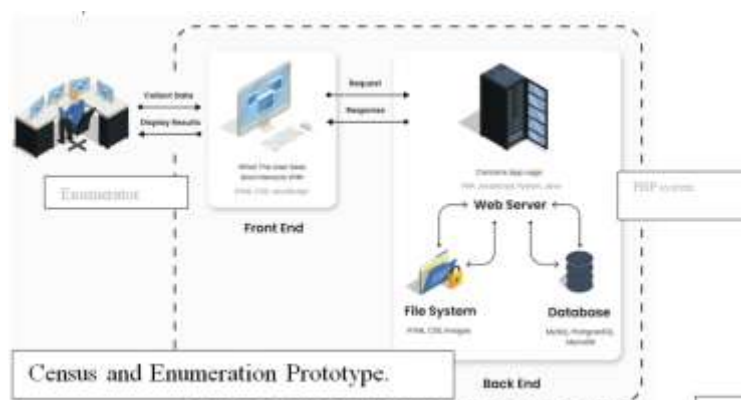


Figure 1. System architecture

The front-end interfaces are what the user and enumerator can see. That is coded in html combined with php and styled with CSS. They are made responsive using bootstrap and CSS.

The admin is responsible for the back end of the system which contains MySQL and php data. The admin is also responsible of directly adding and removing enumerators from the database. That is what the system is compressed of if we talk about the rights each person or user has. The other part of the design is the data storage component where in which digital data is stored on servers in off-site locations.

3.7.4. User Interface Components and Design

To ensure that the system meets its specific requirements, tests need to be done. Below are the system's interfaces that users interact with. Figure 3.4 shows the login page where users can log in if they are registered on the system.



Figure 2. Login page for citizens

Figure 3.5 shows the dashboard that displays when one logs in as Enumerator. Different Tabs shown on top shows what the enumerator can do when they are logged on. Which is to register and view all users.

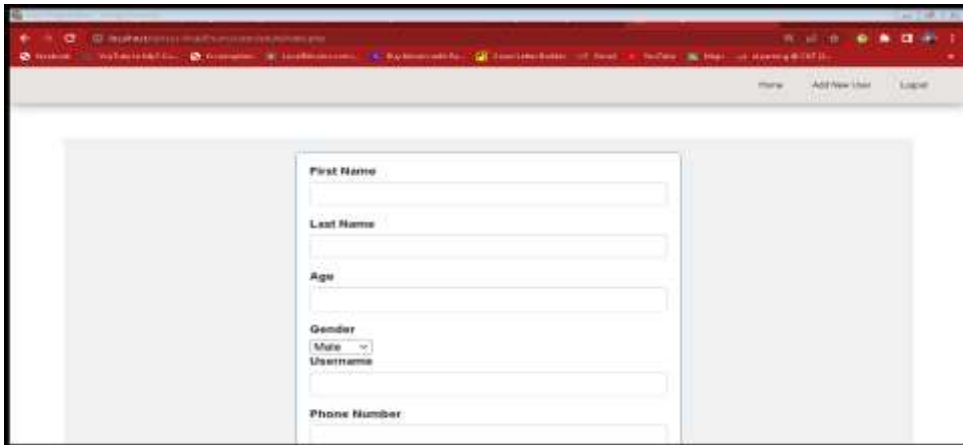


Figure 3. Enumerator Dashboard

Figure 3.6, illustrates the dashboard that appears when one logs in as a user. Here users can add kids details.

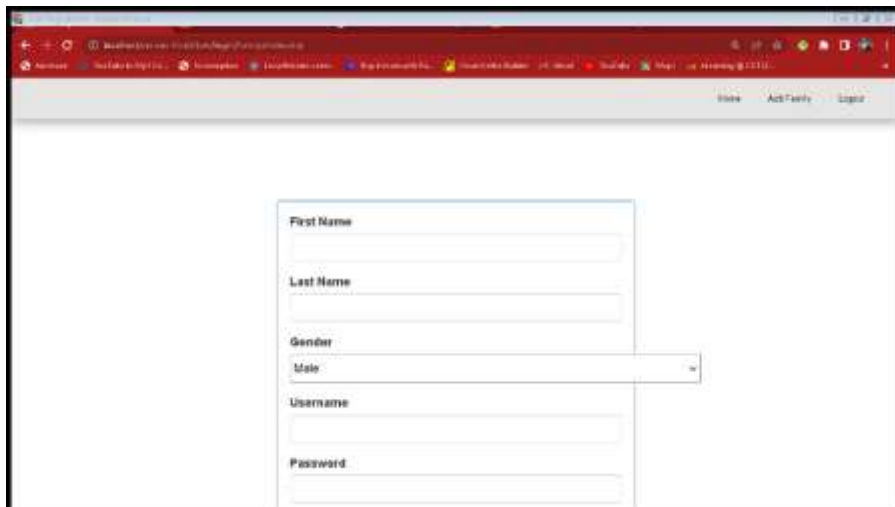


Figure 4. Enumerator dashboard

4. RESULTS

4.1. Demographic Information

This study reached data saturation with 20 participants. The participants of this study were asked questions to identify their gender.

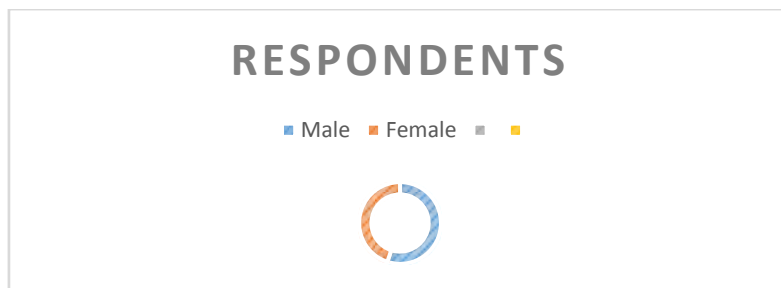


Figure 5.

4.2. Research Results

4.2.1. What Challenges do You Face when Using the Current System?

“We spent more time on data entry”

“We work more hours than expected”

“The current system requires data collected to be entered manually, this is a time-consuming process.”

“It is all about time and over-time working hours that this system is currently imposing on us”

“I have to face-call IT people to come to fix my computer every time the system updates”

“Data entry is my problem; it is tiring”

The result shows that every individual has their own challenges when it comes to the current system used Namibia Statistics Agency(NSA). However, there are those challenges which was shown by many of the sample population. These challenges are manually entering records into the system, which the participants indicated that it is very time-consuming and very tiring.

4.2.2. What is Your View on the Introduction of a Web-Based Application to Aid the NSA in Census Data Collection?

“It will save me substantial time and effort”

“I am not against it but it may higher chances of census fraud”

“I think it will help us more on getting responses that are not biased”

“It will eliminate survey fatigue; it is very boring to do interviews with different people but just repeating the same thing”

“This system may or may not bring us more problems, people may tend to leave more unanswered questions”

“It will make our work easier”

The results proved that employees at NSA, are more willing to allow the implementation of the prototype of census and enumeration in Namibia. The employee feels that the introduction will give them benefits such as working fewer hours and reducing costs of data capture, questionnaire printing, storage, and transportation. Another unique answer that came through is a doubt that the system may give more trouble as it may increase survey fraud and claimed that people may tend to leave more unanswered questions.

4.3. Key Finding

4.3.1. The Web Base Application for the Census will Reduce Time Spent on Data Entry Collections

The finding of the study identified that most employees face multiple challenges when dealing with data entry and data collection. NSA employees expressed that there is more work to be done that is time-consuming and tiring. This indicates that there is a need to address these challenges. Because the platform allows citizens to enter their own information, the web-based protocol proves to be the answer to these problems.

4.3.2. The Budget for the Census Will Decrease as the Web-Based System will Reduce the Cost

The study's participants predicted that the prototype would alter NSA's standards and procedures. This means the cost will be reduced due to the fact that no more money will be needed to print questionnaires. The prototype will eliminate the need of hiring enumerators for data collection and data entry.

4.3.3. The Results of the New Prototype

The requirements of the system we collected using the specification document produced. Those requirements were implemented to produce the prototype that has some features that we will mention below.

The system has a user interface and back-end parts. At the backend, we have code that works with the database to store the data that is entered from the database. On the interface we have three users, which are enumerators with the highest rights to the system, then we have users that

share the same rights but when counted they have to be summed up in different columns as adults and kids.

When the user interacts with the system for the first time they will have the option of registering themselves and their data will be entered into the database as soon as they press enter. In order to prevent users from entering a weak system password that anyone can guess, the password field should contain a restricted length. When registering the user should enter their name, first name, age, username, gender password, number, and region. When they have registered they can now log in to the system and they can now register kids and other adults that do not have access to the system. Users can also view statistical details without logging on to the system by using only the main home page.

The other user is the enumerator. Enumerators are entered by the admin who is the owner of the system straight into the database and they are given log in details. Enumerators can log in the system using their log in details and can add an adult or child. Enumerator can also edit the details of users. The system also has a log out for enumerators so they can end their session.

Below we have the system screenshot results to show results of each functionality.

The General Dashboard of the System

All the user or enumerator that launches this system will see this general dashboard before they can go ahead and navigate to other links on the screen, this is what they will see first.

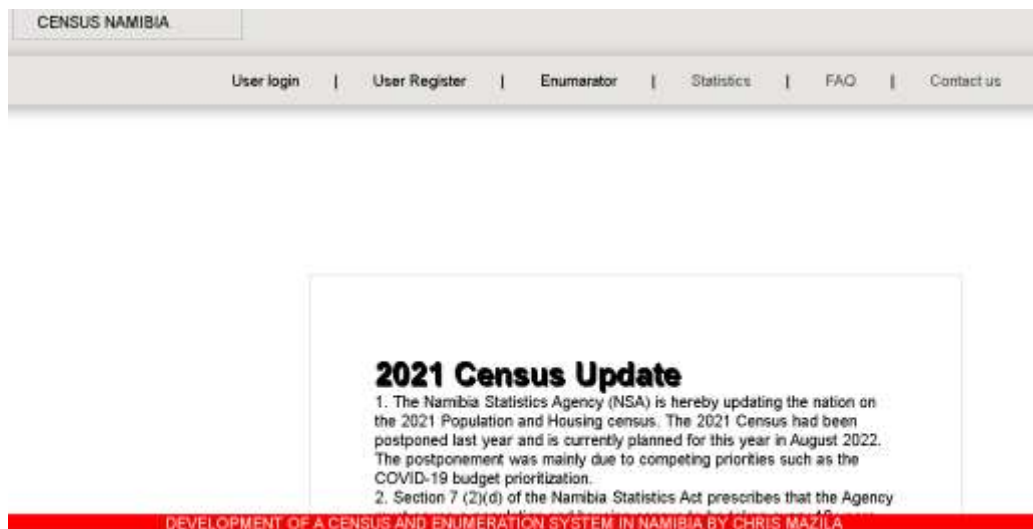


Figure 6.

User Registration Form

All the users need to be registered here before they can be re directed to the log in page. Before enrolling, they must fill out all of the fields; otherwise, the form will not submit. The Age is not allowed to be negative number.



USER REGISTRATION!!

First Name

Last Name

Age

Figure 7. Shows user registration form

Data in the Database after being Entered on the Interface.

This is where data entered by user and enumerator is stored after being entered.

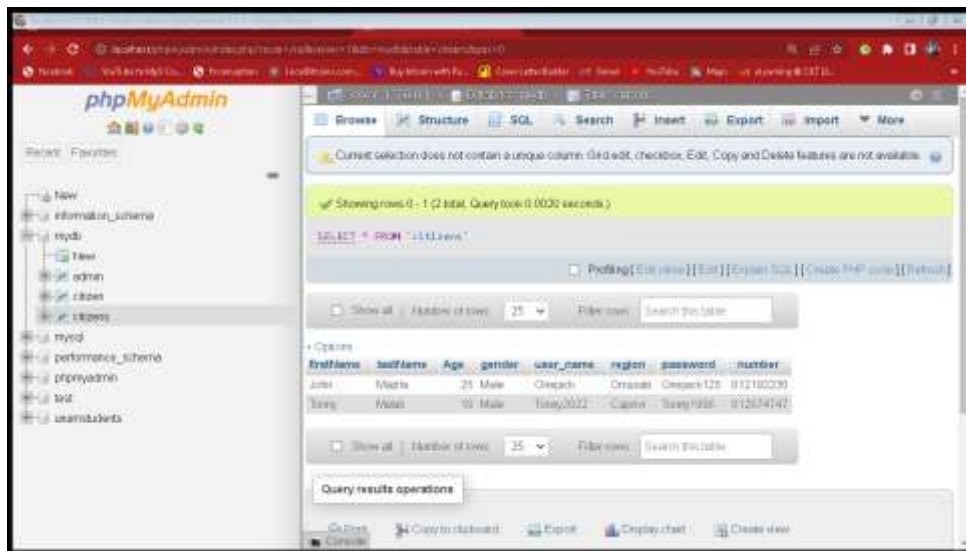


Figure 8. shows the table in the data base with data entered

User log in

This is the screen where the user log in using the details they entered on the form after registering. If they enter a wrong pin this screen will not allow it and they will be redirected back here with the error log in name or password. They will only be directed to the user dashboard if they enter correct data. The user also cannot log in without user name and password.

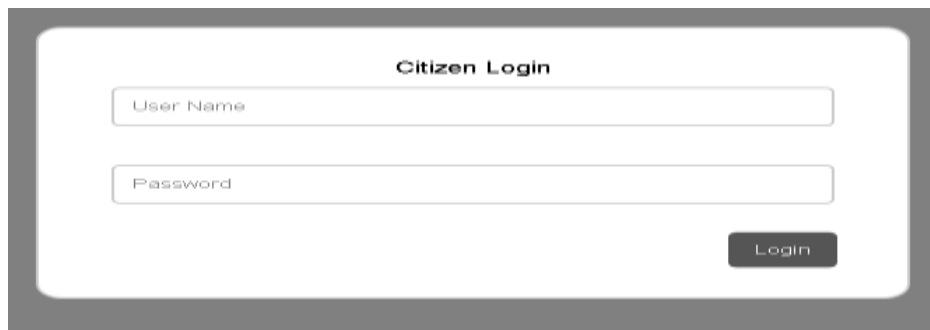


Figure 9. Citizen log-in screen

User log in Page

Demonstrates the page that appears after a person logs in and can enter any info they desire using drop-down menus in the top right corner.



Figure 10. User logged in screen

Enumerator Page

After the Enumerator logs on this page displays for them to enter or view child or adult data.



Figure 11. Shows the enumerator page

Statistical data used for getting the number of people

The screenshot shows a web application interface. At the top, there is a navigation menu with the following items: Home, User login, User Register, Enumerator, Statistics, and Contact us. Below the menu is a table with three columns: Region, Number of adults, and Number of Children. The table contains data for eight regions: Otjikoto, Oshana, Omusati, Khomas, Erongo, Ohagwena, and Kunene. The 'Number of adults' column shows values of 0 for Otjikoto, Oshana, Khomas, Erongo, Ohagwena, and Kunene, and 1 for Omusati. The 'Number of Children' column shows 0 for all listed regions.

Region	Number of adults	Number of Children
Otjikoto	0	0
Oshana	0	0
Omusati	1	0
Khomas	0	0
Erongo	0	0
Ohagwena	0	0
Kunene	0	0

Figure 12. The statistics of the number of people in the database per age category.

The results above show what the prototype actually does after it was implemented, we did not put a lot of functionality on the prototype because it is just simply a demonstration of what the real system could be doing.

5. DISCUSSION

The study was mainly based on a development of a census system prototype. This study was mainly on the collection, analyzing, and coming up with systems requirements that could help us develop a prototype at the end. In that prototype, we should be able to enter data. View the data and save it to a server database. This objective seems to have been done and now we wait for the creation of the real system. They are certain factors that influence this process and that as how much time the respondents have and how patient the researcher is. Collecting requirements for systems like this is also a bit of a challenge the researcher has witnessed. The respondents will have a lot of answers and each of them will have unique answers to the same question which will make it very difficult to handle. As the researcher was conducting the study while having commitments somewhere else this seemed to be a bit of a challenge.

6. CONCLUSIONS

This study focused on the development of a prototype that will aid Census operations in Namibia. The web-based system was designed to allow Namibia citizens to help NSA in data collection in doing via computer-assisted personal interviewing. One of the objectives of this study was to investigate the challenges that the current system is experiencing. Through the online questionnaire, this objective was met when participants were asked to express their challenges when working with the current system. It is, therefore, reasonable to conclude that the current system is giving more challenges to the employees than expected. The other objective was to develop a web-based prototype system that will aid the existing NSA system. As with the adoption of any new technology, understanding the value of electronic data collection technologies is a critical step in making an informed decision on whether or not to use these technologies in censuses. Any nation must make sure that there is enough value in the introduction of these technologies in a census by taking into consideration the unique national conditions because doing so can be an expensive and hazardous process.

This study, therefore, concludes the web-based system is not only the required solution but a necessity needed to solve a national issue. The NSA and Namibian individuals would both gain many advantages from offering a Web-based census response option to the population, including convenience, higher accuracy, lower costs, and increased security compared to conventional paper-based approaches. For instance, a drawback of the paper-based census is that some large households are unable to fill out the entire questionnaire with all the details about each household member. This space issue would not arise with a web-based census form. Second, web forms may have automatic error detection to stop users from sending in incorrect or incomplete information. Additionally, as data collected online may be processed more quickly than data collected using paper forms, online data collection can speed up the release of census results. This concludes that the web-based system is the only solution to Census and enumeration in Namibia.

7. FUTURE WORK

Digital data vaults are a relatively new concept. Until recently, the use of biometrics in censuses was at most experimental. But it is simple to predict that in the not-too-distant future, discussions about these and related techniques will intensify due to all the varied consequences they have. It is a component of "pervasive computing," which refers to the increasing use of computers, sensors, and controllers in daily life. To ensure that their needs are considered in new developments and standards, statistical organizations must participate in this discussion.

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Chris M, Mazila graduated with his bachelor of science in computer science honours his research work was based on the development of census and enumeration application in Namibia at the University of Namibia. Technology is an enumeration system in the NSA organization that will help in many areas of information processing, storage, and efficient and accurate recording of data.

