An Integrated Cloud-Based Identity Management System For Stemming Insecurity in Nigeria

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ABSTRACT

Insecurity is one of the banes of development of the Nigerian nation. Like many nations of the world, Digital Public Infrastructure (DPI) could be leveraged to proffer a more robust and effective solution. Digital identification is an integral part of DPI and an essential component in fighting insecurity in many nations of the world. Many countries have taken advantage of this digital technology to improve security of lives and property. Nigeria too have attempted to leverage unique identification system with little success. Currently, the country has in existence different identification and database systems derivable from the registration of bank verification number (BVN), national identification number (NIN), international passport number, national voter's card and host of others. These identification systems are not synchronized, lack synergy and yet unable to achieve their desire purpose in changing the narrative in the Nigerian security landscape. Proposed in this work is unified social security identification(USSID) system, a pinnacle of identity management which is underpinned by array of integrated technological frameworks using HTML, CSS, PHP, JavaScript, and the robust infrastructure of XAMPP. The system is simulated based on field data collected from personnel of law enforcement agents and relevant professionals were analyzed. Results showed that USSID, if fully implemented could prevent all sort of identification related security threats and in the long run stem insecurity in the country.

1.0 INTRODUCTION

Presently, Nigeria as a country is faced with myriad of challenges. Economic downturn due to high interest rate, inflation and dollarization of the local economy. Food insecurity as a result of low productivity, incessant farmers/herders' conflicts, lack of storage for farm produce, inadequate processing and epileptic power supply that could not meet the demand for the preservation of agricultural products. Also, insecurity of lives and property as witness in the wanton destruction of lives and property by insurgents, banditries, terrorisms and other security threats to the Nigerian nation and so on [11]. The latter has remained major problem successive governments have been battling with without significant success. For instance, [15] published the Global Rights report that says Boko Haram/ISWAP, gunmen and insurgents have killed a total of five hundred and fifty-five (555) and kidnapped two hundred and sixty-seven (267) Nigerians between 29th May and 3th July, 2023 alone.

This number keeps increasing and security agencies across the country are unable to put an end to it since they lack requisite knowledge in terms of intelligence to deal decisively with this level of insecurity and the required military hardware and equipment to fight these bad ones. This has continued to have negative impact on country's image with attendant effects on other facets of the Nigerian national life such as low foreign direct investment (FDI) into the country because nobody wants to put his or her money in an unsafe nation [14]. Insecurity is a great enemy of Nigeria and must be tackled headlong. In fact, winning the war against insecurity could have resolved majority of the problems confronting the nation. One feasible, inclusive and effective solution could be expansion and adoption of the nation's Digital Public Infrastructure (DPI), considered critical for improving service experience and for saving the cost of governance through digitization [3].

Interestingly, digital identification is an integral part of DPI and an essential component in fighting insecurity in any nation of the world [13]. Many countries have taken advantage of this digital technology to improve quality of life for their people [16]. Biometric [5] and Blockchain [7] methodologies have been previously but with some pitfalls. Particularly, Nigeria too have attempted to leverage unique identification system with little success. For example, the country has in existence different identification and database systems derivable from the registration of bank verification number (BVN), national

identification number (NIN), international passport number, national voter's card and host of others. These identification systems are not synchronised, lack synergy and yet unable to achieve their desire result in changing the narrative in the Nigerian security landscape. Meanwhile, apart from promoting the security of lives and property, the benefits of an inclusive, generally acceptable and uniform identification system include helps in economic and financial inclusion; use as proof of identity in crucial situations; helps the populace to access bureaucratic services, and participate in business or civil transactions [18].

Unconventional problems require unusual solution, the positive disruption of digital technologies could be leveraged to develop a synergize, unified and integrated identification system that promotes wellbeing of the people and security of lives and property. For [6], the identity management system is meant to leverage DPI and could tremendously benefit from cloud computing paradigm that gives on-demand access, via the internet, to computing resources—applications, servers (physical servers and virtual servers), data storage, development tools, networking capabilities, and more—hosted at a remote data centre managed by a cloud services provider [1]. This cloud-based system especially provides everything-as-a-service to a variety of organizations including the governments. The proposed integrated identification system will improve the efficiency and effectiveness in gathering intelligence, tracking of criminals and protecting lives and property in Nigeria. So, pertinent to the fight against insecurity in the country is the harmonization of these digital assets to innovatively design a unique identification system that would be generic to serve all purposes.

Thus, proposed in this work is an integrated digital identity management scheme that aims to stem insecurity in the country. The proposed cloud-based identity management scheme known as unified social security identification (USSID) is an amalgamation of different technological frameworks using HTML, CSS, PHP, JavaScript, and the robust infrastructure of XAMPP with intricate functions of each technology, clarifying their unique roles in influencing the system's design, user interface design, and seamless functionality. Hybrid research methodology was adopted in this work and the proposed system is evaluated accordingly.

2. RELATED WORK

In this section, we conduct the review of relevant literature from the conceptual reviews, theoretical reviews and frameworks, to review of the empirical extant studies, in identifying gaps and presenting the novelty of the current work.

2.1 The Conceptual Review

Digital Public Infrastructure (DPI) is crucial tool for digital acceleration of any nation that consists of open and interoperable platforms, accessible to anyone for usage and development [3].It is an avenue in which the

digital transformation of a country can be enhanced. The case of India, Singapore, Estonia and Kenya are few notable examples, where DPI has been used to provide a wide range of digital public services [3]. The centralized model of DPI is needed in a complex nation like Nigeria to help improve the efficiency and effectiveness of governance[4]. During Covid-19 for instance, DPI functions like digital identity, digital payments, and health data exchanges were so crucial tool that help in data gathering to understand disease spread, organize the logistics of response, and distribute emergency cash transfers to mitigate hunger while helping people stay safe at home [12].

Development in the public infrastructure of country is closely related to its economic development [13]. Nigeria, as a matter of urgency needs to rejig and reprioritize her adoption and use of DPI for the improvement of government service delivery to the people. Digital identification, payments, and data exchanges platforms should be included in a DPI [12], for easy facilitation of identification, security, privacy preserving data exchange, seamless and secured transactions. Digital identification system refers to "infrastructure and process used to design, establish, use and maintain digital identities either for civil identification, or as an adjunct to broader service delivery" [19].Thus, a cloud-based identity management scheme known as unified social security identification (USSID) proposed in this work could help the country in overcoming its social and economic challenges due to insecurity.

2.2 The Theoretical Review

Every new technology is expected to be subjected to acceptance testing and evaluation so as to avoid "dead on arrival" scenario. Technology acceptance model (TAM) has been used to explain the acceptance of information based on the users' behavioural intention that is predicated on the constructs of perceive usefulness (PU) and perceived ease of use (PEOU) of technology [8].
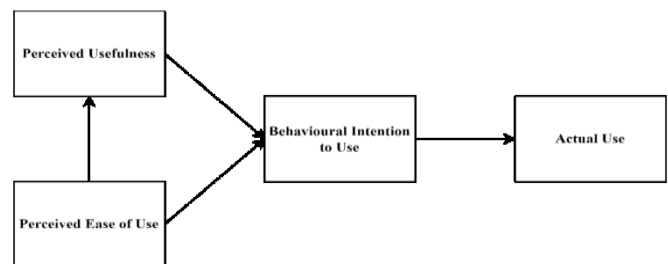

Figure 1: Technology Acceptance Model (source: [8])

Originally proposed by Davis (1989), the TAM is based on the constructs of perceive usefulness and perceived ease of use of technology that predict the behavioural intention of

technology use and in turn predict the actual usage as shown in Figure 1. Its uses transcend the field of information system and can be applied to any form of acceptance model.

2.3 The Review of Empirical Studies

The study is very germane in tackling the menace of insecurity of the Nigerian nation and as such researchers from different fields have looked at this area with all seriousness. For instance, [9] proposed an intelligent approach to fighting crime and insecurity in Nigeria. They proposed a Centralized Database as a backbone model serving as a central point of reference for all law enforcement agencies. Their work integrated various modern technologies such as Facial recognition surveillance, Automatic plate number recognition, GIS and Crime Mapping, and Voice recognition to identify and predict criminal activities. The work failed to explain incorporation of it in DPI and its acceptability using appropriate models.

[10] presented a conceptual information and communication technology (ICT) framework that encompasses all the relevant tools needed in combating the insecurity challenges in Nigeria. Again, instead of implementing and evaluating the proposed model, the authors merely provided the conceptual design without any form of testing. Meanwhile, an innovation should have both conceptual and theoretical soundness. Particularly,

In [14] Nigeria was identified as the main cause of the prolong insecurity problems in the country, its leadership has failed to tackle the challenges head-on and every "lip-service" course of actions has resulted in futility and deeper chaos. This problem has remained persistent because of lack political will, policy somersault and insincerity on the part of governments at all levels. So, a viable and generic solution is urgently required to address this situation before it finally gets out of hand. The registration of birth and death could play a significant role in national security especially when combined with relevant technologies [14] to develop a responsive digital identity management system with seamless functionalities in achieving its purpose. This is the overall aim of this current work.

3. RESEARCH METHODOLOGY

This section presents the research methodology of the proposed work. A hybrid research methodology in which predesign analysis and post-design analysis were conducted for determining the usefulness and effectiveness is determined respectively. The section also gives full details of design, implementation procedure, experimental setup and testing of the proposed scheme.

3.1 Design

The design subsection includes predesign analysis, input design, output design, and architectural design, the details of which are given as follows:

3.1.1 Predesign Analysis Stage

First and foremost, a feasibility study was conducted based on design specification to determine its usefulness and acceptance. A predesign questionnaire as an instrument of data collection was designed and using judgmental sampling method, it was administered to four set of professionals comprising six (3) law enforcement agents, four (3) lawyers, three (2) policy makers and two (2) researchers making a total of fifteen (10) respondents in this feasibility study. The questionnaire features ten (10) questions that intend to elicit responses using Linkert scale. The responses were collated, analyzed and the results obtained were so encouraging and thereby serve as the basis for which the design of the proposed scheme was embarked upon. The detail is given in section 4.1

3.1.2 Input Design

The input design takes cognizance of different previously designed databases for the Nigerian populace such as bank verification number (BVN), national identification number (NIN), international passport number, national voter's card (VID), national identity card and many others. It is of interest here that the proposed system is not prescribing the jettison of all the previously implemented the identification system in Nigeria but rather a synchronization and harmonization that will generate a more robust, effective and efficient cloud-based identity management system. To this end, pseudo-random number generator (PRNG) is used in the design of USSID that concatenate different obtained information in the previously implemented databases.

i. Pseudo-Random Number Generator (PRNG)

The PRNG is an algorithm that uses mathematical formulas to produce sequences of random numbers. Computer systems are majorly deterministic meaning they try to predict the outcome of events with certainty. However, many natural phenomena are stochastic and so some degree of randomness is needed for their computations. Random numbers have been used in whether forecasting, scheduling problems, and encryption of information etc. Hence, adopted in this work is linear congruential generator (LCG), an algorithm that produces a sequence of pseudo-randomized numbers determined by a continuous piecewise linear equation. This is defined as:

$$X_{n+1} = (aX_n + c) \bmod m \qquad (1)$$

Where:

X is the sequence of pseudo-random values, and;
$m, 0 < m$ is the modulus;
$a, 0 < a < m$ is the multiplier;
$c, 0 \leq c < m$ is the increment;
$X_0, 0 \leq X_0 < m$ is the seed or base value.

LCG is very effective since it goes longer enough before repeating itself. Nigeria with over two hundred million population, can benefit from the largesse of LCG which can take up to one billion (1,000,000,000) if specifies at ten digits.

i. Concatenation of Identity Numbers

As earlier stated, the proposed system adopted the use of concatenation of the identity numbers. Concatenation in a sense, is simply the addition of two numbers. This means that it is an additional operator on two values to generate another value. If the values are strings, it can be used to

bring together or combine the strings. Basically, if X_1 and X_2 represent two strings of values, concatenation could be expressed mathematically as:

$$X_1 \oplus X_2 = X_1 \times n^{1+[Log_n(X_2)]} + X_2 \qquad (2)$$

Where n is a positive integer, $Log_n(X_2)$ is the logarithm in base n of the second argument and $\oplus$ is the concatenation operator.

3.1.3 Output Design
The output of the proposed system is formatted concatenate function of different information found on many identification systems previously implemented in Nigeria. For example, we use city, local government, ward or village codes for the USSID. Based on the concatenate function, the proposed system generates the USSID of the form:
0123456789.OG24.006.07.061 i.e XXXXXXXXX.xx. xxxx.xxx.xxxx consisting of unique

uses the concatenate addition operator to create the USSID.

3.2 Implementation Procedure
The USSID is implemented based on the identity management concepts using innovative and sophisticated technological frameworks of HTML, CSS, PHP, JavaScript, and XAMPP in an amalgamated version that lays the foundation for a robust, secure, and user-centric system. This transcends conventional identity registration and management paradigms. Each of these technological frameworks and infrastructure is explained based on their usage as follow:

HTML (Hypertext Markup Language): HTML serves as the backbone of the USSID Management System, providing the structural framework for web pages. Responsible for creating the user interface and defining the elements on each page, HTML ensures a cohesive and
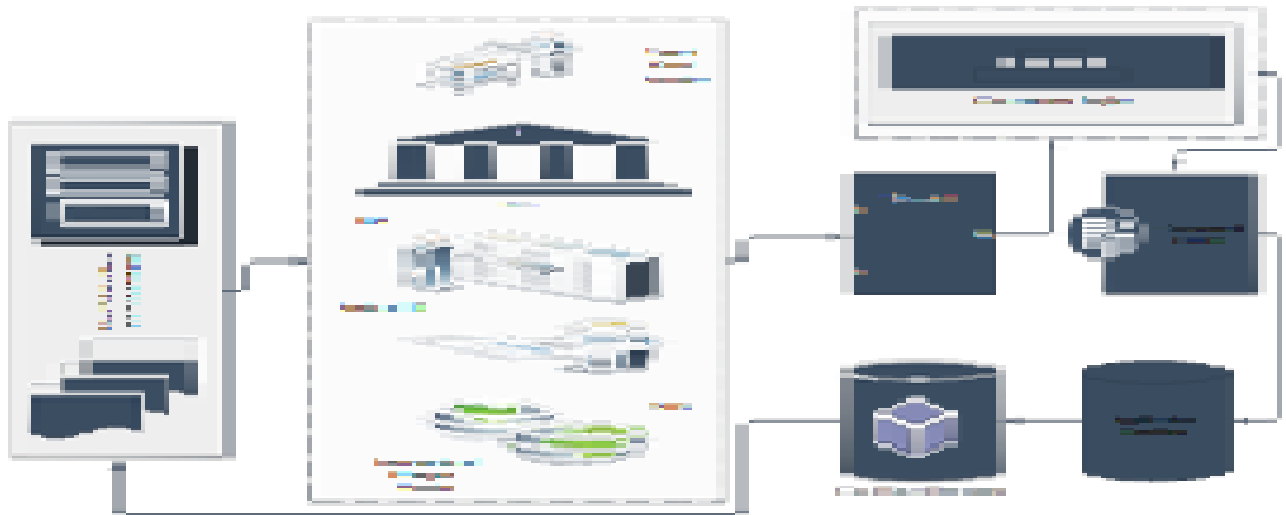

Figure 2: Architectural Design for Unified Social Security Identification Management System

random number generated, state, local government, ward, town and village codes. This ensures that each generated USSID can be traced to the house unit the holder belongs to, which can be used to determine other information such as address, mobile number, picture etc.

3.1.3   Architectural Design
The architectural framework of the proposed USSID is a three-tier design which consists of three main components: the identity database integration; pseudo-random number generator; and concatenate engine. These components interact with one another in an effective and efficient version giving the system a seamless functionality.
The identity database integration component ensures that identity number enter through the user's interface is pass to the pseudo-random number generator which generates a unique for each candidate and the concatenate engine

intuitive design.

CSS (Cascading Style Sheets): CSS brings life to the structure crafted by HTML, controlling the visual presentation of the USSID Management System. Through CSS, the system achieves a harmonious and aesthetically pleasing design, enhancing user experience and engagement.

PHP (Hypertext Preprocessor): PHP functions as the server-side scripting language, handling the dynamic aspects of the USSID Management System. Responsible for user registration, login authentication, USSID code generation, and data linkage, PHP ensures seamless interaction between the user interface and the server.

JavaScript: JavaScript   injects   interactivity   and

responsiveness into the USSID Management System, enhancing the user experience. Dynamic elements, such as real-time USSID code generation and client-side validation, are achieved through JavaScript, fostering a dynamic and engaging user interface.

XAMPP (Cross-Platform, Apache, MySQL, PHP, Perl): XAMPP provides the robust server environment needed to deploy and manage the USSID Management System. Apache serves as the web server, MySQL handles the database management, PHP executes server-side scripts, and Perl supports additional scripting functionalities.

The key features of proposed USSID are User Registration, Secure Login Functionality, Dynamic USSID Code Generation, Comprehensive Information Viewing, Seamless Data Linkage, and a Powerful Search and Fetch Mechanism are explored in conjunction with the technological framework. These features are briefly summarized as follows:

User: Registration: This uses HTML to capture user's input, CSS styles the registration interface, PHP processes the input, and JavaScript enhances the form's interactivity. XAMPP, with its integrated Apache and MySQL, ensures secure data storage and retrieval during the registration process.

Secure Login Functionality: HTML and CSS structure the login interface, while PHP handles authentication logic and JavaScript adds dynamic elements. XAMPP secures login credentials and manages user sessions, ensuring a secure and seamless login process.

Dynamic USSID Code Generation: PHP dynamically generates USSID codes for user inputs and selected states based on concatenated pseudo-randomized numbers generated. JavaScript enhanced the real-time display of USSID codes, providing instant feedback to users during the registration process.

Comprehensive Information Viewing: HTML and CSS present detailed user information, while PHP fetches and processes the data from the database. XAMPP facilitates efficient database operations, ensuring a smooth data retrieval process.

Seamless Data Linkage: PHP establishes data linkage by creating relationships between user profiles using USSID codes. MySQL, within the XAMPP environment, efficiently manages the storage and retrieval of linked user data.

Powerful Search and Fetch Mechanism: JavaScript helps the search interface, providing a responsive and dynamic user experience. PHP, with the support of MySQL in XAMPP, executes search queries and fetches user information based on the entered USSID code.

3.3 Experimental Setup and Testing
To test the proposed USSID, we use life data of different available identification numbers such as National Identity Number (NIN), International Passport Number IPID, National Voter's Number (VID), Bank Verification Number (BVN) and Driver's Licence Identification Number (DID). These identification numbers are fed into the system via their various portals. On receiving the numbers, the proposed system generates a corresponding identification number which is concatenated with the identification numbers supplied via the portals to develop a unique and robust unified social security identification number for each candidate. It should be noted that each person would need to provide at least two of the already existing identification numbers for the proposed system to work effectively. It is designed to integrate these already existing identification number systems, any identification number not provided would be represented with xxx in the final USSID.

4. RESULTS AND DISCUSSION
The results of the pre-designed study conducted along with the experiments and testing of the proposed system are presented in this subsection. As explained earlier, the evaluation of the proposed system is to determine its usefulness and effectiveness. The TAM constructs of PU and PEOU provide a mean for the evaluation using simple percentage ratios in pre-design stage to describe the intended acceptability and usefulness of the proposed system while accuracy evaluation is conducted at the post-design data stage to analyze its effectiveness.

4.1 Data Analysis and Results
As mentioned in the predesign stage, a concise questionnaire as the instrument for data collection was designed based on the technology acceptance model (TAM) constructs of perceive usefulness (PU) and perceive ease of use (PEOU). The result of this study is as presented in Table 1.

Table1: Pre-Design Study Using TAM Constructs

S/N	Questions	Categories	SA	A	U	SD	D
1	Identification management system should be used to identify	Desc1	4 (40%)	4 (40%)	0 (0%)	1 (10%)	1 (10%)
2	Ideal identification management system should combine all the exiting databases	Desc2	4 (40%)	2 (20%)	1 (10%)	1 (10%)	2 (20%)
3	Identification management system should be unique and unified	Access1	3 (30%)	6 (60%)	0 (0%)	0 (0%)	1 (10%)
4	Ideal identification management system should interactive and accessible everywhere	Access2	2 (20%)	5 (50%)	0 (0%)	2 (20%)	1 (10%)
5	I would find integrated identification management system very useful	PU1	3 (30%)	4 (40%)	0 (0%)	1 (10%)	2 (20%)
6	Using an integrated identification managem ent system would make it easier for curbing insecurity	PU2	4 (40%)	3 (30%)	1 (10%)	1 (10%)	1 (10%)
7	An integrated identi ty management system could stem insecurity in Nigeria	PU3	5 (50%)	4 (40%)	0 (0%)	0 (0%)	1 (10%)
8	An integrated identi ty management system would make it easy for culprits of insecurity to be identified.	PEOU1	6 (60%)	2 (20%)	0 (0%)	1 (10%)	1 (10%)
9	It would be easy for me to know about my identification using an integrated identi ty management system	PEOU2	5 (50%)	3 (30%)	1 (10%)	0 (0%)	1 (10%)
10	I would find an integrated identification management system very interactive and useful.	PEOU3	6 (60%)	3 (30%)	0 (0%)	0 (0%)	1 (10%)

Source: Researchers' Field Survey, 2023.

Where SA – Strongly Agree; A – Agree; U – Undecided; SD – Strongly Disagree; and D – Disagree

Respondents were asked to pick one choice in each case. Questions are based on the authors' perception of ideal identification system which address four categories of description (Desc), accessibility (Access), with the TAM constructs of PU – perceive usefulness and PEOU – perceive ease of use. For the post-design stage and as mentioned in the experimental set-up and testing, various real life existing identification numbers of twenty (20) participants were collected. Four testing trials for combined two, three and four identification numbers were used in five different experiments. Presented in Table 2 is the result of the experiment and testing of the proposed system.

Table 2: Result of Experiment and Testing

S/N	Combined IDs	Trial 1	Trial 2	Trial 3	Trial 4	Trial's Number
1.	NIN, BVN	C = 4; I = 0	C = 3; I = 0	C = 1; I = 0	C = 1; I = 0	13
2.	IPID, VID	C = 2; I = 0	C = 4; I = 0	C = 2; I = 0	C = 3; I = 0	11
3.	VID, IPID, DID	C = 2; I = 0	C = 1; I = 0	C = 2; I = 1	C = 3; I = 0	9
4	NIN, IPID, BVN	C = 3; I = 0	C = 4; I = 0	C = 3; I = 0	C = 2; I = 0	12
5.	NIN, VID, DID, BVN	C = 1; I = 0	C = 3; I = 1	C = 2; I = 0	C = 1; I = 0	8
					Total	53

Source: Result from experiments conducted by Authors, 023.

Where C = correctly classified observation; I = incorrectly classified observation.

Using accuracy metric, this generally describes how model performs across all classes of samples. It is the most intuitive performance measure and it is simply a ratio of correctly classified observations to the total observations given as:

$$\text{Accuracy} = \frac{\text{correctly classified observations}}{\text{total observations}} \quad (3)$$

So, form Table 2, it can be deduced that out of fifty-three (53) observations, fifty-one (51) were classified correctly, that is evaluating accuracy means:

$$\text{Accuracy} = \frac{51}{53} = 0.962$$

or the proposed system is 96% accurate.
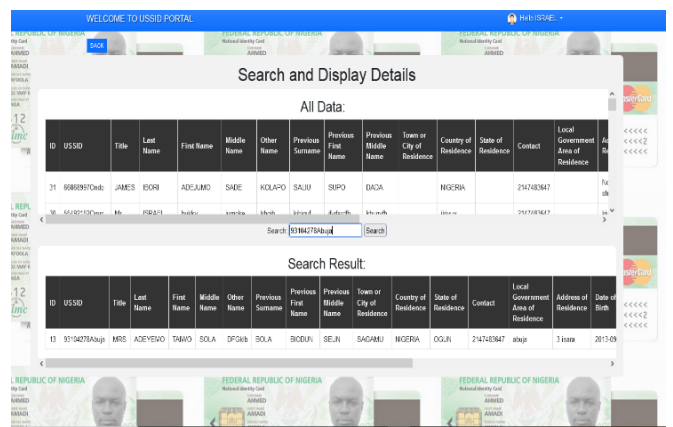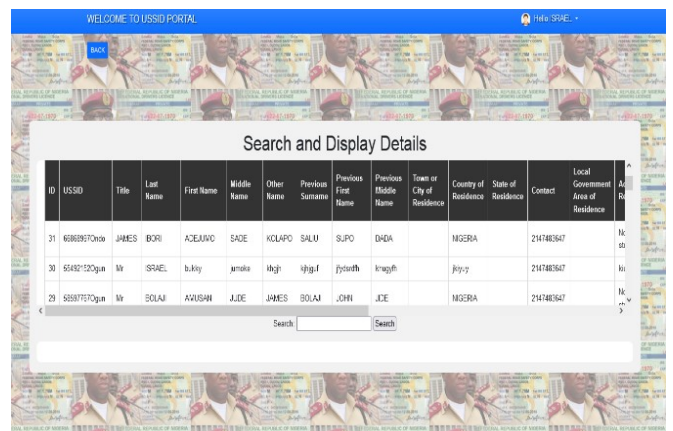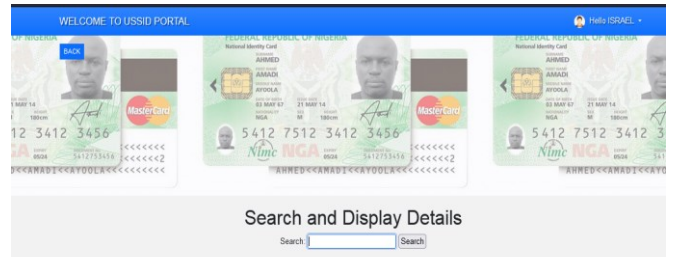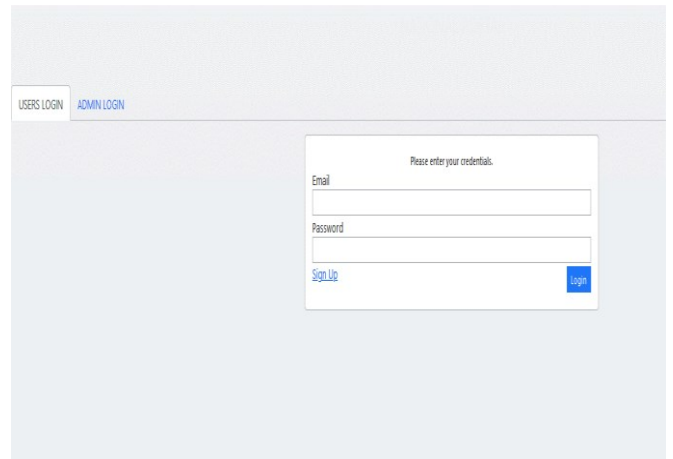
4.2 Discussion

From Table 1, questions 1 and 2 described an ideal identification management system, questions 3 and 4 give the accessibility of such ideal identification management system, questions 5, 6 and 7 present the PU – perceive usefulness of the ideal identification management system, while questions 8, 9 and 10 present the PEOU – perceive ease of use of an ideal identification management system. In the description category, 80% and 60% respondents agreed on the Desc1 and Desc2 respectively. This means that respondents knew what an ideal identity management system should look like and they are willing to give it a try. For the accessibility category, the 90% and 70% of respondents chose strongly agree and agree respectively which means that the existing identity management systems are not efficient and urgently need to be replaced.

The questions on PU1 to PU3 category, because the proposed system is perceived to be useful, the respondents chose strongly agree and agree for 70%, 70% and 90% respectively. Also, for the questions on PEOU1 through PEOU3, 80%, 80% and 90% were chosen respectively by respondents for strongly agree and agree. This shows that the perceived ease of use of proposed system is important to the respondents. Following the submission in [2], this research work relies on the effectiveness in the design, accessibility and technology acceptance model, to describe a proposed digital innovative system. This means that the digital platforms particularly cloud computing system could be leveraged to innovatively design a unique identification system that would be generic to serve all purposes.

5 CONCLUSION

Based on the initial feasibility study conducted and the results of the analysis, this work described a cloud-based integrated identity management system. The main aim of the work is to design a robust identity management system that could help in the fight against insecurity in Nigeria. The proposed system was designed to integrate all existing forms of identification in the country to generate a unique identification number that comprises of basic credentials of the Nigerian populace known as unified social security identification (USSID). The USSID management system was implemented using HTML, CSS, PHP, JavaScript, and the robust infrastructure of XAMPP tested with real data of the existing identity management systems in Nigeria. Results were interesting and with an accuracy of 96% obtained showed that USSID, if fully implemented could prevent all sort of identification related security threats and in the long run stem insecurity in the country.

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest among us whatsoever.

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