Proceedings of the
14th International Conference on Cyber Warfare and Security

Stellenbosch University
South Africa
28 February - 1 March 2019

Edited by
Noëlle van der Waag-Cowling
Stellenbosch University, South Africa
Dr. Louise Leenen
CSIR and the University of the Western Cape, South Africa

A conference managed by ACPI, UK

Proceedings of the

14th International Conference on Cyber Warfare and Security
ICCWS 2019

Hosted By
Stellenbosch University and the CSIR
South Africa

28 February - 1 March 2019

Edited by
Noëlle van der Waag-Cowling
and
Dr. Louise Leenen

Review Process
Papers submitted to this conference have been double-blind peer reviewed before final acceptance to the conference. Initially, abstracts were reviewed for relevance and accessibility and successful authors were invited to submit full papers. Many thanks to the reviewers who helped ensure the quality of all the submissions.

Ethics and Publication Malpractice Policy
ACPIL adheres to a strict ethics and publication malpractice policy for all publications – details of which can be found here:
http://www.academic-conferences.org/policies/ethics-policy-for-publishing-in-the-conference-proceedings-of-academic-conferences-and-publishing-international-limited/

Conference Proceedings
The Conference Proceedings is a book published with an ISBN and ISSN. The proceedings have been submitted to a number of accreditation, citation and indexing bodies including Thomson ISI Web of Science and Elsevier Scopus.

Author affiliation details in these proceedings have been reproduced as supplied by the authors themselves.

The Electronic version of the Conference Proceedings is available to download from DROPBOX http://tinyurl.com/ICCWS19. Select Download and then Direct Download to access the Pdf file. Free download is available for conference participants for a period of 2 weeks after the conference.
The Conference Proceedings for this year and previous years can be purchased from http://academic-bookshop.com

E-Book ISBN: 978-1-912764-12-9
E-Book ISSN: 2048-9889
Book version ISBN: 978-1-912764-11-2
Book Version ISSN: 2048-9870

Published by Academic Conferences and Publishing International Limited
Reading
UK
44-118-972-4148
www.academic-conferences.org

Contents

Effective Policing Apparatus in Nigeria: The Place of Forensic Soundness

John Alhassan[1], Adamu Muhammed[2], N. Iwokhagh[3], Musa Aibinu[4], Joseph Ojeniyi[1] and A.Uduimoh[1]
[1]Department of Cyber Security Science, Federal University of Technology, Minna, Nigeria
[2]Department of Mathematics, Federal University of Technology, Minna, Nigeria
[3]Department of Information and Media Technology, Federal University of Technology, Minna, Nigeria
[4]Department of Mechatronic, Federal University of Technology, Minna, Nigeria
jkalhassan@futminna.edu.ng

Abstract: The acquisition of a reliable evidence during litigation is a major policing-challenge especially among the policing agent in developing nations. Whilst most policing agents have adopted technology towards evidence gathering, analysis and representation through mobile applications, the reliability of these digital evidences are often overlooked. To examine this probable anti-forensic practice, this study evaluated police-assisted mobile application based on the number of application-download and user rating on the Google playstore. Furthermore, the study developed a forensic-process model for the integration of reliable forensic practice into police-assisted mobile application development. Based on the developed forensic practice the study evaluated the practicability of ensuring the forensic-soundness of police-assisted mobile application. The result from the evaluation supports the underlying level of forensic-soundness through which evidence admissibility can be ensured. This finding therefore establishes an empirical expose for awareness and the mitigation process against the anti-forensic practices. Additionally, the finding provides a justification for the acceptance or rejection of an evidence acquired from police-assisted digital applications.

Keywords: digital policing, forensic soundness, developing nation, digital evidence, evidence admissibility

1. Introduction

Policing is essentially seen as maintaining law and order in a society. It is the actions of a person or group of persons in authority to ensure fairness. The two Basic concepts of policing are: law enforcement approach and community service driven policing. Strict adherence to the rule of law of the land is the fundamental requisite operation of the first approach which focuses more on mitigation and consequently prevention of crime. The second concept depicts a holistic approach to policing by involving community participation in solving the community specific problems. In both concepts, Digital media plays an important role in information gathering and dissemination.

The demographics of the Nigerian media both traditional and social, is an evolving one. Previously prints, radio, and television were leading the media industry. However, advancements in technology has given digital media the lead. The Millennial rise in internet services changed the face of the media industry in Nigeria, defining the way journalist make and publish news. Printed news needed timely distribution and purchase for the masses to access the information, or the listening of radio broadcast at particular times of the day. Presently news is now available just as it is happening, and on-the-go. Though some of these media platforms have been politically engineered, they have served as the train for disseminating information and even as source of evidence in the law court.

Social media platforms such as Google, Facebook, Twitter, and WhatsApp, have also become a channel for news, with advertisements also maximizing these medium. Alexa commercial web traffic data and analytic company reported that Nigeria is the highest user of Facebook in Africa (Alexa, 2018). News propagated through social media is gradually becoming replacing traditional media outlet, as most online users follow these newspapers and television station for most recent news through their Facebook and Twitter accounts (Kolawole, 2018).These traditional and social media channels can be used to achieve policing, disseminating security tips and information. These media can also be harnessed to achieve digital policing. In the US, Digital media such as videos has become an admissible evidence in court, with standardized criteria. This admissibility standard has resulted in increase in the number of cases that digital evidences (such as surveillance cameras) have help to corroborate claims during litigation (Dwyer, 2011). The video functionality can be harnessed toward achieving digital policing through a policing application that citizens can leverage to report incident either in quick snap,

video, or audio recording of crime scenes with the application. Such potential evidence can then be forensically stored for litigation purpose, or event correlation purpose. For an evidence from a digital media to be forensically admissible in a court of law, the onus of evidence preservation lies on the police and other government security agencies that may partner with the police in using these evidences for litigation (Nolo, 2018).

The Nigeria Police force (NPF) is currently maximizing advancements in technology, in various aspects of her activities in combating and mitigating crime (Ibikunle & Adefihan, 2009). The police department partners in conjunction with mobile Network providers have deployed technology to track down current location of hoodlums. On the 7th of January 2016, The Lagos State command of Nigeria police launched a mobile security application, with which registered users can report an incident with a brief description of the incident for prompt response. The degree of usability and relevance of the application have been stated by citizens number over ten thousand. The security of user id is guaranteed, as information sent via the application can only be accessed by approved police officers. The Nigeria police now uses surveillance cameras, drone, CCTV and IP enabled-cameras to monitor certain cities or areas of interest. There are many more devices available in Nigeria that the NPF can utilized for maximum digital policing (Fagbohun & Oni, 2016). Background to the study is further presented in the next section.

2. Background to the study

Digital policing has become one of the main approaches for curbing the trending crimes and criminality. The lack of forensic soundness from the architectural design of a digital policing apparatus in mobile applications is however a major problem. With this challenge, admissibility of digital evidence retrievable from this new policing platform is threatened. Consequently, the whole essence of policing would be defeated without recording successful prosecution in a law court. This research thus focuses on forensically-protected technology in which self-check which induces user interference with the evidence is highly minimized if not entirely mitigated. Consequently, the study presents mechanism for gathering reliable potential evidence. This will further induce improvement in presentation of digital evidence for litigations.

Forensic analysis requires the acquisition and management of different types of evidence, including individual disk drives, network packets, memory images, and extracted files. However, some digitally storage media are volatile and highly vulnerable to alteration and or manipulation. Furthermore, digital information are vulnerable to accidental or intentional deletion. The degree of admissibility of digital evidence thus present a fallible argument for the opposing counsel during litigation. This therefore presents a need for ensuring the reliability and the admissibility of digital component in a legal battle. A logic that attempt to prevent wrongful conviction/dismissal of case in court of competent jurisdiction. Given the proliferation of digitally altered content, particularly on the social media, investigation personnel are further required to present a digital evidence beyond any reasonable doubt.

2.1 The current capability of the Nigeria Police

The Nigeria Police force (NPF) is currently maximizing advancements in technology, in various aspects of her activities in combating and mitigating crime (Ibikunle & Adefihan, 2009). Evidence gathering and storage is challenge in the policing arsenal of most developing nations. The integration of technology has however, presented a potential platform for intelligence-led evidence acquisition process. In addition, technology integration has provided a platform for synergizing the two concepts of policing (law enforcement approach and community service driven policing). One area that has received significant patronage from both concepts of policing is the use of mobile policing applications for evidence gathering, and reportage. A descriptive summary of existing mobile application as policing apparatus is presented in Table 1.

Table 1: Analysis of policing application in Nigeria and other countries

S/N	Application	Functionalities of the App	Strengths	Weakness
1.	Smart Police (Lagos- Nigeria Downloads: 10,000 + Reveiws:153)	Reporting incidents of robbery, assault, rape, theft and other incidences.	Android Only: a popular choice in Nigeria User Friendly	1. Report goes only to the (Lagos State) Command 2. Requires Mobile data to be able to work. 3. Creating an account does not work as expected. 4. Only available for Android,

S/N	Application	Functionalities of the App	Strengths	Weakness
2	Naija Sentinel (Downloads: 10+ Reviews: None Yet)	Nigerians can give tips to the Nigerian Police to support their Work	Enhances Community Policing	Not yet widely known by the Nigerian Populace
3.	Naija Save Nigeria (downloads:100 + Ratings: 4.8 Reviews: 8)	This app provides a platform for reporting Injustice against Nigerian citizen	Gives Nigerian a voice that can fight for them	The government is not linked to this platform, hence not utilized by the Nigerian Police.
4.	EFCC Nigeria (Downloads 1,000+ Ratings: 4.8 Reviews: 4)	Provides the Nigerian citizens with latest news and Information from the Agencies website, Facebook Page, Instagram Page, Twitter Handle, YouTube Channel and Hotlines and Emails.	(Android Only) Citizens can keep up to date with Nigeria's Anti-Graft Agency EFCC	It is only for news update, it doesn't have a report crime or whistle-blowing functionality
5.	Hawk Eye (India- Telegana Downloads: 10,000+ Reveiws:94)	Reporting incidents of robbery, assault, rape, theft and other ugly incidences to the Hyderabad police in Telegana, South of India.	Need GPS location to work	Battery optimization problem
6.	Hong Kong Police Mobile App (China Downloads: 50,000+ Reviews: 1,035)	Give the citizens in Hong Kong information	(Android iOS) General security information	Map or distance information of the user to the nearest Crime location
7.	Frisco Police Mobile App (Downloads:50+ Reviews:1)	Users can report issues of concern, get community resources, access police contact and many more.	(Android and iOS) Give the citizens of Frisco a public safety access and information	Limited to just the City of Frisco.
8.	PoliceOne (US Downloads: 100,000+ Reviews: 1,017)	Up-to- date on breaking police news	Keeps security officers up-to-date with required information.	It is only for security professionals, it does not cater for the general public.
9.	Ask the Police Scotland, Wales and England (Downloads:50+ Reveiws:1)	Answers Policing Questions	(Android and iOS) It can help in public stay up to date on policing issues questions. The public are updated with latest news about policing issues	1. News alerts about crime is not part of the app. 2.Does not provide a platform to report crime
10.	RAIDS Online (US Downloads:1000 + Reviews:None)	Crime Mapping Information	Reduce Crime and improves public safety by connecting the public to law enforcement	Only cities that their security agencies have been integrated with the App can be seen
11.	Evidence Cam (Downloads:100 0+ Reveiws:11)	On screen information on photos: GPS coordinates, street Address, time stamp. Case file numbers, information about subjects, witness, suspects and victim.	(iOS and Android) Make it possible to use photos as evidence in court.	1. This app requires internet connection. 2. The app is limited to picture only. 3. The app is limited to just security professionals

S/N	Application	Functionalities of the App	Strengths	Weakness
12.	My Police Department (MyPD) (US and Canada Downloads: 100,000 Reviews:823)	About 40 features with which User can receive notifications, send crime alerts, etc.	(iOS and Android) Encourages community policing	Only those agencies that connect are available on the app.
13.	CrimePush Security (US)	Report crime to the police authorities or be alerted of dangerous situation, just by pushing a button	(iOS and Android) The report a crime through text, photos, videos,	1. The app, does not give notification of the nearest available station. 2. Users placed a warning on the iTunes app pages because the app has not yet been integrated with all the police departments in US.
14	Officer (downloads:100 + Ratings 5.0 Reviews 2)	Quick Reporting of Crime to the Nigerian Police Force	Need GPS location to work and Incidences such as accidents to the Road Safety Corp.	1. Limited to Only Lagos State. battery optimization problem

2.2 Nigerian policing application (Smart Police)

This is a policing mobile application launched in 2016, by the Nigerian Police for reporting crime. Case such as rape, robbery, domestic violence etc. Reports sent on this app are secure and are only accessed by designated police for response. Confidentiality of the sender is ensured as the report are received as anonymous, with real time updated information of the location sender. The app is currently restricted to the Lagos state command of the Nigerian Police. However, the operational capability of Smart Police within the Lagos environ remains a major challenge. The application is also limited to the Android platform, while the windows, Blackberry and iOS versions have not been developed (NigeriaPolice, 2016). A major drawback in existing mobile applications used in potential evidence acquisition for litigation is the lack of adequate forensic mechanism in the lifecycle of the evidence availability. The life cycle of evidence available typically include potential evidence identification, capture, storage, authentication, retrieval, analysis, reporting and presentation. For each element in the lifecycle, one or more forensic attributes are required as criteria for admissibility. As highlighted in table 1, the response rate of citizen to the use of the mobile policing application is significantly low. For instance, Nigeria is projected to have a population of approximately 190Million, and the permeation/adoption of technology has seen significant increase. However, this is commensurate with the rate of adoption of digital policing mechanisms (using the Application download as a metrics), the increase in technology related crime notwithstanding. One possible explanation could be related to the perceived usefulness of the digital policing mechanism. The degree of admissible evidence from such digital policing platform could provide an enhanced tendency for the adoption of such technology. A brief exposition on potential evidence admissibility is provided in the next section. This include existing literatures on methods to enhance evidence admissibility as well as criteria for evidence admissibility in litigation.

2.3 Naija Sentinel

This app was designed by Adefolajuwon Amoo a Nigerian, to help Nigerians to give important tips to the Nigerian police that can assistant the Nigerian Police Force gather useful evidences for investigation and Litigation Process. Citizens want to be involved in policing process, but also want to keep their identity anonymous. This app has a unique functionality that should be incorporated into a full policing app.

2.4 Naija Save Nigeria

This is a platform that encourages citizens to report cases of maltreatments, corruption or injustice by the Nigerian Police or other federal government agencies. The platform helps citizens to fight reported incidences legally. This app, is a mobile arm of this platform that provides a functionality for users to send their reports via text, pictures, audio and videos reports.

2.5 EFCC Nigeria

Provides the Nigerian citizens with latest news and Information from the Agencies website, Facebook Page, Instagram Page, Twitter Handle, YouTube Channel and Hotlines and Emails. The app has just been updated on 15th of October, 2018, though only 7 reviews for now, but users are happy with the information they are getting from the application. This app has a functionality that can be incorporated into a full policing app.

2.6 Hawk Eye

In 2014 Hyderabad police in Telegana south of India, launched this Hawk Eye to promote citizen policing, there by promoting community policing. With this app women can travel safely such that they can send details of the car they about to travel in and after arriving destination. Users can also send reports to the police, access quick help response by just clicking the SOS button, and get contacts of nearest Hyderabad city police officers. The identity of the user is kept anonymous for confidentiality (TELEGANA, 2014). Within two years the Hyderabad police have received about seventeen thousand (17,000) actionable calls. In 2016, the app has gotten an update, and the app get a gold award in January 2017, for its impact on digital policing (Bhattacharjee, 2017).

2.7 Evidence CAM

This policing app, that provides security professionals with crime scene investigation, with which they can take pictures. The pictures header had the following information: GPS coordinates in decimal format, Time/Date stamp using National time protocol (NTP) in Coordinated Universal Time (UTC). The device time is used with an asterisk* next to the time, if the NTP server is unavailable. If the picture is taken in an open field, the Street Address, City, State Zip can be turned off. The user can add comment in text, about the photo at the left footer of the photo (COP-APPS, 2014).

2.8 MyPolice Department (MyPD)

My Police department popularly called MyPD App, is an app that promote community policing, via providing users a feature to anonymously report crime or violent and also receive up-to-date notification on the app dashboard or through Twitter. Users can select from several topics of crime scenarios, about forty (40) features, through which the community and the police are able to connect with each other. This app is being used by the local police, state police and college police agencies in the United States and Canada. Police responds upon reception of crime alerts form the app. Users do not need to browse before getting notification of unsecure zones and parking reports. Two hundred (200) police agencies in US and Canada have deployed this app, (Peabody, 2018; PoliceDepartment, 2018). This app is a trailing app in digital policing.

3. Evidence admissibility

Admissibility has to do with the state of acceptance or rejection of any testimonial, documentary or tangible evidence introduced to a factfinder (Judge or Jury) in a court of law. The admissibility of evidence is generally predicated on rules of evidence. Digital evidence admissibility raises practical considerations. Some of these considerations are: the appropriate threshold for admitting the presented document or testimonial as evidence, the burden of proof on the proponent or opponent of evidence, the procedural requirements and/or safeguards to be in place to ensure proper examination by the court (Society, 2012). The sources of evidence from digital devices are on the increase. Some of the sources are the Internet, computers, removable media, mobile devices, global positioning systems and other digital devices. In addition to the inherent volatility of evidence from these sources, devices to track and collect them are also inadequate in forensic soundness. In the work of Karie, (2013), methodologies and specifications typically designed to enhance potential digital evidence presentation and interpretation in a court of law were formulated. A demonstration of how mobile forensic techniques can be used to recover evidentiary artefacts from client devices when popular cloud apps- Google Drive, Dropbox, and OneDrive were used on the devices (Dwi, Cahyani, Glisson, & Choo, 2016) was presented. A design of a benchmark was developed to show the relationship between validation and testing (Wilson, Florida, & Florida, 2018).

Whilst these studies focused on the development of modalities for enhancing the admissibility of digital evidence, the core component of evidence are assumed to have been addressed. This assumption are further summarized in Table 3. These studies, as shown in Table3, attempt to provide a context-based evidence admissibility criteria as well generic profile for potential evidence admissibility. For instance the observation

from the report by the ITU Council, (2006) presents a generic criteria which is applicable to any form of potential digital evidence. Similarly, the extrapolation developed in Billard, (2018) provides a context dependent platform for evaluating the admissibility of an evidence. Collectively, the admissibility of evidence can be defined with the context of forensic attributes. This include availability and reproducibility of evidence, integrity and reliability of evidence, decisive and repeatable analysis of evidence, documented chain-of-custody and chain-of-evidence, as well as confidentiality of evidence throughout the evidence lifecycle. The criteria formulated in the study further shows the potential of identifying diverse context through which potential evidence can be identified and extracted.

Table 2: Summary of related works on evidence admissibility

Author/Year	Problem Being Solved	Methodology Used	Achievement/Result	Weakness/Gaps
Billard, (2018)	The study addressed the problem of weighted digital evidence.	1. Digital Evidence Inventory (DEI). 2. Forensics Confidence Rating (FCR) structure. 3. Global Digital Timeline (GDT).	A sound Digital Evidence was achieved which was expressed in terms of Confidence and ordered through a timeline.	A more precise confidence of error rating probabilities and a semi-automated tool for the building of the GDT
Chen & Liu, (2014)	Uncertainty and Inaccuracy in Quality of Efficiency (QOE) were addressed.	Dempster-Shafer evidence Theory (DST) based weighting method.	Combination of Quality of Efficiency (QOE) of multiple users.	Extending the linear user request model to more general cases. Also in developing future admission control schemes, the termination of services needs to be dynamically considered.
Yadav, (2013)	The challenges of mobile forensics investigation and admissibility of acquired mobile data as electronic evidence in Indian jurisdiction.	A step by step guide to the acquisition and preservation of data from mobile devices.	Presentation of a process model for investigators to perform effective mobile forensics.	Relate admissibility of digital evidences in global context using a process model
Karie, (2013)	The lack of methodologies and specifications typically designed to enhance potential digital evidence presentation and interpretation	Presentation of a step-by-step framework to propose a high-level guidelines.	Provision of high-level guidelines for enhancing the potential digital evidence presentation in any legal proceedings that will be helpful to digital forensics experts.	Development of new techniques to support potential digital evidence presentation and interpretation in any court of law.
Wilson, Florida, & Florida, (2018)	Validating digital forensics software data specifically for smart phones.	A data validation framework was used.	A design of a benchmark was developed to show the relationship between validation and testing.	A data acquisition model that ensures the integrity of acquired data.
Dwi, Cahyani, Glisson, & Choo, (2016)	Mobile technologies exploited in terrorist activities.	A Series of controlled experiments were used on Android and Windows devices.	A demonstration of how mobile forensic techniques can be used to recover evidentiary artefacts from client devices when popular cloud apps- Google Drive, Dropbox, and OneDrive were used on the devices.	Extending the study to other apps and mobile devices.

Table 3: Overview of admissibility criteria

Author/Year	Criteria
Kearsley, (1999)	-Fixed usage procedures -Integrity-check record keeping even during faulty system performance -Document audit trail records -Awareness of the importance of detail record keeping
ITU Council, (2006)	General criteria: Legitimacy/Lawful Finality, Useful, Respect for fundamental rights, relevant, effectiveness, pertinent, necessary, respect for data protection rules, proportionate/reasonable, transparency in the gathering, presented in an adequate process, respect for individual privacy, proportionality in the gathering, respect for the secrecy of communications, facilitating display means, impartial, reliable, justified, important, best available, original Technical criteria: Identification of the sender, guarantee of integrity, storage in safety conditions, technical requirements for the electronic evidence, confidentiality, requirements to check the delivery, security of the evidence, previous information to the computers owner, technical requirements for the electronic certified
Wilson & Chi, (2018)	Aimed Data Criteria: when, what, who, where Return Data: Images, video Validation: Application of hash algorithms (MD5 & SHA-1), Verification of metadata (timestamp, data creations, changes, deletion, etc. Preservation of Data: Creation of file with acquired data, Store on a storage with hash values for investigator Collection Review: Generation of summary that contains information about the collected files.
Billard, (2018)	Digital Evidence Inventory is based on the Scrybe Provenance Framework; Blockchain technology based Model is used with lightweight mining and distributed consensus. The lightweight mining criteria are: Each miner, from a total of N miners, generates a random number Each miner broadcasts the hash of their random number Once all hashes have been broadcasted, each miner broadcasts its own random number. Each miner verifies the hashes and calculates Elected_miner = sum % N, where sum is the sum of all the random numbers The miner with an id equal to Elected_miner creates the new block and broadcasts it to all other miners
Chabot, Bertaux, Nicolle, & Kechadi, (2015)	Ontology-based criteria for the reconstruction and analysis of digital evidence based on credibility, integrity, reproducibility.
Coudert, Gemo, Beslay, & Andritsos, (2011)	National legal framework Balance between the truth and respect for fundamental rights during investigation

Given that the admissibility of evidence can be modelled, as identified in the study in Yadav, (2013), and Billard, (2018), the current study further redefined a generic process for evaluating the composition of a system for evidence admissibility. The logic utilized to achieve this process, in addition to improved forensic soundness scrutiny, is further discussed in the proceeding section.

3.1 Forensic soundness

Forensic soundness is often predicated on proper documentation. A case built on detail supporting documentation, reporting evidence sources with chain-of-custody is referred to as a solid case. In addition to characteristics of the evidence source, such as a computer hardware clock or the number of sectors of a hard drive, an audit log and chain of custody enable an independent examiner to authenticate the evidence and assess its integrity and completeness (Fo- & Tools, 2007). Forensic soundness is generally governed by the tenet of security triad: confidentiality, integrity and availability (CIA). Other additional composition include authorization, authentication and non-repudiation. A forensic mechanism that integrates these attributes often satisfies the legal requirement, litigation scrutiny, and evidence reproducibility criteria of forensic standards. This composition is further integrated in the mathematical formulation presented in the next section.

3.2 Mathematical model based on internal composition of the information report system

The Entire System denoted by, ϕ, is made of four fundamental components which are; the Web application for Image, Video and Voice Report represented by, W_{IVV}, HTML Rendering Engine Web-View by W_{View}, System Plugins by $S_{plugins}$ and Mobile OS by M_{OS}. The components comprise of sub components and forensic attributes which can be mathematically represented as follows:

W_{IVV} = $\{\{R, C\} * FS\}$ in HTML (1)
Where W_{IVV} = Web Application for Image, Video and Voice report, R = System Resources and C = System Configuration (config.xml), FS= forensic soundness attributes
W_{View} = $\{W_{IVV}\}$ = $\{\{R, C\} * FS\}$ ϵ W_{View} (2)
Where W_{View} = HTML Rendering Engine – Web-View
$S_{plugins}$ = $\{A_m, G_l, C_a, M_e, D_{e,} N_e, C_o, S_t, FS_{specific}\}$ (3)
Where $S_{plugins}$ = System Plugins, A_m = Accelerometer, G_l = Geolocation, C_a = Camera, M_e = Media, D_e = Device, N_e = Network, C_o = Contact, S_t = Storage and = appropriate forensic attribute for the given instance
M_{OS} = $\{W_{View}, S_{plugins}\}$ (4)
M_{OS} = $S_v + I_p + S_e + G_r$ (5)
Where M_{OS} = Mobile OS, S_v = Services, I_p = Input, S_e = Sensors and G_r = Graphics
This implies that;
ϕ = $\{W_{IVV}, W_{View}, S_{plugins}, M_{OS}\}$ (6)
ϕ = W_{IVV} + W_{View} + $S_{plugins}$ + M_{OS} (7)
Where ϕ = Entire System.

To further evaluate the relevance of forensic soundness in the policing apparatus, the study developed a mobile policing application that integrates the tenet of information security. The application leveraged the advances in the functionalities in mobile technology. This include the integration of geolocation functionalities, timestamping functionality, high resolution multimedia data capture functionality, as well as ease of accessibility. A descriptive architectural framework of the proposed mobile application is shown in Figure 1.

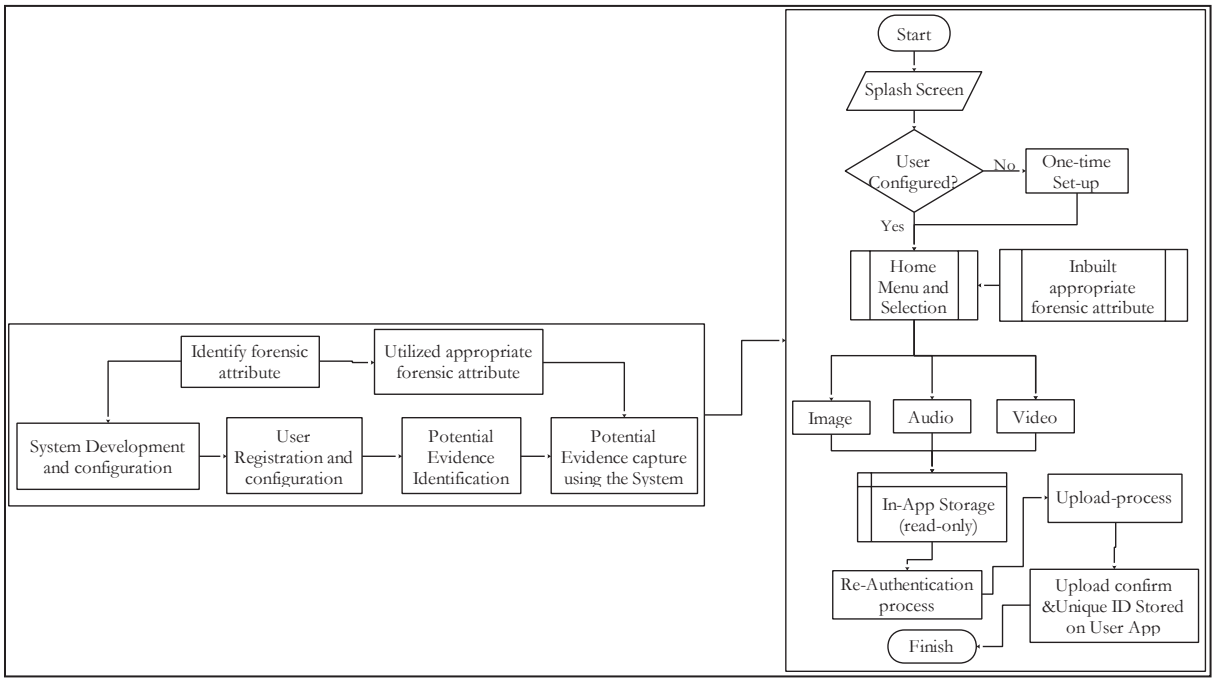

Figure 1: Architectural block diagram of the proposed mobile application

The requirement for this application are given thus; an android mobile phone with operating system 4.0, camera support, GPS enable and cellular network compatibility. Also, MySQL database server for record keeping and centralized access. Firebase database for file instant storage and retrieval. Internet connectivity for fast data transfer. Upon successful setup of the application, it will display the following Home Menus for the Users: Image Report; Voice Report and Video Report. The image report provides an optional event description and a button to instantly capture image of the event to be reported. If image is captured successfully then it is immediately

uploaded to the centralize server for analysis. The voice report provides an optional event description and a button to instantly record voice message of the event to be reported. If voice is recorded successfully then it will immediately upload to the centralize server for analysis. The video report provides an optional event description and a button to instantly record video of the event to be reported. If video is recorded successfully then it will immediately upload to the centralize server for analysis. Attached to the report sent to the server are the following metadata; name of reporting user; Location of user; Time of event capture; Phone number of the user; Captured image, voice or video and Event descriptions.

4. Discussion

Considering the volatile nature of some potential digital evidence and the likelihood of vulnerability to various forms of attack, and or negligence, the need for a structured method of potential evidence identification, collection and preservation is essential for litigation. Technique and modality to ensure the admissibility of potential digital evidence is hugely required in the research space. The proposed mobile application has the potential to address evidence admissibility throughout the lifecycle of the potential evidence. However, this contrast existing modalities which assumes the user would abide by stated guidelines and measures of forensic soundness. In a digital society where potential evidence can be deliberately altered to reflect a given narrative, such an assumption cannot be considered. In Nigeria where the admissibility of digital evidence remains a large debate among legal minds, there is a core need from forensic practitioners to ensure that the reliability of potential evidence is ensured. When the integrity of the potential evidence is not violated, higher confidence in the usage of digital evidence in event corroboration can be achieved. Much efforts must be given to the adherence to forensic procedures for seizing or collecting digital devices especial mobile devices as data extraction to be used for evidence, must meet criteria for admissibility in court for litigation. This posit therefore that more research are required to consider other probable sources of potential digital evidence.

5. Conclusion

Information gathering is key to Forensic soundness. However, the methodology used for information gathering determines the forensic soundness of such information. The Nigerian demographic is such that social media have become the main platform for information dissemination. More information is spread via Facebook, twitter, and other social networking platforms than the conventional news media such newspaper or television. Mobile technology is leading the core of technological advancement which has made countries and cities of the world like Hong Kong, Frisco and many others to deploy mobile policing applications. Mobile Policing application around the globes have be analyzed, and their solutions to digital Policing and limitations are presented in the manuscript. This analysis has thrown more light on the need for a more effective policing apparatus in Nigeria other than the Smart police app, deployed by the Lagos State Police Command. A mobile application which satisfies the criteria for evidence admissibility is further processed in the study. The proposed approach will enable a prompt and accurate response from the Nigerian police. Furthermore, the proposed approach will provide a platform for acquiring potential evidence with high evidential weight and reliability. Future work will consider other aspect of potential evidence acquisition process which will attempt to self-verify information using behavioral signatures, time correlation, media characteristics, as well object characteristics to profile the evidential value, weight and reliability of potential evidence.

References

Alexa. (2018). Top sites in Nigeria.pdf. Retrieved September 20, 2018, from https://www.alexa.com/topsites/countries/NG

Billard, D. (2018). Weighted Forensics Evidence Using Blockchain. *Proceedings of the 2018 International Conference on Computing and Data Engineering*, 57–61. https://doi.org/10.1145/3219788.3219792

Chabot, Y., Bertaux, A., Nicolle, C., & Kechadi, T. (2015). An ontology-based approach for the reconstruction and analysis of digital incidents timelines. *Digital Investigation*, *15*, 83–100. https://doi.org/10.1016/j.diin.2015.07.005

Chen, C. W., & Liu, B. (2014). Admission Control for Wireless Adaptive HTTP Streaming : An Evidence Theory Based Approach, Proceedings of the 22nd ACM international conference on Multimedia,893–896.

Coudert, F., Gemo, M., Beslay, L., & Andritsos, F. (2011). Pervasive monitoring: appreciating citizen's surveillance as digital evidence in legal proceedings. *4th International Conference on Imaging for Crime Detection and Prevention 2011 (ICDP 2011)*, P33--P33. https://doi.org/10.1049/ic.2011.0130

Dwi, N., Cahyani, W., Glisson, W. B., & Choo, K. R. (2016). The role of mobile forensics in terrorism investigations involving the use of cloud apps. https://doi.org/10.4108/eai.18-6-2016.2264416

Dwyer, T. P. (2011). Legal considerations in the use of Digital Video in criminal cases. *Police Liabilty and Litigation*, p. 4.

Fagbohun, O. O., & Oni, O. A. (2016). Security Devices Application Studies in Crime Prevention and Policing in Nigeria . *American Journal of Enginnering Resear h (AJER)*, *5*(12), 58–69.

Fo-, N., & Tools, A. (2007). What does ‘“ forensically sound ”’ really mean ?, *4*, 49–50. https://doi.org/10.1016/j.diin.2007.05.001

Ibikunle, F., & Adefihan, B. (2009). Effectiveness of Information and Communication Technology (ICT) in Policing in Nigeria. *Scottish Journal of Arts, Social Sciences and Scientific Studies -*, 90–103.

ITU Council. (2006). *The Admissibility of Electronic Evidence in Court: Fighting Against High-Tech Crime*. https://doi.org/10.1080/15567280701418049

Karie, N. M. (2013). Towards a Framework for Enhancing Potential Digital Evidence Presentation.

Kearsley, A. J. (1999). {L}egal admissibility of evidence held in digital form. *{C}omputer {L}aw & {S}ecurity {R}eport*, *15*(3), 185–187.

Kolawole, S. (2018). Nigeria - Media Landscape, 13. Retrieved from https://www.researchgate.net/publication/261065031_The_Print_Media_Landscape_in_Nigeria_and_Reporting_Conflict

NigeriaPolice. (2016). SmartPolice. Retrieved from http://smartpolice.ng/

Nolo. (2018). Preservation of evidences in Criminal Cases.pdf. Retrieved from https://www.nolo.com/legal-encyclopedia/preservation-evidence-criminal-cases.html

Society, T. S. L. (2012). *Admissibility of Electronic Evidence - Singapore Law Gazettee*.

Wilson, R., & Chi, H. (2018). A framework for validating aimed mobile digital forensics evidences. *Proceedings of the ACMSE 2018 Conference on - ACMSE ’18*, 1–8. https://doi.org/10.1145/3190645.3190695

Wilson, R., Florida, A., & Florida, A. (2018). A Framework for Validating Aimed Mobile Digital Forensics Evidences.

Yadav, D. (2013). Mobile Forensics challenges and admissibility of electronic evidences in India. https://doi.org/10.1109/CICN.2013.57