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An application-based framework for curbing mobile phone-related crimes: Results of a preliminary study in Eastern Uganda

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Abstract

Background: Police has relentlessly reported increased crime rates in Uganda, many of which are committed with/or through mobile phones. This positions mobile phones as potential sources of incriminating evidences for digital investigations and crime reporting. In this study, we explored the use of mobile phones for crime investigation and propose an application framework for curbing mobile phone-related crimes in Eastern Uganda, East Africa.

Main body: Data was collected using self-administered questionnaires from 36 respondents who were police investigators and State Attorneys. The framework proposed is based on a client-server-model. Results of the study indicated that whereas criminal investigators believe in the application of mobile phones in crime reporting and collaborating evidences, they seldomly use them as a potential source of evidence when making criminal case decisions. Of the 10 files of criminal cases encountered, only 1 to 3 of them were considered during prosecution. This was found to be largely dependent on the criminal investigators' training level in mobile phone forensics and their average mobile phone applications' competence.

Conclusions: Policy makers, Ministry of Internal Affairs, Ministry of Constitutional Affairs and other criminal investigation organs in Uganda should consider developing customized police mobile applications and sensitizing the public on how to use them through capacity building among crime investigators so as to curb mobile phone-related crimes in Uganda.

Background

Various aspects of daily life involves the use of mobile phones, computers, wireless connections and the internet in both the developed and developing nations (Bongomin et al. 2020; Caponnetto et al. 2021). Consequently, many crimes are committed with and/or through these facilities. This has rendered them a potential tool in crime reporting and a source of incriminating evidences in court proceedings (ACPO, 2007; Ademu & Imafidon, 2012; Agangiba & Agangiba, 2013; Felka et al. 2020). Crime rates in both the developed and developing countries are high. For Uganda (a country in Eastern Africa), the underlying causes of crimes are unquestionably complex — but crime rates have been exacerbated by chronic poverty, illiteracy and high unemployment rates (Uganda Police Force, 2021).

The Uganda Police reported that in 2020 there was a 8.9% decrease in the volume of crimes reported to Police from 215,224 cases in 2019 (Uganda Police Force, 2021). This was because in 2019, there were more than 748 phones with invalid international mobile equipment identity (IMEI) numbers which makes them illegal and can be used by hardcore convicts, drug dealers and anti-social people to perpetrate crime because such phones cannot provide traceable records (Kamusiime, 2019). The COVID-19 pandemic outbreak and the subsequent containment lockdowns, and the anti-crime infrastructures such as Closed-Circuit Television (CCTV) Cameras were noted as some of the reasons for the reduction in the crime rates.

Thus, it was recommended that the institution should adopt science and technology developments in the country to further curb down crimes (Uganda Police Force, 2021).

Mobile phones provide a wealth of data in form of text and multimedia messages, metered data (numbers dialed, received and missed; time and dates of calls), emails, internet data, image, audio files and location data (Agangiba & Agangiba, 2013; Mantoro et al. 2014; Mugisa, 2013). These data can be used to link a perpetrator to a crime. For example, mobile phone records may place an individual at a crime scene because of the location data that is retained by the phone and/or obtained from network service providers or by forensic tools during an investigation. Digital images and videos provide substantial data for use in courts (so long as the information has been authenticated). In addition to providing documentary evidence of a crime, images and videos contain metadata. Metadata is relevant when the process by which a document was created is an issue or where there are questions concerning a document's authenticity. They can reveal when a document was created, how many times it was edited, when it was edited and the nature of the editing done (Hansen & Pratt, 2020).

The main barrier in using digital evidences in a manner that ensures its admissibility in courts is the problem of authentication (Maras & Miranda, 2017). Information extracted from digital devices must be authenticated in order to be used as evidence(s) in a court of law (Section 29 of computer misuse Act, Section 7 of electronic transactions Act). Each nation should therefore, develop a domestic forensic capacity to handle digital evidences (Maras & Miranda, 2017; Selvarajah & Mailvagnam, 2021). The current study examines the use of mobile phone applications (MPAs) in criminal investigations and proposes a mobile phone-based application framework for curbing mobile phone-related crimes in Uganda, East Africa.

Materials And Methods

Study area and design

This study was carried out in 4 magisterial areas of Mbale, Tororo, Iganga and Busia districts, out of the 38 magisterial areas of Uganda (Fig. 1). The selected areas serve 17 districts namely: Mbale, Sironko, Bulambuli, Namisindwa, Manafwa, Bududa, Tororo, Butaleja, Iganga, Mayuge, Luuka, Namutumba, Kaliro, Bugweri, Bugiri, Namayingo and Busia. The study area has 4 chief magistrate courts, 4 chief magistrates and 13 magistrate grade I courts. The choice of the area was because it report all kinds of crimes and the legal officers working therein were deemed to own, use more and are ahead of others in applying mobile phones in crime prevention.

The study adopted a descriptive research design to respond to the research questions and problem. The research design guided on how the data was collected and analyzed. To determine how often mobile phones are used in evidence collection and to establish the common approaches of evidence extraction from them, it required the data to be collected from the sampled target that is directly involved in criminal investigation. This generated reliable samples for the study which facilitated inductive inferences about

the population. Inductive approach was chosen because the inferences were derived from the “bottom-up” using the respondents’ views to build an application framework (Croswell & Prank, 2007).

Descriptive research design is best suited for establishing the attitudes, actions and influence that affect relationships between variables. This study was a cross-sectional survey and involved getting the views of respondents at once. A survey is suitable for systematically collecting information at a particular time, with the aim of describing existing situations (Kerlinger & Lee, 2000).

Population and sample size determination

This study used expert purposive sampling to determine the sample size from the population of the 4 magisterial districts. According to previous authors (Mugenda & Mugenda, 2012; Wambugu, 2017), 10–30% of the population targeted is enough to represent the study population (as a sample). This research took 10% of the total population to represent the study population which translated to a sample size of 38 respondents (Table 1).

Table 1
Sample matrix for the study

Respondents	Population (N)	Sample (n)
State Attorneys	15	2
Police investigators*	366	36
Total	381	38
*The police investigators are from the Criminal Investigation Department (CID).		

Conceptual framework and study measurement of variables

The framework utilized in this study (Fig. 2) is hinged on channel expansion theory and conceptualizes the relationship between the independent variable (application of mobile phones) and the dependent variable (crime control). The independent variable (application of mobile phones) is conceptualized in terms of voice calls, short message services (SMS), internet browsing, social media, e-mailing and information storage. This is linked to the dependent variable (crime control) through the use of mobile phones as a potential evidence source and crime reporting medium. During the empirical part of this study, popularity of directly extracted evidence was measured using tasks such as call history analysis, files transfer and mobile money transactions among others. Forensic tools extracted evidence was assessed by considering tools used for analysis of deleted audio, video and digital photograph files, e-mail headers for deleted e-mails and password-protected files among others. The extraneous variables included: favorable legislation, specialized training of criminal investigators, motivation of criminal investigators, adequate equipping of forensic laboratories and sensitized community on legally acceptable crime reporting procedures.

Data collection

Primary data was collected from criminal investigators in the four magisterial areas using a self-administered questionnaire (Wambugu, 2017). This allowed the informants to provide the detailed information relevant for the study. The instrument was designed to suit study objectives (**Supplementary File 1**). They were sectioned as follows: Part A captured the respondent's general information, Part B probed the respondent on their perceived ease of use on mobile phones, Part C inquired on the factors influencing police officer's intention to use mobile phones in criminal investigations while Part D sought the respondent's extent in which subjective norm influences their behaviour towards use of mobile phones in crime prevention. Part E inquired from respondent on police officer management style influence on use of mobile phones applications systems such as Facebook, WhatsApp, SMS, twitter and e-mails in crime prevention approaches based on elements of adapted technology acceptance model (Wambugu, 2017).

The questions were administered in closed form Likert scale to enable the researcher capture the gaps in police officers perceived utilization of the mobile phone that exist in the field through this primary source of data collection. The scale rated from 1 to 5 based on the respondent conviction (**Supplementary File 1**).

The validity of the questionnaire was established using the content validity test. Every item of the instrument was analyzed and the reliability of the instrument was established using the Cronbach's alpha coefficient of internal consistency in SPSS. The analysis was performed per section and later the overall for the questionnaire administered. The questionnaire had an Excellent Inter-Item Consistency of 0.943.

Statistical analysis

The questionnaires were coded forming a code book in SPSS. The coded responses were entered into SPSS software version 16.0. Data cleaning was done by checking the missing and out-of-range values. The cleaned data was then analyzed using descriptive statistics and expressed in terms of frequencies, valid percentages, measures of central tendency, measures of dispersion and summarized in form of graphs. Pearson's correlation and paired sample t-tests were done to establish the association of mobile phones with crime control.

Results

Demographic characteristics of the respondents

The study registered a response rate of 95%; that is, of the 38 respondents, 36 returned fully filled questionnaires that were considered for analysis. Of the 36 respondents, 94.4% were police officers from criminal investigations department while 5.6% were State lawyers particularly State Attorneys. These consisted of 75% male and 25% female. The largest number of the respondents (44.4%) were in age group of 31–41 years. In terms of education, 58.3% of the respondents were secondary school leavers while 22.2% were diploma holders. Thus, 80.5% of the respondents hold a diploma and below. Only 5.6% of the respondents attested to having postgraduate qualification while 13.9% held bachelor degrees.

Further, 80.6% of the respondents reported having undergone at least through a professional training whereas 19.4% had received no such trainings. Of the 36 respondents, only 38.9% had undertaken digital forensics training. Of the respondents reached, majority (86.1%) had no training in mobile phones forensics. Additionally, 50% of the respondents had no experience in mobile phones forensics, 22.2% reported to have at least 5 years of experience, more 22.2% had 1–2 years of experience and 5.6% have between 3–4 years of experience.

Competence in the use of mobile phone applications (MPAs) in criminal investigation

On plotting frequency with competency rating, a histogram with a super-imposed normal curve was obtained demonstrating normally distributed responses with mean of 3.03 and standard deviation of 0.883 (Fig. 3). This indicated that generally investigators are averagely good at utilizing MPAs for criminal investigations. From the respondents self-rating, call log registered the highest competence mean of 4.25, mobile money transactions at 4.22 followed by SMS at 4.08. This indicates that respondents rated themselves as Good at call log, mobile money transactions and SMS. The majority had **no idea** about password removal and data recovery using forensic tools thus **mode** and **median of 1** and **mean of 2**. Most of the respondents rated Average or weak at other applications.

Description of the dependent variable: crime control

This was measured from the respondents' safe-rating basing on a Likert scale ranging from 1 to 5 rated at Strongly Agree = 5, Agree = 4, Ambivalent = 3, Disagree = 2 and Strongly Disagree = 1 while responding to the Likert items of the questionnaire. A histogram with a superimposed normal curve was obtained demonstrating normally distributed responses with a mean of 3.70 and standard deviation of 0.463 (Fig. 4). A further test for normality (Shapiro-Wilk) was done and returned $P > 0.05$, which confirmed that the mean responses were normally distributed. With a crime control mean response of 3.70, median of 3.675, mode of 3.25 and standard deviation of 0.463, respondents agreed to using mobile phones in crime control.

The frequency of use of mobile phone applications as a potential source of incriminating evidences was established from the respondents' self-rating basing on a Scale ranging from 1 to 5 rated as At least 8 of 10 files = 5, 6 to 7 of 10 files = 4, 4 to 5 of the 10 files = 3, 1 to 3 of 10 files = 2 and Not at all = 1 while responding to the items in the questionnaire. A plot of frequency of App use with App use rating gave a histogram (Fig. 5) with a superimposed normal curve, alluding to normally distributed responses with a mean of 2.28 and standard deviation of 0.886.

A test for normality was done ($P = 0.020$; $P < 0.05$), indicating that the mean responses were not normally distributed. Further test of normality was done on the logarithms of the transformed mean responses of mobile phones App use ($P = 0.059$; $P < 0.05$), confirming that the mean responses were normally distributed. A plot of frequency with logarithms of mean responses for MPAs use gave a histogram with a

superimposed normal curve (Fig. 6), demonstrating normally distributed responses with a mean of 0.32 (standard deviation = 0.176).

Generally, MPAs use as a potential source of incriminating evidence had an average of 2.283, median 2.25 and a mode of 1.50, implying that they are used as a potential source of incriminating evidence for 1 to 3 of the ten files of criminal cases. However, analysis of the dynamics of using mobile phones in criminal investigations showed that only 17.2% of the CIDs have ever used and attended forensic training while none of the State Lawyers had the same. Of the 36 respondents therefore, only 13.9% had this specialized training. This obviously makes mobile phones forensic investigations vulnerable.

A paired sample t-test was performed, and it showed that MPAs competence and mobile phone use were statistically significant ($P < 0.05$). A Pearson correlation coefficient of 0.59 existed between the two, indicating a high positive correlation between MPAs as a source of evidence with MPAs competence. That is; it was evident that for an investigator to consider a phone as potential source of evidence some degree of App competence is a prerequisite. This was corroborated by the results of paired sample t-test which indicated that MPAs competence and crime control were statistically significant ($P < 0.05$). Pearson's bivariate correlation coefficient of 0.425 existed between the two, indicating a moderate positive correlation between crime control with MPAs competence.

Variation of crime control with MPAs as a source of evidence

A paired sample t-test was performed and it showed that MPAs as a source of evidence and crime control were not statistically significant ($P > 0.05$). Pearson correlation coefficient of 0.279 existed between the two, which is a low positive correlation between crime control with MPAs as a source of evidence. Whereas the investigators believed in the application of mobile phones as a tool for crime control, they did not often use them as a potential source of incriminating evidence.

An application framework for using mobile phones in crime control: the case of Uganda

The proposed framework involves first training the police especially the investigation department in mobile forensics who in turn sensitizes the community on the same. The community using the available mobile phones reports (inputs crime update) criminal activities to either the command Centre or the nearby police. Depending on the nature of the crime tip and the mobile phone, the tip is sent as voice calls, SMS, photographs of suspect, video recording of the criminal activity, audio recording, emails, the suspect's mobile phone details (if known), among others. Police updates (output crime updates) the community on the new crime tricks, hotspots, photographs of suspects, videos of criminal activities, audio files, emails using the various mobile phone apps (Fig. 7).

The police then collect more details of the suspect's mobile phone. The suspect is pursued by tracking or arrest. Once the suspect's mobile phone is recovered, evidence extraction is first done manually. If

satisfactory evidence is not obtained, advanced evidence extraction is done by forensic experts using tools. Depending on the state of the phones and the nature of the evidence, logical, physical or file system extraction is done. After investigation, collaborating evidence is presented before court, assessed and a verdict is made. Figure 8 demonstrates the application of mobile phones in crime control spotting out the key players with the enabling forensic environment.

Discussion

Crimes occur in different forms and cause socio-economic losses to both the victims and the government (Felka et al. 2020). For this reason, several efforts have been made to reduce them, including the use of technology (Ademu & Imafidon, 2012; Agangiba & Agangiba, 2013). For mobile phones, the key factors responsible for inconsistencies in mobile devices include digital forensic evidence extraction process and forensics extraction tools used, forensics extraction methods applied, the nature of the data, devices and policy factors (Ocen et al. 2019). To meet the requirements when assessing the evidential weight of a data message or an electronic record (ACPO, 2007), competence of the investigator in mobile phones forensic is the key factor. Otherwise, the evidence may not pass admissibility test in the courts of law. Investigators should be trained on how to manipulate manually MPAs to effectively identify and extract evidence(s) from phones using digital forensic tools following digital evidence governing laws, preservation of digital evidences and maintaining chain of custody for them (Ademu & Imafidon, 2012).

In this study, most of the respondents (75%) were males because activities related to crimes are beloved to be of a masculine nature. The largest number of the respondents (44.4%) were in age group of 31–41 years, meaning that they are in the active working age. At least 80.6% of the respondents reported having undergone through a professional training whereas 19.4% had received no such trainings. Of the 36 respondents, only 38.9% had undertaken digital forensics training. Of the respondents reached, majority (86.1%) had no training in mobile phones forensics. Additionally, 50% of the respondents had no experience in mobile phones forensics, 22.2% reported to have at least 5 years of experience, more 22.2% had 1–2 years of experience and 5.6% have between 3–4 years of experience. These findings emphasize the need to put in place measures to train criminal investigators in Uganda.

Criminal investigators in this study were found to be averagely good at utilizing MPAs for criminal investigations. Particularly, call log registered the highest competence mean followed by mobile money transactions and then SMS. However, training on password removal and data recovery using forensic tools are required to enhance the use of mobile phones in crime control.

MPAs use as a potential source of incriminating evidence had an average response of 2.283, implying that they are used as a potential source of incriminating evidence for 1 to 3 of the ten files of criminal cases. For investigators to embrace mobile phones as potential source of evidence, some degree of apps competence is a prerequisite and this can only be achieved through training. The respondents agreed that Uganda’s delay to advance in mobile phone forensics is greatly affecting crime control effort. This is consistent with The Uganda Police strategic policing plan to, among other things, sustain the declining

trend of crime rates through strengthening of criminal investigator's capability to enhance application of ICT in crime reduction (Uganda Police Force, 2021).

The proposed application-based framework considers the process of criminal investigation to be initiated by suspicion/occurrence of a crime which is detected/reported to the Police by the local residents, local leaders or intelligence communicating through mobile phone networks. For effective crime reporting, this study recommends that the Police Force in addition to toll-free hotline and SMS should consider developing customized police mobile applications and sensitizing the public on how to use them through capacity building among crime investigators so as to curb mobile phone-related crimes in Uganda. Such a platform should allow all modes of phones to communicate with the police control centre. The platform may further allow the transmission of photographs, video and voice clips but only using smartphones.

Given the wider connection on the internet and increasing literacy rates in Uganda, using a mobile phone app (preferably WhatsApp since the platform allows transmission of multimedia) is a better option for timely crime reporting. The platforms should be used for community sensitization as well. This would be analogous to Agangiba and Agangiba (2013) framework for metropolitan crime detection and reporting which suggested a mobile communication framework based on the client server model, allowing both the police and the general public to interact more effectively with the help of a mobile application. Kenya's Hatari.co.ke which is used is web-based platform enable citizens to report various crimes by sending a text message containing the location and the type of crime being reported to a number, the message is displayed on the platform including a position on the map where it was reported from. Whereas it provides GPS, it only targets smartphones but the prospective TEXT-A-TIP is compatible with all modes of phones.

For collaborating evidence, investigators ought to consider preliminary examination of MPAs for evidence retrieval without Forensic Tools. Generally, cyber-attacks can primarily be identified from security settings of the phone. The Applications under emphasis shall depend on the crime at hand. Determining the type of network within which a mobile phone has functioned is essential prior to commencing the investigation. For serious crimes such as homicide, fraud, robbery, theft/burglary among others are subjected to sophisticated analysis using Forensic Tools by trained Forensic professionals. Wondershare, Dr. Fone and Whaspy are some of the forensic tools which are efficient and are not affected by screen lock. Smart Phone Forensic Professional (SPF Pro) and mobile Tracker Free are other perfect ones but only work on phones with unlocked screen. Most expert extraction is always done with the aid of the internet. The tools provide all operations including voice calls, SMS record and GPS, showing how the suspect moved while in possession of the mobile phone among others. This could improve on the current criminal investigation efforts in Uganda which entirely depend on network service providers.

For the proposed framework, the investigator summarizes the findings during the investigation to obtain information that can be used in case settlement. A report is written, accompanied by a description of the incident, evidence(s) obtained, findings data, relevant information and other supporting documents.

Several copies of the report can be made for different officers and archiving. The Expert or any other investigator presents the findings in the trial court.

Whereas this study proposes similar framework to communication framework of mobile solution for metropolitan crime detection and reporting (Agangiba & Agangiba, 2013), it possesses some unique components (such as using all types of phones, elaborate description of evidence collection, GPS tracking, community sensitization and extraction of collaborating evidence) that can enhance effective use of mobile phones in crime control. In addition, the framework accounts for the legal requirements for mobile phones forensics as per the Ugandan Law and the professional standard in general.

Conclusions

This study revealed that mobile phones are not often used as a potential source of incriminating evidence by criminal investigators in Uganda, East Africa. We found that criminal investigators depend on network service providers for evidence extraction and there is no evidence of forensic tools used. The study highlights that an extension of the study of crime with technological dimensions of disruptive technologies such as location-based MPAs in crime countermeasures. The proposed framework supports the notion that maintenance of mobile network infrastructure utilizing MPAs can be a useful and cost-effective crime reduction tool which is worth to be considered in the process of extending the government's efforts in curtailing crime in Uganda.

Abbreviations

Apps
Applications
CID
Criminal Investigation Department
MPAs
Mobile Phone Applications.
SMS
Short Message Services

Declarations

Ethics approval and consent to participate

Approval to carry out this study was granted by the Directorate of Graduate Studies, Research and Innovations of Busitema University to introduce the first author to the courts and police where data were collected. He also obtained an authorization letter from the University Security Officer and endorsement from Regional Police Commanders (RPCs). Ethics issues such as privacy and confidentiality of the respondents were ensured as in the questionnaire.

Consent for publication

Not applicable

Availability of data and materials

The datasets supporting the conclusions of this study are available from the corresponding author upon request.

Supplementary Materials

Supplementary File 1: Questionnaire used in the study.

Competing interests

The authors declare that there is no conflict of interest regarding the publication of this paper.

Funding

This research received no external funding.

Authors' contributions

JBW, GGO, DM, AEA, GO & TS designed the study. JBW collected and analyzed data. GGO, DM, AEA, GO, OB & TS provided analytical support. JBW, GGO & TO wrote the first draft of the manuscript. All the authors revised and approved the final manuscript.

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Figures

Figure 1

Map of Uganda showing the location of the study districts with other magistrate districts. Inset is the location of Uganda in Africa.

Figure 2

Conceptual framework for the relationship between the use of mobile phones and their application in crime control. **Source**: authors.

Figure 3

Distribution of competence in the use of mobile phone applications for criminal investigations in Eastern Uganda

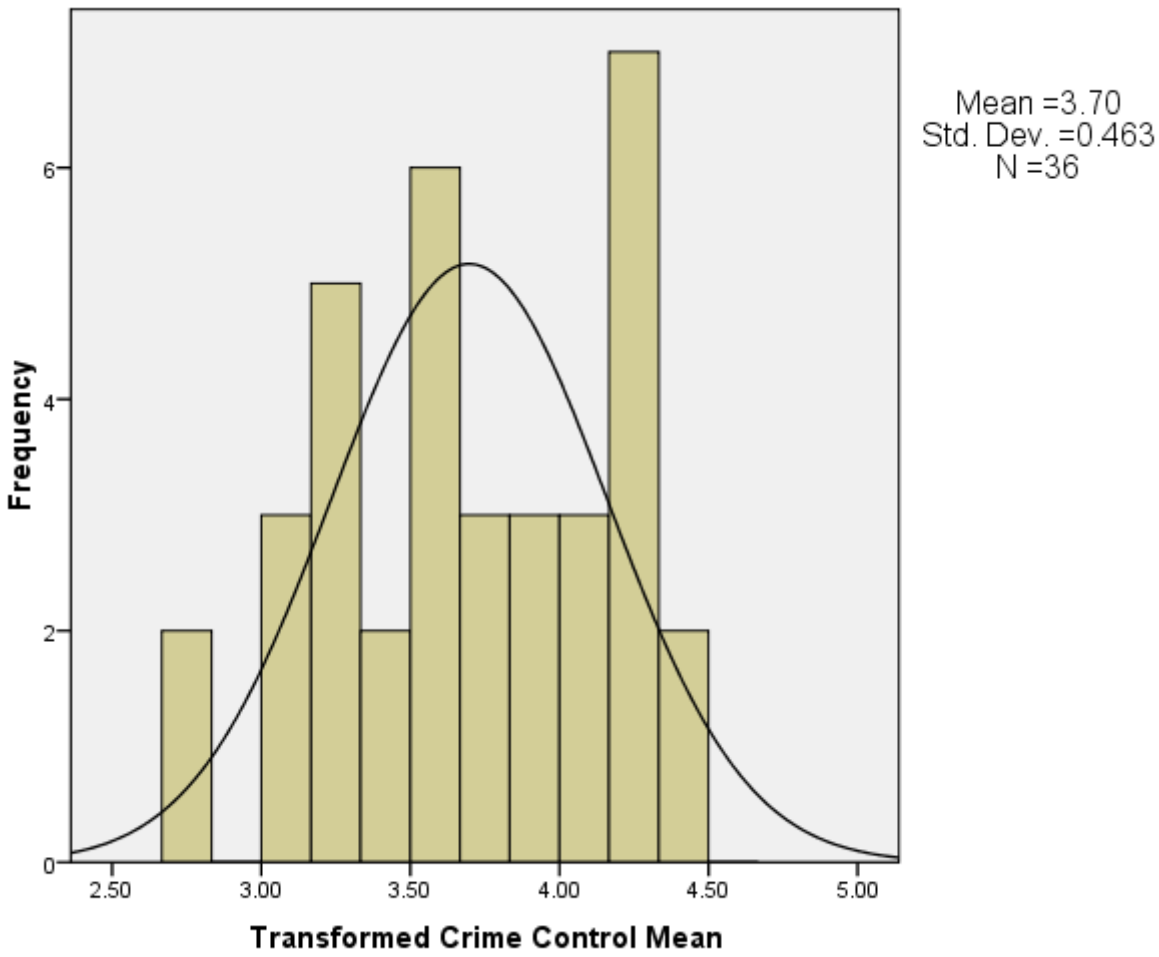

Figure 4

Distribution of crime control transformed mean responses

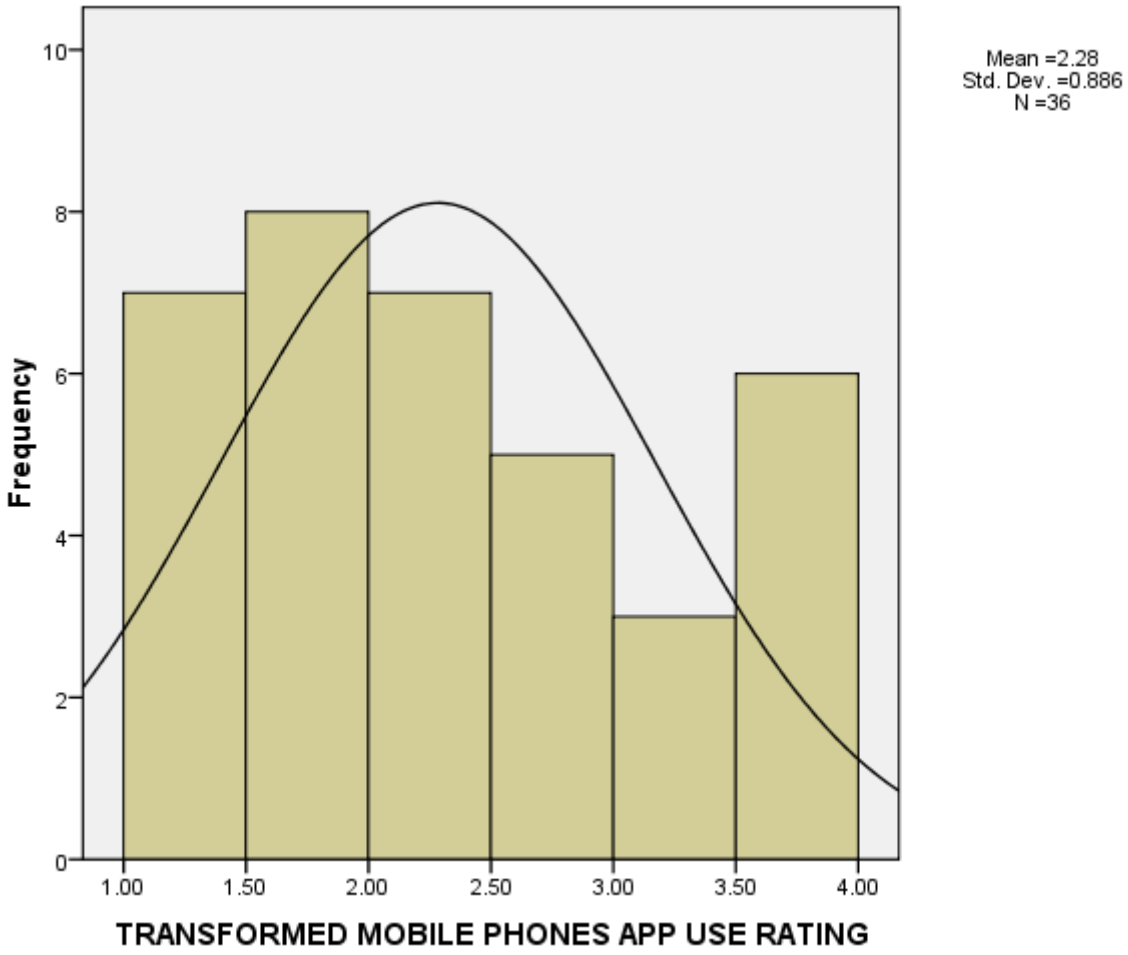

Figure 5

Distribution of transformed mean responses of mobile phone Apps usage

Figure 6

Distribution log of transformed mean responses of mobile phone apps use

Figure 7

An application framework for mobile phones in Uganda

Figure 8

The proposed application of mobile phones in crime control in Uganda.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryFile1.Questionnaire.docx