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INTRODUCTION

REVIEW OF LITERATURE

NEED/IMPORTANCE OF THE STUDY

STATEMENT OF THE PROBLEM

OBJECTIVES

HYPOTHESIS (ES)

RESEARCH METHODOLOGY

RESULTS & DISCUSSION

FINDINGS

RECOMMENDATIONS/SUGGESTIONS

CONCLUSIONS

LIMITATIONS

SCOPE FOR FURTHER RESEARCH

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APPENDIX/ANNEXURE

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CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–23

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- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, Kurukshetra University, Kurukshetra.

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- Garg, Bhavet (2011): Towards a New Gas Policy, Political Weekly, Viewed on January 01, 2012 http://epw.in/user/viewabstract.jsp

USERS' CONSCIOUSNESS AND PRACTICES REGARDING SMARTPHONE SECURITY THREATS, VULNERABILITIES AND SECURITY MEASURES: A RESEARCH IN THE TARKWA-NSUAEM MUNICIPALITY OF THE WESTERN REGION, GHANA

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ABSTRACT

Mobile phone; which in some few years past was nothing more than a call-making tool, and at best for text messaging, has evolved to be very powerful device, hence the modern name: Smartphone. Smartphone's unique computing capabilities, varied catalogue of software applications, fast connectivity, intuitive tendency and user-friendliness, blended with portability make it a fully-fledged miniaturized computer that fit into the user's pocket. Owing to the enormous functionalities and wealthy information a smartphone can hold, it has become an attractive mine field for attackers and malware creators. As smartphone gain unprecedented admiration and international usage statistics swells exponentially, hackers are enticingly lured to maliciously prey on the unsecured device of the uninformed user. This research focuses on smartphone user's consciousness towards mobile security threats, vulnerabilities and user's security culture and countermeasures taken to avert any mobile threat. The interpretation of results revealed that most of the smartphone users were not conscious of the need for security on their mobile handset nor do users enable the necessary security features.

KEYWORDS

mobile, smartphone, cyber security, vulnerabilities, countermeasures, mobile security, security threats.

I. INTRODUCTION

A. DEFINITION OF SMARTPHONE

Smartphone refers to the state-of-the-art cell phone device, distinguishable from the ordinary telephone by the integration of advanced features such as operating system to run software applications, wireless technology for connectivity, web browsers for internet accessibility, digital camera with video capturing capabilities and an embedded memory for storage [1].

Smartphone as "a mobile communication device is optimized in its specification and features to support one or more primary functions like music, video, gaming, pictures, browsing, mobile TV, navigation and messaging." Smartphones typically have larger displays, powerful processors, embedded memory, improved battery capacity and touchscreen for content manipulation and data input [2].

Smartphone is currently a fully-fledged miniaturized computer that fit into the user's pocket. Intended for making voice and video calls, web browsing, capturing videos and images, instant text messaging, playing built-in and downloaded games, listening to audio and watching videos, managing contacts, rendering social media applications, connecting to other devices via Bluetooth technology, mobile banking, storing personal data and a host of functionalities; smartphone has almost turned out to be an inseparable part of user's personal and professional lifestyle. It is becoming an intimate component of the digital ecosystem and has permeated the facets of modern lifestyle for millions of users around the world. Contemporary smartphones have improved capabilities, enhanced processing power, and unprecedented internet connectivity that make them to be virtually as resourceful as a computer [3].

Nevertheless, smartphones are open to security risk and security challenges that would yield undesirable results if left unattended to [4]. Hostile intruders and interlopers are relentlessly intercepting the device to gain access to sensitive information such as ATM codes, credit card pins, bank account numbers, login credentials, etc., that can lead them to steal elements of financial worth.

Furthermore, the smartness of the smartphone is displayed by the mobile applications it runs. These mobile applications have some mischievous ones which have malware embedded in it to spy on the user's call logs, browsing history, precise locations, and viewing private pictures or videos of victim's device.

There is therefore a need for defensive mechanisms to mitigate information leakage and data lost, protect the confidentiality and integrity of data, thwart the effort of ruthless spies from locating mobile devices, block unscrupulous intruders from accessing a locked phone, fish out malicious websites and emails, and remotely lock out phone thieves from cracking down the device for unsolicited information.

B. OBJECTIVES OF THE STUDY

The objective of this research is to evaluate user's awareness regarding smartphone security threats, vulnerabilities and to also appraise the countermeasures users take in the incidence of security threats. The specific objectives are:

1. To evaluate user's knowledge of smartphones security threats and vulnerabilities.
2. To analyze user's security culture and practices in the incidence of the security threat.

3. To propose efficient measures to protect the mobile device and its sensitive content

C. RESEARCH QUESTIONS

In realizing the purpose of the research, the following research questions are raised:

1. What is the level of importance that user's accord to the content or information stored of their smartphone?
2. Do smartphone users put in place authentication mechanisms or access control methods to restrict unauthorized access to their device?
3. Do smartphone users fully read and understand permissions that accompany mobile applications they download from the various mobile app stores?
4. Do smartphone users install security software on their device to detect, protect and offset any security threat?
5. Do smartphone users know the availability of anti-theft applications, locating tracking services or retrieval mechanisms that can be used to trail, wipe remotely or retrieve the device in case phone lost or theft?

D. IMPORTANCE OF THE STUDY

With virtually all financial businesses going mobile, social media applications via mobile device gaining unprecedented admiration, worldwide smartphone usage statistics swelling exponentially and hackers' skills growing to be more advanced, it is even more critical that mobile devices are appropriately provided the requisite security. Nearly every smartphone user stands a chance of being a prey of the malicious deeds of cybercriminals; consequently, the need for mobile security [5]. Keeping the user out of the darkness of ignorance of mobile security and enhancing the user's knowledge on mobile device security measures can greatly improve the compliance with effectual security practices to counterbalance any security threat to mobile devices [6].

II. RESEARCH REVIEW

A. MOBILE SECURITY THREATS AND CLASSIFICATION

Mobile security threat is a probable risk that might exploit a weakness in a system to violate security and consequently cause a possible mischief. The essential attractive entities for attackers of mobile devices are: the data on the device, the identity of users and the denial of service to user. [7]

Mobile security threats can be broadly classified as:

1. User-based threat vector
2. Application-based threat vector
3. Web-based threat vector
4. Network-based threat vector
5. Physical threat vector

User-based threat vector: The principal threat to the leakage of confidential and delicate material (images, videos, audio, etc.) on smartphones stems from user's sheer negligence and carelessness, rather than technical interloping [8]. Most users make their device an easy prey for attackers in their indulgence of unsafe behaviors such as not protecting the mobile device from unauthorized entry through access control mechanism (password, pattern or pin), ignorantly clicking on any link inserted in text messages or email from unknown sources, joining anonymous Wi-Fi networks and using free public Wi-Fi hotspots, not being particular about apps' permissions when installing apps and removing software restrictions on smartphone to evade security controls (Jail breaking or rooting). [9]

Application-Based Threat Vector: This threat resides in downloaded applications from mischievous websites or app stores. Some developers embed malicious codes into applications to fraudulently spy on users. Included in application-based threats are malware and spyware. *Malware* (shortened form of "Malicious software") executes its intended actions secretly while installed on smartphone without the user's awareness. It's mostly found in game demos and free apps. [10, 11]. *Spyware* is related to software that pops up advertisements (called *adware*) to generate a revenue pond for its creator. Information often aimed at by spyware includes call log history, received or sent text messages, user's precise location, browsing history, phonebook contact list, email's inbox or outbox. [12,13]. Recent report from Snoop Wall Mobile Security indicated that most flashlights on the Google Play Store are malicious and can access user's device storage and install additional backdoors or Remote Access Trojans (RATs). [14]

Web-based threat vector: This threat presents an incessant, relentless and persistent risk to mobile devices due to the fact that the device is continuously connected to the web. Some well-known major threats to smartphone via the web include: Phishing Scams (use of email or SMS to send illicit link, premeditated to trick receivers in given out passwords, pins, or useful information), Browser exploits [15] and Drive-By downloads (a misleading pop-up) [16] [17].

Network-based Threat Vector: Characteristically, smartphone supports cellular network (GSM) as well as local wireless networks (Wi-Fi and Bluetooth). These data transmission networks can horde various classes of threats such as Network exploits, Wi-Fi Sniffing [18] and Bluetooth network vulnerability [19] [20].

Physical Threat Vector: Possibly, the very lightness and portability of mobile phones makes them easily to be stolen or misplaced. This is the physical threat to the device. Stolen or misplaced smartphone also implies stolen or loss of sensitive data and information stored on the device. It is riskier, if the stolen or misplaced mobile device finds itself in the hands of an advanced attacker; slack security features of most mobile phones could be overpowered affording the attacker entry to any information stored [21] [22].

B. MOBILE SECURITY MEASURES

The risk of intruders interfering with mobile devices can be significantly reduced to barest minimum, if users are cautious to develop a security culture and apply proper security measures on their smartphones. Keeping the user out of the darkness of ignorance of mobile security and enhancing the user's knowledge through enlightenment can greatly improve the compliance with effectual security practices to counterbalance any security threat to mobile devices. The following tips can ensure maximum security on the device [23].

1. Securely lock mobile device with a PIN, pattern or password and set up a lock on the SIM card as well.
2. Install applications from only trusted app stores and toggle off the installation of application from "unknown sources" option in the security application settings menu.
3. Do not jailbreak, root or meddle with the mobile device software to evade its controls.
4. Remember to logout from websites initially signed in to transact business, shopping, or emailing services that requires user account.
5. Turn off Wi-Fi and Bluetooth when not in use. Also, do not transact business or shop online via free unsecured public Wi-Fi network.
6. Don't click on links or open attachments in emails or text messages from unknown and unsolicited sources.
7. Install mobile security software such as antivirus, spam filters and antispyware to safely protect the mobile device from the looming dangers of malware and spyware.

C. COUNTERMEASURES

A Countermeasure is an act, practice, or technique taken to neutralize the effect of a dangerous action. Generally used in Intrusion Prevention System (IPS), a "countermeasure is a defensive technology method used to prevent an exploit from successfully occurring once a threat has been detected" [24]. For maximum mobile security, the following countermeasures; which are also defense mechanisms should be adhered to. These include: countermeasures against misplaced or theft of mobile devices, countermeasures against malware infection and countermeasures against leakage of sensitive information [25]. These countermeasures are required to be proactive (i.e. putting up the necessary security measures in readiness for the risky action rather than waiting for the occurrence of the menace before acting.) or must be swift in response (i.e. the rapidness in reacting to a situation. In the occurrence of stolen phone, the victim must immediately go online and activate the anti-theft app or location tracking app installed on the phone). Some of the correct proactive and swift precautions may include:

a) Setting up a strong screen lock password to restrict unauthorized access [26].
b) Installation of Anti-theft and Lock Screen Protection Applications such as Lookout, Prey, Android Device Manager, Find My iPhone, Cerberus, etc. to locate misplaced or stolen device [27] [28].
c) Attachment of Owner's Information and activation of "the intelligent assistant" Siri on iPhone to assist in the returning of the device by an honest person who finds a misplaced device [29].
d) Keeping safely the smartphone's unique numbers: IMEI, serial number and model number for tracking and identification [30].

e) Installation of antivirus or anti-malware application to scan the device and fish out duplicitous software that may be inadvertently downloaded and installed on the handset.
f) Being cautious of repackaged and fake applications that mimic the original but are more likely to be malware or trojanized [31] [32]. A recent fake app, supposedly to be an antivirus, was "Virus Shield" misled a lot of users due to its professional appearance [33] and Flappy Bird; a favorite android game was feigned, trojanized and introduced to the app stores [34].
g) Patronizing the trusted app stores over third-party app stores [35].
h) Cautiously reading and comprehending app permissions, terms and conditions, end users license agreement and user's reviews and ratings before down-loading any app. [36].
i) Patronizing paid applications over supposedly free applications. Free applications appear harmless, but it could be a source of danger to user's privacy [37]. The ancient adage that "there's no such thing as a free lunch" seem to hold an element of truth. "If you are not paying for it, you're not the customer; you're the product being sold" [38]. Patronizing paid applications may reduce the lurking attack on user's information

III. RESEARCH METHODOLOGY

The research design used was both Quantitative and Qualitative Research inclined, which commenced by appraising related works and literature from journals, books, website, and reports. The quantitative phase was used in the data collection method, i.e. the use of questionnaire. The qualitative aspect was concerned with the subjective evaluation of respondent opinions to gain an essential understanding of the subject researched on.

The target population for this research was users of android and iOS powered smartphones within the Tarkwa-Nsuaem Municipal Assembly of the Western Region, Ghana.

Purposive or deliberate convenient sampling procedure was used for the research. This type of sampling technique involves a deliberate selection of particular components of the total population to represent the whole population, and inference and judgement made characterizes the whole. It is tagged convenient due to the ease of access during the selection.

The sample was 809 respondents of the 31,890 population who owned a mobile phone [39]. The sample was arrived at and adjusted from online sample size calculator with confidence level of 95% [40].

Data gathered from respondents was analyzed by using Microsoft Office Excel 2010. Pie charts and Bar graphs were used to graphically represent the data for easy judgement.

IV. RESULT ANALYSIS

FIGURE 1: BRAND OF SMARTPHONES USED BY RESPONDENTS

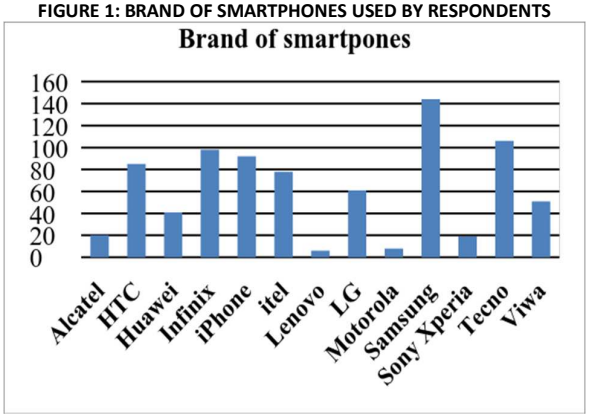


FIGURE 2: OPERATING SYSTEMS OF SMARTPHONES USED BY RESPONDENTS

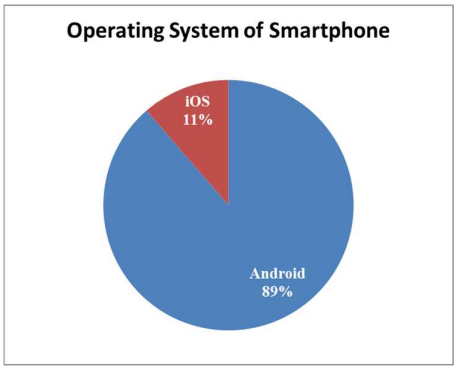


FIGURE 3: LEVEL OF IMPORTANCE OF INFORMATION ON RESPONDENT'S MOBILE DEVICE

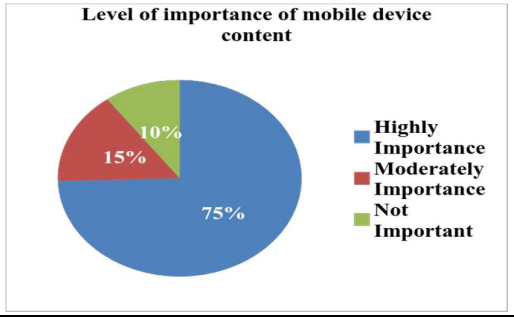


FIGURE 4: SCREEN LOCK METHODS USED BY RESPONDENTS

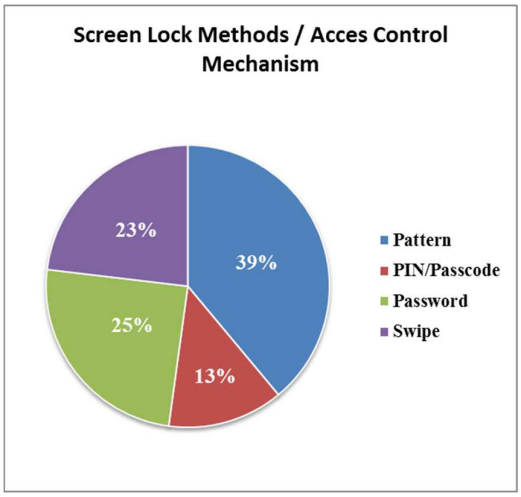


FIGURE 5: SIM CARD LOCK SET UP BY RESPONDENTS

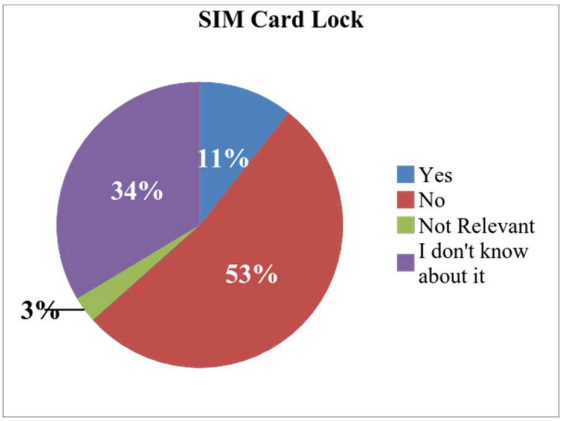


FIGURE 6: INSTALLATION OF ANTIVIRUS ON RESPONDENTS' SMARTPHONE

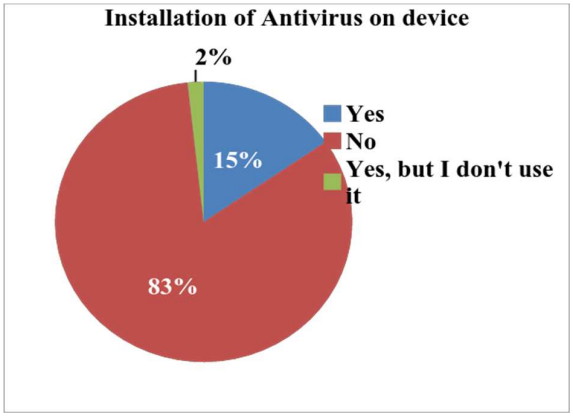


FIGURE 7: INSTALLATION OF APPS FROM UNKNOWN SOURCES

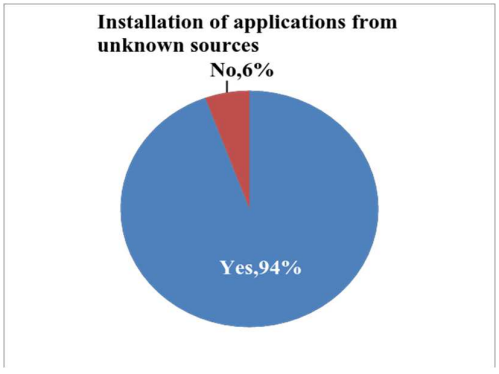


FIGURE 8: RESPONDENTS ATTITUDE TOWARDS APPLICATION PERMISSIONS AND PRIVACY POLICY

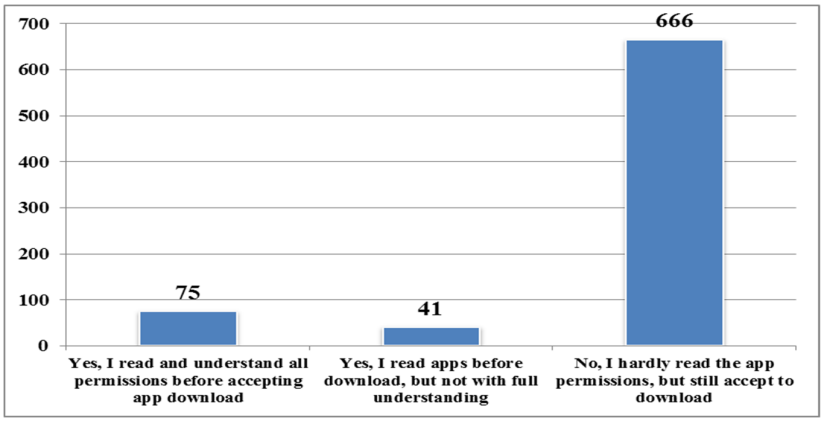


FIGURE 9: INSTALLATION OF ANTI-THEFT OR LOCATING TRACKING APPLICATION

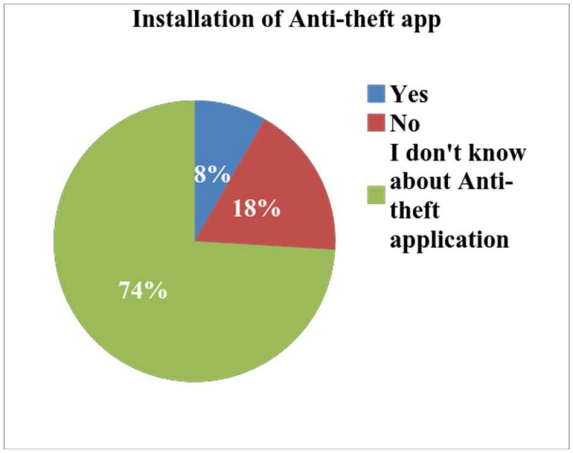
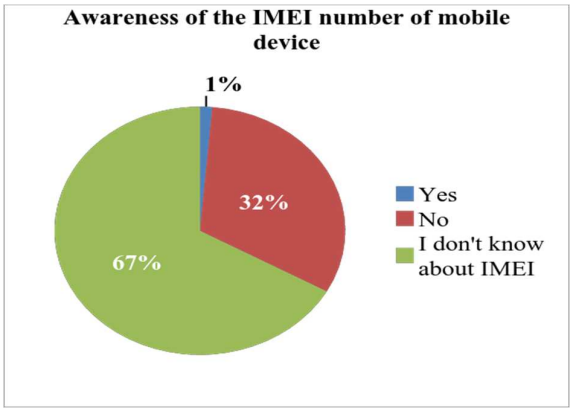


FIGURE 10: IMEI NUMBER WRITTEN DOWN BY RESPONDENTS



V. RESULT & DISCUSSION

The findings of this research were targeted at evaluating the security culture and consciousness of mobile security among smartphones users. The summary of the research is in answering the proposed research questions:

Research Question 1:

What is the level of importance that user's accord to the content or information stored of their smartphone?

Respondents scored that the content or information on their mobile device is of high importance and losing it will be ruinous (Figure 3). This feeling could be a reason for the greater number of respondents recorded for the use of access control mechanism to protect unauthorized entry into the device (Figure 4). Also, respondents had sensitive personal data on their device, alongside the contact list, other information such as ATM and email passwords, Bank Account Numbers, House Numbers, Index Numbers, Passport Numbers, Social Security Numbers, Staff/Employee and Voter IDs.

Research Question 2:

Do smartphone users put in place authentication mechanisms or access control methods to restrict unauthorized access to their device?

It was discovered that most respondents had an access control or authentication mechanism set up, with pattern drawing gaining the prevalence. However, locking of SIM Card was not encouraging (Figure 5). The screen could be locked securely, but the content of the SIM is not protected as just simply removing and inserting into another mobile device will expose all the useful data it contains.

Research Question 3:

Do smartphone users fully read and understand permissions that accompany mobile applications downloaded from the various mobile app stores?

Mobile applications in android has the capacity to read the phone contacts, call logs, content of device's memory, text messages and can determine the approximate or precise location of users of smartphone. Others can directly call phone numbers, send messages, and record audio without the user's intervention and explicit confirmation. But this activity of mobile application is made possible by the user's acceptance of permission during the download and installation of the

applications. Analysis from Figure 8 revealed that majority of the users of smartphones, during the download and installation from the app stores do not thoroughly read and fully understand the permissions but are quick to accept to host the application on their devices. This exposes the low, if not totally slack in security culture and practices on the part of the users.

Research Question 4:

Do smartphone users install security software on their device to detect, protect and offset any security threat?

Figure 6 shows users attitude towards the installation and running of antivirus application as security software to detect and protect their device from malware and any security threat. The figures portray that the use of antivirus among respondents was on the lower side. Particularly when majority of the respondent have toggled on the installation of applications from unknown source (Figure 7), an antivirus would have been a good option to scan for malware and ward off potential harmful applications.

Research Question 5:

Do smartphone users know the availability of anti-theft applications and location tracking services that can be used to trail or remotely wipe their confidential data on their device in case phone lost or theft?

The use of anti-theft applications among respondents of this research also registered low patronage. (Figures 9 and 10) painted the true portrait of respondent's awareness of the usefulness of Siri on iPhones, Android Device Manager, Anti-theft app and IMEI number. The ignorance of respondents stood at 55% did not know about Siri, 60% about Android Device Manager, 74% about anti-theft application and 67% about IMEI. Therefore, in the unfortunate event of misplacing of the smartphone or it being stolen, users are unable track the mobile device.

VI. CONCLUSION

It could be logically concluded that;

- Users treasure the content of their smartphone but lack the security attitude in protecting such delicate information. The deficiency in security awareness reflects respondent's hesitancy to neither install security applications such as antivirus and anti-theft app nor make use of android device manager and siri on their android and iPhone respectively.
- Though respondent's statistics on strong access control method was positively encouraging, there still remains an unsecured hole that is a threat to mobile security. Failing to set up SIM card lock, allowing installation from unknown sources and leaving Bluetooth on and in discoverable (visible) mode still make the device an easy prey to ruthless attackers.
- User's lack of security awareness was also seen in respondent's reluctance to read thoroughly the mobile application permissions and privacy policies that accompany applications.

VII. RECOMMENDATIONS

Based on research findings, the authors would like to recommend the following to smartphone users: -

- Smartphone users should be cautious and wakeful about mobile application permissions and the information the application would want to access before granting permission during installation.
- Smartphones manufacturers, telecommunication service providers as well as the mobile security agencies should enhance security awareness creation to inform users on the various security threats, as well as the security measures and defensive mechanisms needful for maximum protection of the mobile handset and its content against data loss.
- Smartphone users should take advantage of the value of mobile antivirus and anti-theft applications to counter potential mobile malwares and spywares as well locate, protect and restrict access to misplaced or stolen mobile handset.

VIII. SCOPE FOR FURTHER RESEARCH

It is hereby suggested that further studies and a nationwide survey be carried out on this research to ascertain the mobile security attitude of smartphone users as the usage of the device swells exponentially on the national or international level.

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