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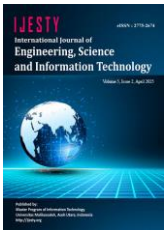

Measuring the Level of Security Awareness of Smartphone Users Among Universitas Malikussaleh Students Using the Fuzzy Analytical Hierarchy Process Method

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Abstract

Technology is developing rapidly; its benefits are manifold. The development of technology, especially smartphones, Has become a part of everyday life that cannot be distinguished anymore. The increasing number of smartphone users has also impacted the rising information security and privacy cases caused by a lack of awareness of spam, malware, and phishing. Many users upload personal information such as photos, phone numbers, and addresses without antivirus protection. This study aims to identify security and privacy challenges in smartphone use by measuring problems in the dimensions of attitude (knowledge), knowledge (attitude), and behavior (behavior). There are five focus areas: Backdoor, hardware, and AndroidOS, which is still low compared to applications and permissions. The method used the Analytical Hierarchy Process (AHP) with the Fuzzy concept to measure the level of information security awareness of Malikussaleh University students who use Android phones. The results showed that the overall level of understanding was good (80%). Although the attitude and behavior dimensions showed good awareness, the knowledge dimension was moderate. This may be why information security breaches still often occur among Android phone users. Faculty of Economics, Less Aware: 23 people Unaware: 1 person. Faculty of Social and Political Sciences, Less Aware: 24 people. Faculty of Teacher Training and Education, Less Aware: 21 people. Faculty of Law, Less Aware: 24 people. Faculty of Medicine, Less Aware: 27 people and Aware: 3 people. Faculty of Agriculture, Less Aware: 30 people. Faculty of Informatics Engineering, Less Aware: 70 people and Aware: 5 people. Total Awareness, Less Aware: 199 people, nine people, and Unaware: 1 person.

Keywords: *Smartphone, Information Security Awareness, Fuzzy, AHP.*

1. Introduction

Smartphones have become an inseparable part of everyday life. In 2021, the number of smartphone users globally reached around 3.9 billion. In Indonesia, with a population of 274.9 million, there are 170 million active social media users, equivalent to 61.8% of the total population in January 2021. This figure has increased by 10 million or around 6.3% compared to the previous year [1].

A system can be interpreted as a network consisting of various interconnected elements to achieve specific goals [2]. Given the challenges and risks that continue to grow, information security awareness is a dynamic process. Therefore, information security awareness needs to be measured and managed according to the developments and changes [3].

Security awareness includes rules designed to reduce incidents of information security breaches, either due to negligence or intentional actions (., 2020). Currently, smartphones are not only a means of communication but have also transformed into a part of a lifestyle and entertainment with various multimedia features that make them versatile devices or "all in one." devices (communication, multimedia, and entertainment) in a compact form [4].

AHP (Analytical Hierarchy Process) is a decision-making method that considers various criteria and alternatives, where the selection of other options is based on evaluating all relevant criteria (Saaty, 2004). Each criterion has a different level of importance, and alternatives have different preferences according to each criterion [5]. In this study, the best-packaged milk drink selection is based on two main variables: price and nutritional content. The process used in this study includes fuzzification, determining fuzzy rules, fuzzy inference using the Mamdani method, and defuzzification. The data analyzed were obtained through a direct survey conducted by researchers at one of the supermarkets in Makassar [6].

2. Literature Review

According to [2], a system consists of various interconnected elements to achieve predetermined goals. The understanding of a system is a profound and essential concept in the world of information technology. Meanwhile, according to [7], a system is a network of interrelated work processes that interact to achieve specific goals and carry out certain activities. Thus, understanding the system is key to understanding the complexity of information technology that continues to develop.
According to [8], a system can be explained as a harmonious combination of various elements, components, or variables that are integrated to form a complete unit. With this integration, the system can effectively achieve its goals and objectives. A deep understanding of combining elements in a system is key to understanding the complexity and success of implementing information technology in various contexts.
According to [9], information technology has become vital for organizations and companies. The role of information technology is not only limited to assistance in processing information but also aims to improve convenience, effectiveness, and efficiency in various tasks carried out by humans. Thus, implementing information technology is a necessity and a key to achieving success and competitiveness for organizations in this digital era.

2.1. FAHP

flexible to criteria and alternatives based on varying levels of confidence. In FAHP, the assessment value is usually given in the form of fuzzy numbers, such as interval numbers or triangular fuzzy numbers, which are then used to calculate the relative weight of each criterion and alternative. Fuzzy Analytical Hierarchy Process (FAHP) is a breakthrough methodology that combines the advantages of the AHP method with fuzzy concepts for more sophisticated ranking and more efficient aggregation. FAHP can overcome the weaknesses of AHP, especially in handling more complex subjective criteria. By utilizing fuzzy set theory, FAHP allows the measurement of aspects involving human subjective judgment more accurately and informatively through language or linguistics.

2.2. Smartphone

Smartphones are an evolution of mobile phones that are enhanced with additional features and facilities to become versatile smartphones [10]. Smartphones offer features beyond the basic ability to make phone calls. Although the term "smartphone" can be applied to various types of phones, smartphones are generally known as mobile devices with more capabilities than just regular phones. Over time, the concept of smartphones has continued to evolve into increasingly sophisticated and multifunctional handheld devices.

2.3 Information Security Awareness

Data security is an effort to protect data and essential parts, such as the construction and equipment used to store and send data (Whitman and Mattord, 2011). The possibility of information security can be described in four perspectives: exceptionally fundamental security as a shared opportunity versus security as a careful asset, assurance as the need to limit access, and security as the ability to obtain individual information. (Jeff Smith, Dinev, and Xu, 2011).

3. Methods

The type of research conducted is qualitative research, where data is obtained through the distribution of questionnaires. This study includes 42 questions about information security awareness and 13 questions regarding privacy awareness to test attitudes, knowledge, and behavior in Android smartphones. Some questions are answered on a 3-point scale, namely agree, do not know, and disagree (attitude and knowledge dimensions), while others only require answers that agree or disagree (behavior dimension). Examples of questions asked can be seen in Table 1. The questionnaire was distributed online. Some questions are answered on a 3-point scale, namely agree, do not know, and disagree (attitude and knowledge dimensions), while others only require correct answers wrong (behavior dimension). Examples of questions asked can be seen in Table 1. The questionnaire was distributed online

Table 1. Research dimensions

Question	Answer	Dimensions
Attitude	Is your Smartphone experiencing a Backdoor attack that allows attackers to access and steal personal data?	• True • False • Don't know
Knowledge	I understand that smartphones running the Android operating system are at risk of backdoor attacks that could give attackers access to users' personal information.	• True • False • Don't know
Behavior	I used to take precautions against backdoor-based attacks on my Android smartphone.	• True • False

To test the validity of each item in the questionnaire, the author uses the Pearson Product Moment correlation, where each item with a correlation coefficient equal to or more than 0.3 is valid. For reliability testing, the author uses the Fuzzy Ahp method. The weighting is determined using the analytical hierarchy process (AHP) [11]. The AHP approach uses pairwise comparisons to provide subjective evaluations of factors based on the considerations and opinions of management professionals. Each dimension has a weight that will be used to calculate the awareness score. The weights are defined in Table 2. as follows.

Table 2. Dimensional weighting

Dimensions	Weight
Attitude	20
Knowledge	30
Behavior	50

The framework of this study uses the Krueger and Kerney (2006) model, which adapts the theory of social psychology and proposes three components to measure the favorable or unfavorable way toward a particular object. These components are used to develop three dimensions: knowledge, attitude, and behavior. The knowledge dimension is used to determine the user's knowledge. The attitude dimension is used to determine the user's attitude, and the behavior dimension is used to determine what the user can do. The framework of this study refers to the Krueger and Kearney (2006) model, which adapts the theory of social psychology in measuring favorable or unfavorable responses to an object. This model includes three main components, knowledge, attitude and behavior, which are used to develop three measurement dimensions.

The knowledge dimension aims to identify the level of user knowledge. In contrast, the attitude dimension is used to understand the user's attitude, and the behavior dimension focuses on actions that the user can take. Each of these dimensions is then categorized into Five focus areas related to information security and three focus areas of privacy. The method used in this study was adopted from the Krueger and Kearney model, as shown in Fig 1.

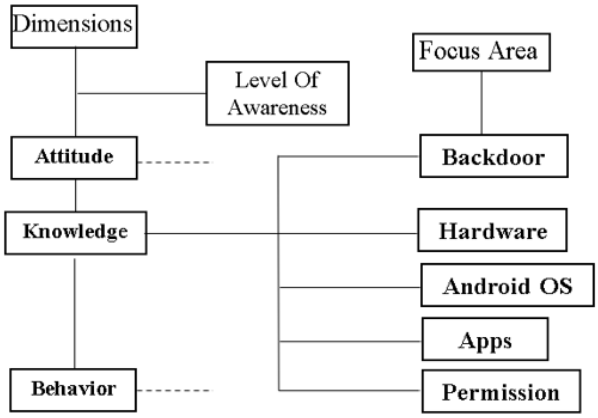

Fig 1. Information security awareness measurement framework

The calculation is divided into five stages: summing the respondents' answer scores to the questions for each focus area in each dimension; calculating the awareness score for each focus area in each dimension; calculating the total awareness in the focus area; calculating the total awareness of the dimensions; and calculating the overall awareness score and the conclusion of the security comparison between each faculty. For each emphasis area in each dimension, the respondents' scores on the questions are summed to create the first stage using equation (1).

$$JNJ = NJ1 + NJ2 + NJ3 + \quad + NJn \tag{1}$$

Description:
JNJ : Total Value of Respondents' Answers
NJ : Respondent's Answer Value
N : Division Of Questions For Each Focus Area

$$TJTN = JNJ1 \quad + JNJ2 \quad + JNJ3 \quad + \quad + \tag{2}$$

$$\frac{JBPi}{10} \qquad \frac{JBPi}{10} \qquad \frac{JBPi}{10} \qquad \frac{JNJnJBPi}{10}$$

$$NKAF = TJTN\ JR\ X\ 100 \tag{3}$$

The awareness value of each focus area on each dimension is then determined in the second step using equations (2) and (3). Calculations are carried out for each dimension to facilitate data analysis and prevent data from piling up on one sheet or too much.
TJNJ : Total Score of Answers from All Respondents
NKAF: Focus Area Awareness Score in Each Dimension
$JNJn$: Total Score of Answers from Nth Respondent
JBPi : Total Weight of Questions from Ist Focus Area
JR : Number of Respondents.

The third stage then involves using equation (4) to determine the overall awareness value for each focus area. The range of overall awareness values in percent is 0 to 100.

$$TNKAF + (\ NKAF1\ X\ 0{,}3) + (\ NKAF2\ X\ 0{,}2) + (\ NKAF3\ X\ 0{,}5) \tag{4}$$

Description:
TNKAF: total awareness value for each focus area

$NKAF1$: awareness value of focus area on dimension 1 (Knowledge)
$NKAF2$: awareness value of focus area on dimension 2 (Attitude)
$NKAF3$: awareness value of focus area on dimension 3 (Behavior)

$$TNKD = \frac{(NKD1 + NKD2 + NKD3 + NKD4 + NKD5)}{5} \quad (5)$$

Description:
TNKD : total awareness value for each dimension
$NKD1$: awareness value of focus area 1 (Backdoor)
$NKD2$: awareness value of focus area 2 (Hardware)
$NKD3$: awareness value of focus area 3 (Android OS)
$NKD4$: awareness value of focus area 4 (Apps)
$NKD5$: awareness value of focus area 5 (Permission).

The fifth stage involves using equations (6), (7), and (8) to calculate the total awareness value as a consequence of the security awareness value of E-Wallet users. The range of the total awareness percentage is 0 to 100.

$$TNKD = \frac{(TNKAF1 + TNKAF2 + TNKAF3 + TNKAF4 + TNKAF5)}{5} \quad (6)$$

$$TNKAF + (TNKD1 \times 0,3) + (TNKD2 \times 0,2) + (TNKD3 \times 0,5) \quad (7)$$

$$NKS = RTNKAF + RTNKD2 \quad (8)$$

Description:
NKS : overall awareness score
RTNKAF : average total awareness score for each focus area
TNKD : average total awareness score for each dimension
$TNKAF1$: total awareness score for focus area 1 (Backdoor)
$TNKAF2$: total awareness score for focus area 2 (Hardware)
$TNKAF3$: total awareness score for focus area 3 (Android OS)
$TNKAF4$: total awareness score for focus area 4 (Apps)
$TNKAF5$: total awareness score for focus area 5 (Permission)
$TNKD1$: total awareness score for focus area on dimension 1 (Knowledge)
$TNKD2$: total value of awareness of the focus area on dimension 2 (Attitude)
$TNKD3$: total value of awareness of the focus area on dimension 3 (Behavior)

By adopting the Kruger and Kearney model in this study, a value will be determined from calculating the level of awareness that can represent the level of understanding of smartphone users as a whole, both research respondents and individuals and groups of individuals.

Information was collected from respondents who completed the survey. Data cleaning must be carried out first; then, the analysis process can be continued. Data cleaning attempts to eliminate information that shows duplication or that the same information has been entered more than once. In addition, data cleaning attempts to eradicate information that does not meet the research requirements for respondents.

4. Results and Discussion

Respondent characteristics were obtained from the questionnaire results distributed on various social media platforms that focused on Malikussaleh University with two characteristics as identities for each respondent, including Gender and Faculty.

Table 3. Respondent characteristics

Characteristics	Amount	Percent
Gender		
Male	74	36,6 %
Female	129	63,5 %
Faculty		
Engineering	61	30,0 %
Fissip	23	11,3 %
Economics	24	11,8 %
Law	23	11,3 %
FKIP	20	9,9 %
Agriculture	27	13,3 %
Medicine	25	12,3 %

4.1. Respondent Gender

There were 74 male respondents, or 36.5% of the total, and 129 female respondents, or 63.5% of the total. This shows that the number of female respondents is more than male.

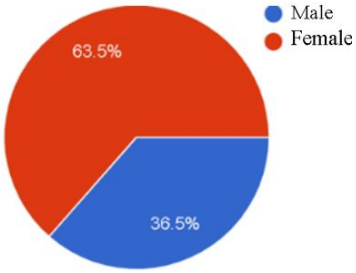

Fig 2. Percentage graph of respondent gender

The following graph shows that the highest percentage is in the engineering faculty, with a rate of 30%, while the lowest is in the FKIP faculty, which is only 9.9%.

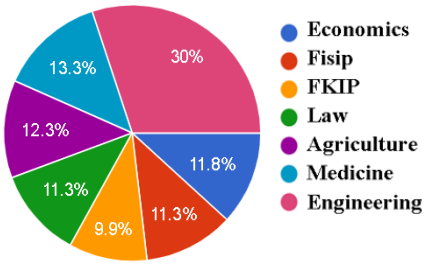

Fig 3. Percentage graph of respondent faculties

In Table 4.2 above, Smartphone Use at Malikussaleh University received an awareness score of 80, which is considered an average value in this study. The average figures for knowledge, attitude, and behavior dimensions range from 74 to 89. The hardware and permission focus scores range from 76 to 89 in the five focus areas. Thus, although security awareness related to the hardware and Permission focus areas is good and needs to be maintained, the Backdoor, Android OS, and Apps focus areas get a score of 47 to 88. This means that security awareness related to the Backdoor, AndroidOS, and Apps focus areas is considered quite good, but there is still room for improvement

4.2. Score Calculation

The calculation of the security awareness score of Smartphone users in the Malikussaleh University environment is shown in Table 4. below. The final overall security awareness score is obtained from the sum of the values for each dimension and area of emphasis.

Table 4. Respondents' Awareness Score Results

Focus area	Knowledge (30)	Attitude (20)	Behavior (50)	Total Awareness/Focus Area
Backdoor	74	78	99	84
Hardware	76	79	89	81
Android OS	74	79	79	77
Apps	75	79	87	80
Permission	76	76	88	80
	75	78	88	**80**

The use of smartphones at Malikussaleh University scored 80 for its awareness value, which is considered an average number in this study. The average number for each dimension of knowledge, attitude, and behavior also has a value between 74 and 89; from the five focus areas, only the hardware and Permission focus areas get a score with a score range of 76 to 89.

Table 5. Male awareness scores

Focus area	Knowledge (30)	Attitude (20)	Behavior (50)	Total Awareness/Focus Area
Backdoor	75	79	87	80
Hardware	78	77	88	81
Android OS	74	79	79	77
Apps	78	78	86	81
Permission	79	79	86	81
Total dimensional awareness	75	78	85	**80**

The score of 80 is obtained from the male perspective in Table 5. This is converted into an average value from each dimension of knowledge, attitude, and behavior from the five focus areas of Hardware, Apps, Backdoor, Android OS, and Permission. The awareness category has an average value of 78 to 88. In other words, security awareness related to the focus areas of Apps, Backdoor, Android OS, and Permission. is already good and needs to be maintained for its awareness value. At the same time, the focus areas of Backdoor and Android OS get a good category. Although there are still some, there is still an opportunity to improve the value of awareness.

Table 6. Women's awareness scores

Focus area	Knowledge (30)	Attitude (20)	Behavior (50)	Total Awareness/Focus Area
Backdoor	73	76	87	79
Hardware	74	78	87	80
Android OS	74	77	77	76
Apps	72	77	86	78
Permission	73	77	87	78
Total dimensional awareness	75	78	88	**80**

In Table 6, the average score for the awareness value of female respondents is 80. From the dimensions of knowledge, attitude, and behavior, the average value is 72 to 88. The five areas of knowledge focus, namely Hardware, Apps, Backdoor, Android OS, and Permission, show a reasonably good category but still have the potential to be improved. The difference in overall scores between men and women shows a significant difference. Based on the overall total based on the focus areas of Backdoor, Hardware, Android Operating System, Applications, and Permissions, men's scores tend to be higher than women's.

Table 7. Faculty Level Awareness

Focus area	Knowledge (30)	Attitude (20)	Behavior (50)	Total Awareness/Focus Area
Total Awareness/Dimension Faculty of Engineering	75	76	85	**78**
Awareness/Dimension Faculty of Social and Political Sciences Total	**67**	**67**	**76**	**70**
Total Awareness / Dimension Faculty of Teacher Training and Education	68	69	77	**71**
Faculty of Teacher Training and Education Total Awareness/Dimension	69	74	80	**74**
Faculty of Economics Total Awareness/Dimension Faculty of Law	68	71	79	**72**
Total Awareness/ Dimension Faculty of Agriculture	70	71	76	**72**
Total Awareness/Dimension Faculty of Medicine	70	72	79	**73**

5. Conclusion

1. Results at Malikussaleh University showed an average of 74 respondents, with 36.5% male and 63.5% female.
2. Respondents' average level of knowledge awareness was 75%, awareness in attitudes reached 78%, and behavior reached 88%, with total awareness of respondents reaching 80%.
3. Level of awareness based on gender. For male respondents, the average level of knowledge awareness reached 75%, awareness in attitudes at 78%, and behavior at 85%, with a total awareness reaching 80%. Meanwhile, for female respondents, the average level of knowledge awareness reached 75%, awareness in attitudes at 78%, and behavior at 88%, with a total awareness reaching 80%.\
4. Level of awareness based on faculty. The Faculty of Engineering has an average knowledge of 75%, awareness in attitudes reaching 76%, and behavior reaching 85%, with a total awareness of 78%. In FISIP, the average knowledge reached 67%, awareness in attitude at 67%, and behavior at 76%, with a total awareness of 70%. FKIP showed an average understanding of 68%, awareness in attitude of 69%, and behavior of 77%, with a total awareness reaching 71%. The Faculty of Economics had an average knowledge of 69%, awareness in attitude of 74%, and behavior of 80%, with a total awareness of 74%. The Faculty of Law showed an average knowledge of 68%, awareness in attitude of 71%, and behavior of 79%, with a total awareness of 72%. The Faculty of Agriculture had an average knowledge of 70%, awareness in attitude of 71%, and behavior of 76%, with a total awareness of 72%. Meanwhile, the Faculty of Medicine showed an average knowledge level of 70%, an awareness of attitude level of 70%, and a behavior level of 79%, with a total awareness level of 73%.

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