An evaluation of authentication methods for smartphone based on users’ preferences

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Abstract. This study discusses about smartphone screen lock preferences using some types of authentication methods. The purpose is to determine the user behaviours based on the perceived security and convenience, as well as the preferences for different types of authentication methods. Variables used are the considerations for locking the screens and the types of authentication methods. The population consists of the smartphone users with the total samples of 400 respondents within a nonprobability sampling method. Data analysis method used is the descriptive analysis. The results showed that the convenience factor is still the major consideration for locking the smartphone screens. Majority of the users chose the pattern unlock as the most convenient method to use. Meanwhile, fingerprint unlock becomes the most secure method in the users’ perceptions and as the method chosen to be used in the future.

1. Introduction
In 2014, smartphone users in Indonesia increased for more than 70% compared to the previous period [1]. Smartphone is used not only as a communication device (to make phone calls and send messages) but also for storing personal data, some of which are sensitive to be accessed by others. Therefore, the smartphone manufacturers provide some security features to protect smartphones from unauthorized accesses. The operating systems on smartphones such as Android, Blackberry OS, iOS, and Windows Phone provide the unlock screen mechanism (as the security system) with various types of authentication methods that are different on each platform [2].

Concerns about the security and privacy of personal data have been increased, but it is not offset by the behavior of the smartphone users. In a previous study, it was found that more than half of the respondents said they did not use a password or PIN to lock their smartphones or tablets, even 44% of the users who did not lock their mobile devices stated that using a password was “too difficult” [3]. It is also supported by another study which discovered that the users did not lock their devices because of the matter of convenience, in addition the users also felt that protecting the data stored on their smartphones are not necessary [4]. Another previous study found that the most prevalent authentication mechanism used in smartphones was the PIN even though the users did not perceive PIN as a highly secure method [5]. Despite this fact, they will still use this method in the future since it is a relatively convenient authentication method [5]. Those studies demonstrate that convenience beats security. Convenience is still more being a priority than the security because users tend to use a product or service if they feel convenient in using it [3].

In the other hand, there are differences in the behaviors and characteristics of users for different smartphones. Companies wanting their products and services to be widely used would need more information on the use of smartphones and the users’ behaviors in order to be able to create strategies
in a variety of mobile devices [6]. The use of the authentication methods on smartphones is important because among the factors which are considered when selecting a handset is the security features which occupy the second place after battery life [5]. By knowing the characteristics of the users, smartphone companies will be able to customize the types of authentication methods offered to the users based on their needs.

Based on those backgrounds, it is important to describe users’ response regarding the selection and preferences of the authentication method. Therefore, the main research questions are:

1. What are the users’ perceptions regarding the security and convenience in selecting the authentication methods?
2. What are the users’ preferences among several authentication methods to be used currently and in the future?

2. Literature Review

2.1. Information Security

The first and probably the most important aspect of information security is the security policy. If the information security were a person, the security policy would be the central nervous system [7]. To protect the information resources, some controls that support the organization security objectives are needed. Security controls can be grouped into four categories, namely physical control, access control, communication control, and application control [8]. If the security policy was the central nervous system of information security, the access control would be the skin [7]. This research only discusses about the access control that limits the unauthorized individuals from using the information resources by applying several authentication methods.

2.2. Authentication Method

Authentication is the process for determining whether a person or a certain device is allowed to access a system, application, and specific data contained in a device or not [2]. Authentication schemes can be broadly classified into four main categories [7][8]:

1. Knowledge-based authentication; based on the knowledge of "what you know" (single factor). Example: PIN and Password
2. Token-based authentication; based on the ownership of "what you have" (two-factor). Example: Credit Card
3. Biometric authentication; based on the physical state of a certain "what you are" (three factors). Example: fingerprint, face unlocks
4. User doing-based; based on the physical acts or “what you do”. Example: keystroke pattern, voice unlock

This study does not consider token-based methods because the hardware constraints of mobile phones do not favor them at the moment [5]. It does not consider mobile phones used as tokens as well.

2.3. User Perceptions for Using Authentication Method

There are two possibilities of behaviour in using the security features on a smartphone, doing locking screen and not-doing locking screen. This locking behaviour includes a variety of reasons. Based on the previous studies about security and privacy, some popular reasons for using or not using a screen lock consists of [4]:

- Prevent strangers from using smartphone
- Control when other people (friends or family) use the smartphone
- It is easy to do, never thought about why I use one
- Other people I know use a security lock
- In an emergency, others can use smartphone
- It’s too much of a hassle
• No one would care about what’s on my smartphone

The security mechanism is considered as a tool that provides protection against threats [9]. Like other products or services, when using this mechanism, saving time and effort also become the key factors that determine the convenience of usage [10]. Preference category (by comparing the authentication methods) in the study by Ben-Asher et al. [5] consists of three variables:

a. Perceived Security : users’ perceptions about the protection to their personal information in the smartphone that is provided by an authentication method
b. Perceived Convenience : users’ perceptions about the easiness, simplicity and robustness of an authentication method
c. Possible Future Use : likelihood of using an authentication method in the future

3. Methodology

This study employs a descriptive approach with the smartphone users as the population. Data was collected using questionnaires which were distributed to the users via online and offline. Non-probability samples used in this research is the convenience sampling. Samples were taken in accordance with the population and at the most easily accessible by researchers. The total samples used were 400 smartphone users that had responded to the questionnaire. After the data was collected, it was edited and organized in the forms of tables and charts.

The questionnaire consists of several sections. In the first section, the respondents must fill in with the demographic data. Then, those who lock their smartphone screens have to answer the question: "what method do you use to unlock your smartphone screen?". They also have to include the reasons why they use such method by choosing multiple choice questions provided with these options:

a. because the method provides sense of security
b. because the method is convenient to use
c. both
d. I do not know

The final section asks all respondents (both with the screen locked and unlocked) to choose one type of the authentication methods that is considered to be the most secure, most convenient and a method to be used in the future.

4. Results and Discussions

4.1. Respondents Profile

This study uses a non-probability sampling, so the proportion in each category is not specified. The result is calculated based on responses from 400 respondents. Majority of the respondents were female (58,5%), aged between 18 to 24 years old (72%) and high school graduates (46%). Most of the respondents were students (51%) and using Android as the operating system (75%).

The survey found that 329 respondents (82%) chose to lock their smartphone screens, and 71 respondents (18%) chose not to lock them. Most of the respondents who did not lock their phone screens were the Android OS users (70%). However, if it is clustered into its operating system, the Android users who did not lock the screen were only about 18%. Meanwhile, the BlackBerry OS users had the highest ratio (33%) and the iOS users had the lowest (9%). It can be interpreted that among the respondents who used the same platform, the BlackBerry users is the group which uses the least of authentication methods to protect their smartphone’s screens. Another result shows the respondents of 18-24 years of age are the largest group (46 of 71 users) that did not protect their phones since they are also the majority group in this research. On the other hand, the users of >45-year-old group who did not lock their phone’s screens have the highest ratio (85%). The result details are shown in Table 1.
4.2. Motivation For Locking (or not) Smartphone Screen

In this research, the respondents were also asked about the reasons why they chose to use or not use the unlocking screen methods in their smartphones. Some options provided in the questionnaire are based on the popular reasons for users in locking their smartphones referring to the previous study by Egelman [4]. The result is shown in Figure 1 and Figure 2.

![Figure 1. Motivation for Locking Screen](image)

**Legend:**
1. Red circle: Prevent strangers from using my smartphone (if it is stolen, lost or accessed by unknown people)
2. Green circle: Control when other people use my smartphone (from people surrounding like family and friends)
3. Blue circle: It’s easy to do, I’ve never thought about why I use one
4. Purple circle: Other people I know use a security lock
5. Orange circle: None of the above

### Table 1. Demographics of Respondents

| Factor       | Variable       | Total of Respondents |
|--------------|----------------|----------------------|
| Gender       | Male           | 166                  |
|              | Female         | 234                  |
| Age          | 18-24          | 288                  |
|              | 25-34          | 85                   |
|              | 35-44          | 20                   |
|              | above 44       | 7                    |
| Education    | High School    | 184                  |
|              | Diploma        | 50                   |
|              | Bachelor       | 147                  |
|              | Master         | 17                   |
|              | Doctor         | 2                    |
| Occupation   | Students       | 204                  |
|              | Private Employees | 112             |
|              | Teacher/Lecturer | 10               |
|              | Civil Servants | 24                   |
|              | Entrepreneur   | 21                   |
|              | Unemployment   | 15                   |
|              | Others         | 14                   |
| Operating System | Android | 300                  |
|              | iOS            | 68                   |
|              | BB OS          | 24                   |
|              | Windows        | 8                    |
As shown in Figure 1, there are intersections of answer sets because the respondents could choose more than one option. The result shows that most of the users apply an authentication method for unlocking their smartphone’s screens to prevent strangers from using their phones and also to control other people who use them. Both of these answers have something in common which is to restrict the access of others to the mobile phones. This result is similar with the previous study that the main reason why users did the screen locking was to prevent unauthorized access from strangers [4]. Furthermore, there are a lot of users who use an authentication method because the feature is easy to use, instead of protecting their data. The least chosen answer is because people around them are using such methods.

![Figure 2. Motivation for Not Locking the Screen](image)

Legend:
1. Red circle: In an emergency situation, others can use my smartphone
2. Green circle: It’s too much of a hassle
3. Blue circle: I don’t care about what’s on my smartphone
4. Purple circle: None of the above

People who did not use any authentication method for unlocking their device also have some reasons as shown in Figure 2. The result indicates that some respondents still prioritize convenience while using their smartphones without having to repeatedly perform complicated authentication process. In this research, the reason “as a precaution in emergencies” becomes the most chosen reason followed by the inconvenience problem. This result is slightly different from the previous study by Egelman [4] that found the problem of emergency was in the last rank of reasons chosen by the users who did not lock their phone’s screens. Some users still consider that using the method of authentication is too complex. There are also a few people who have other reasons outside the given options. Furthermore, only about 10% from 400 respondents who do not really care about protecting the data in their smartphones, either those who use an authentication method or not.

These results illustrate that smartphone users are more aware about information security issues. Nevertheless, the convenience problem still becomes one of the considerations that drives the users to use any access control to their smartphones, especially in locking the screen.

4.3. Consideration of Security Factor and Convenience Factor

In this section, the total respondents to be further analyzed are only 329 of the 400 respondents. 71 other respondents did not lock their smartphone screens so that the respondents could not provide feedbacks on the authentication methods used and the reasons for using such methods. Result about the reasons why the users apply the authentication methods is shown in Figure 3.
In general, most respondents (116 people) use an authentication method to lock their smartphone screens for the reason that it provides convenience (only). However, the result also shows that giving security is another important reason that received high response. This indicates that the respondents understand that choosing a method which can provide data protection is also a major goal for locking the smartphone screens.

The high response to both aspects of the security and convenience is contributed by 101 respondents who chose this reason. It indicates that 30.7% of the respondents felt that the use of authentication methods provided convenience in use and sufficient protection for their data at the same time. Meanwhile, only 13 of the 329 respondents did not know the reason for choosing the authentication method being used. It indicates that only a few users do not really understand the importance of safety and convenience when choosing a method of authentication. It is also an indication that the authentication method being used did not provide convenience and protection of data (security) as how the users expected.

Based on the results, the reasons for using a method do not have the same proportion to each type of authentication method. In other words, although convenience was the most selected reason by the users, not every method chosen was for the matter of convenience. For more details it can be seen in Table 2. The reason for using PIN and password is because these methods provide a sense of security, while the reason for using pattern and face unlocks is because they are more convenient to use. And, the reasons why the users apply fingerprint and voice unlocks are because these methods are both secure and convenient.

Table 2. The Reason use of Authentication Methods

| Authentication Methods | The Reason Use of Such Methods | Total |
|------------------------|--------------------------------|-------|
|                        | Because the method provides sense of security | Because the method is convenient to use | Both (secure and convenient) | I don’t know |
| PIN                    | 33%                            | 31%   | 30%   | 6%    | 100% |
| Password               | 22%                            | 23%   | 8%    | 8%    | 100% |
| Pattern                | 22%                            | 43%   | 33%   | 2%    | 100% |
| Face Unlock            | 50%                            | 50%   | 0%    | 0%    | 100% |
| Voice Unlock           | 0%                             | 0%    | 100%  | 0%    | 100% |
| Fingerprint            | 25%                            | 25%   | 45%   | 5%    | 100% |
4.4. User Preferences for Authentication Methods

This section will explain the results of user preferences for different types of authentication methods. All respondents were asked to select one type of authentication methods that is considered to be the most secure, convenient, currently used and will be used in the future. The results shown in Figure 4 and Figure 5.

Figure 4 shows that the most widely used authentication method currently is pattern, while PIN and password are the second and the third preferences. This finding is different from the previous study that mentioned PIN and password were the most common methods used [5]. Although they gave different choices, both of them have become the preferred methods by considering convenience as the reason. The least preferred method in this research is voice unlock, whether for the current or future use. Slightly different from the voice unlock, face unlock is more favorable for the future use although it is less used today. Furthermore, fingerprint is not very popular in the current use but it is more considered to be used in the future and so are pattern and password.

Based on the assessment of the respondents shown in Figure 5, fingerprint becomes the most secure authentication method and also a preferred method to be used in the future. It can be said that the respondents (users of smartphones) have already begun to realize that the authentication methods used to lock the smartphone’s screens should be prioritized on the security issues to avoid security threats such as accessing users’ information without permission.

Figure 5 shows that if the choice of authentication method widely used today is the pattern unlock, then it follows the user's needs for convenient use. It is supported by the reasons that are included in the selection of authentication methods that many users use such method because of its perceived convenience. The
result of this research also reveals that the pattern unlock has become the most convenient authentication method. Unlike the previous research [5], fingerprint was the most favorable method based on the perspectives of security and convenience. There was also a similar method like pattern unlock and it became the least selected authentication method that would be used in the future. Yet, in this study it is found to be the second most preferred method for use in the future after the fingerprint. The least chosen authentication method is voice unlock. Based on observations, it probably happens because only a few platforms provide this method. The possibility that makes it different might be the mismatch between the types of the method with the characteristics of the respondents and the different time of research.

5. Conclusion
Indirectly, the security and convenience affect the users when deciding to use authentication methods based on various reasons. The convenience factor is still the major consideration in selecting the authentication method to be used by users.

Fingerprint is selected as the most secure type of authentication method in providing protection for data on smartphones and also as the method which would be mostly used by users in the future. Meanwhile, the pattern unlock is chosen by the majority of users as the most convenient method. This method is also the most widely used today. It is in line with the reason of convenience as the biggest factor in selecting a method. The future expectation of the users is that they can use the most secure method to protect their data.

Manufacturers of smartphones are expected to use this results as a consideration in providing the authentication methods for many users, especially for the future use. It is expected that more and more users would use authentication methods for locking their smartphones in order to increase the level of security for critical data and information in their smartphones. Based on the results, smartphone manufacturers should also reconsider to provide face unlock and voice unlock as the choices of the methods because they are less popular to be used now and in the future.

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