User Experience Analysis for the Use of Electronic Signature in the Academic Activities

Ahmad Zafrullah Mardiansyah(✉), Ario Yudo Husodo, Cahyo Mustiko Okta Muvianto, and Raphael Bianco Huwae

University of Mataram, Mataram, Indonesia
{zaf,ario,cahyo.muvianto,raphael.bianco.huwae}@unram.ac.id

Abstract. During the Covid-19 pandemic that has spread all around the world, the government has announced policies for conducting physical distancing among people and doing work from home (WFH), including in the academic field. Although in WFH there are still tasks that can be done, some activities are still challenging in WFH. One of which is signing a document. In WFH, signing a document tends to be facilitated by using an electronic signature. By using an electronic signature, the people who sign a document do not have to meet directly in one location. They can sign a document through a dedicated system. This kind of process will make the business process becomes easier. Although many papers have discussed the technical aspects behind any electronic signature, there is rarely a comprehensive analysis related to the user experience analysis of the electronic signature from the user perspective. This paper comprehensively analyzes the user experience of electronic signature usage in academic activities. Here, we use the University of Mataram as our research location. According to our research, we conclude that the scores for pragmatic and hedonic qualities are 1.66 (good) and 1.74 (excellent) respectively, so that the final conclusion of the test is 1.7 (excellent).

Keywords: academic activities · electronic signature · user experience analysis · University of Mataram

1 Introduction

Since the COVID-19 pandemic broke out in Indonesia, the government immediately set several policies to break the chain spread of COVID-19. One of the policies in education is online learning for students who refer to the Court Circular published by Minister of Education and Culture No. 3 of 2020 concerning Prevention COVID-19 on the Education Unit, which later also applied to online lectures at the university level [1]. The government also issued a policy to Work from Home (WFH) which refers to Law No. 13 of 2003 concerning Manpower, article 8 paragraph 1 letter a [2, 3]. The two policies require that every student, lecturer, and employee to work online from home. Unfortunately, some activities become challenging because of those policies. One of them is related

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to document ratification. In an academic institution, many activities require ratification by signature, for example legalizing students' academic transcripts. Usually, ratification for that kind of activity was initially carried out manually by affixing a signature and wet-stamped a document. Meanwhile, at WFH, that kind of activity can't be done as usual because the person who needs to give ratifications is working from home.

To fulfill the necessity of giving ratification while doing WFH, one of the best alternatives that can be adopted is using an electronic signature (e-sign). E-sign is a digital product containing a digital image of a person's signature that is embedded with a special mark to identify the legality of a signature in a document. By using an e-sign, a person can ratify a document digitally from home. Still, the legitimacy of that signature is guaranteed because the identification mark embedded with the signature digital image is recorded securely in an information system.

As an innovative university, the University of Mataram (Unram) adopts the usage of e-sign to support ratification activities during the pandemic. Located in Lombok, Indonesia, Unram uses e-sign to support academic activities, especially those related to ratification. In practice, there are many forms of e-sign. In Unram, the form of its e-sign is a digital image of a signature combined with a QR code that shows the identification of a signature. In Unram, e-sign has been used widely for many academic activities during Covid-19 pandemic.

To create magnificent services, we need to ensure that the service has a sufficiently high user experience. A well-known criterion of user experience is written in ISO 9241-210 [4]. There, user experience is defined as "a person's perceptions and responses that result from the use or anticipated use of a product, system or service". In other words, user experience can be seen as a holistic concept that contains all types of emotional, cognitive, or even physical reactions concerning the assumed usage of a product.

From a computer science perspective, many articles have discussed the technical aspect of how an e-sign should be constructed. Nevertheless, few studies comprehensively analyze the user experience aspect of an e-sign to show how acceptable an e-sign is from its user perspective. Because of this phenomenon, in this study, we provide a comprehensive analysis related to user experience testing toward an e-sign. Here, we use the User Experience Questionnaire (UEQ) as our baseline, where the assumed scale structure of the UEQ is shown in Fig. 1 [5]. We run our experiment in Unram because it is located in the middle of Indonesia, which can represent the average dynamics of college student's characteristic in Indonesia.

In this paper, we utilize a slightly different interpretation of user experience, which is to define user experience as a set of distinct quality criteria [6] that includes classical usability criteria, like efficiency, controllability or learnability, and non-goal directed or hedonic quality criteria [7], like stimulation, fun-of-use, novelty, emotions [8] or aesthetics [9]. This criterion has the advantage that it splits the general notion of user experience into several simple quality criteria, which analyze relatively well-defined aspects of user experience that can be measured independently. The main goal of the UEQ is to allow an immediate measurement of user experience. The UEQ considers aspects of pragmatic and hedonic quality [10]. By using UEQ as our experiment baseline, we can objectively provide a comprehensive analysis that shows how well an e-sign system is accepted in an academic environment like a university.

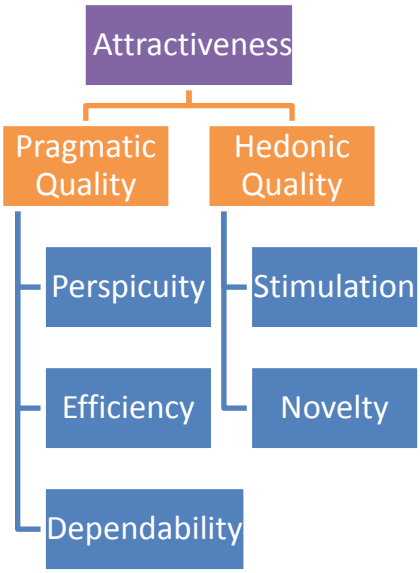

Fig. 1. Assumed Scale Structure of the UEQ

2 Literature Review

2.1 The Characteristic of Electronic Signature

In a digital world, ratification of a document can be conducted by using two main approaches. First is using electronic signature (e-sign), second is using digital signature. According to the U.S. Federal ESIGN Act [11] passed earlier in 2000, the definition of electronic signature was given as "Electronic sound, symbol, or process, attached to or logically associated with a contract or other record and executed or adopted by a person with the intent to sign the record." In other words, an electronic signature is a digital version of signature written on a paper. Meanwhile, the digital signature is a digital product that involves the use of algorithms and coding for signing and validating a document. Unlike e-sign, the digital signature requires to full fill several procedures before obtaining it. It is used not only for signing a document, but also for encrypting a document by using the public key and private key pairs [12].

Table 1 summarizes the difference between an electronic signature and a digital signature. From Table 1, we can analyze that for verifying academic documents for university activities, the usage of an e-sign is preferred. In the current computer science research trend related to e-sign, most articles focus on how to create an e-sign. Unfortunately, no paper comprehensively discusses the user experience testing of an e-sign in academic activities like in a university. In fact, this kind of research is needed to understand how an e-sign system is accepted by its user. Because this kind of research is beneficial, we provide a paper that discusses this aspect comprehensively.

Table 1. Comparison Between Digital Signatures and E-Sign

Aspect	Digital Signature	Electronic Signature
Purpose	Secure documents	Verify a document
Issued by	Trusted certificate authorities	Not having any authorized entity
Verifications	Possible to verify	Not possible to verify
Concern	Secure document	Intended to show the signed document
Encryption	Robust	Not using any encryption
Usage	Not possible to reuse	Possible to reuse

2.2 User Experience Questionnaire

ISO 9241-210 [4] describes usability as "the effectiveness, efficiency, and satisfaction with which a product or service enables specific objectives to be achieved by specific users in a specific context". On the other hand, it defines UX as "the perceptions and responses of a person resulting from the use or anticipated use of a product, system or service", including users' emotions, beliefs, preferences, perceptions, physical and psychological responses, behaviors and achievements that occur before, during and after use [13].

The difference between the terms is that UX tends to be seen as a more holistic view of the interaction concept between users and interfaces [14]. From an experiential perspective, both aspects are essential [15]. On one side, the traditional usability factors were primarily related to performance and smooth interaction, while on the other, the new UX factors relate to affect interpretation and meaning [16].

According to [17], UX is generally interpreted as a multidimensional concept. In this sense, at [18], UX is described as a set of quality criteria, which includes both the classic criteria of usability, like efficiency, controllability, or learning capacity and the criteria of hedonic quality like stimulation, fun, novelty, emotions or aesthetics. In line with this theoretical concept, [19] analyzes three key UX components: usability, emotions, and aesthetic impression or appearance. Within all key aspects of the UX, [20] composed the standardized questionnaires built around different quality aspects called sub-constructs. These sub-constructs define the nature of the key aspects of UX and allow them to be decomposed into measurable characteristics.

3 Existing Platform

3.1 System Design

The E-Sign platform has been used at Mataram University for the past few years. The use of e-signs to accommodate the needs of administrative services during the pandemic, at the level of departments, faculties, and universities. E-Sign was developed based on conventional signature flow but with additional security aspects (Fig. 2).

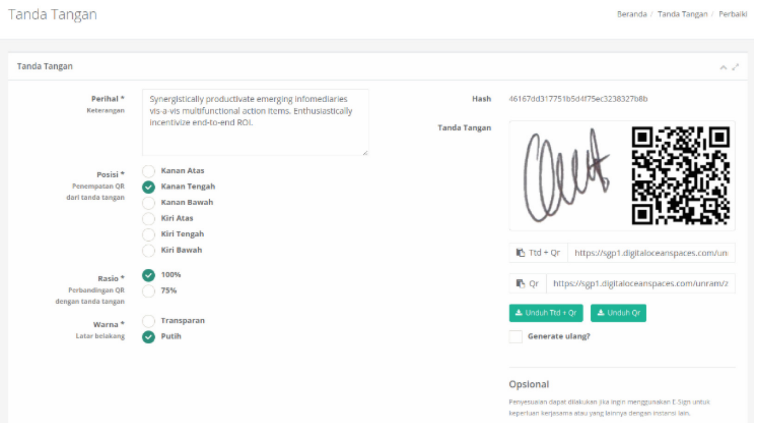

Fig. 2. Create new E-Sign object

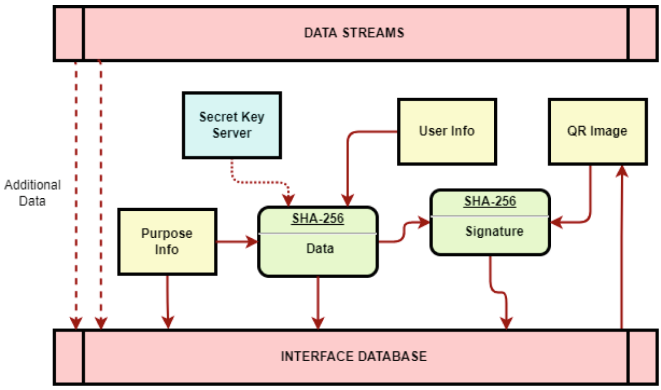

Fig. 3. E-Sign data entry security flow

Access to the E-Sign is available for all academic communities at the University of Mataram through Single Sign-On (SSO) mechanism. E-Sign can be used by students, lecturers, and staff, which have been provided with SSO accounts.

Digital data on E-Sign is a very important object, so it must be stored properly. Figure 3 is an architecture of the E-Sign that stores user data through several stages. Basic user-related information and description about E-Sign are combined into one data and finally hashed using the SHA-256 algorithm.

The QR code object is formed based on the hash generated in the previous process. The integrity of the data on the E-Sign is secured by providing a signature. The signature is generated from a combination of the hash and the existing QR code object data. Signature ensures that every data in each column cannot be changed directly within the database (Fig. 4).

Validation of the QR code object is done through a public URL that can be accessed by anyone. Technically validation is done with two security steps. The first is to ensure

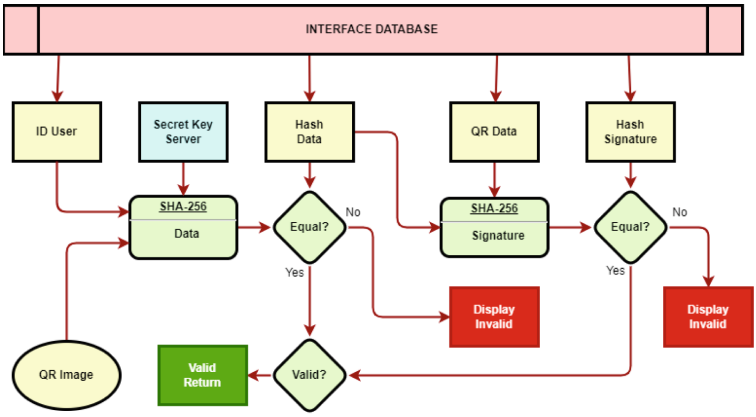

Fig. 4. E-Sign data validation security flow

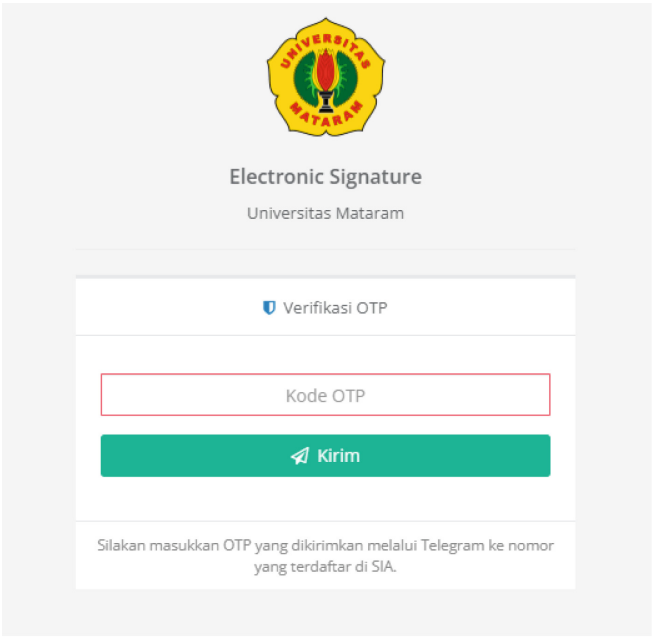

Fig. 5. OTP validation page

that the data requested by the user is valid data and is contained in the database. The second is to make sure the signature of the data matches the way it is compared.

If the validation results get inconsistent results, then the E-Sign will not display user information and signature information (Fig. 5).

To improve user access security, e-sign provides OTP (one time password) facility for users. OTP ensures that the original user who is logging in is notified via the Telegram application with a code that must be entered every time he logs into the E-Sign.

This method can secure user accounts when the worst-case scenario occurs, for example when the user's username and password have been leaked or are known to others. OTP ensures the use of E-Signs is not used by third parties in issuing signatures.

3.2 Implementation

E-Sign is designed to be as easy to use as possible by all levels of users. Using the E-Sign can be done through several easy steps. One mandatory step that must be done in the first place is to upload the user' original signature that will be used (Fig. 6).

After the signature is uploaded, the user can create an E-Sign object by pressing the single "add" button. Making E-Sign can be done many times by using a signature that has been uploaded previously. One E-Sign object can only be used for one document. One E-Sign object represents one purpose in a document. E-Sign cannot be used multiple times for multiple documents.

The E-Sign object in this platform is a signature image of the user combined with a QR code so that it can be embedded into documents or other administrative files (Fig. 7).

Documents that have been signed using an E-Sign object can be validated using a QR reader. In general, QR readers are widely available in the form of applications on smartphones, such as on Android and iOS. When the QR is scanned, the QR reader will display the URL containing the signature information page. The page contains information on the user who released the signature, the original form of the signature, and some additional information regarding the signed document.

Smartphone nowadays supports the process of using E-Sign at the University of Mataram. The latest smartphones can use the built-in camera to scan the E-Sign object inside the document. The results of the scan will produce a URL that can be accessed

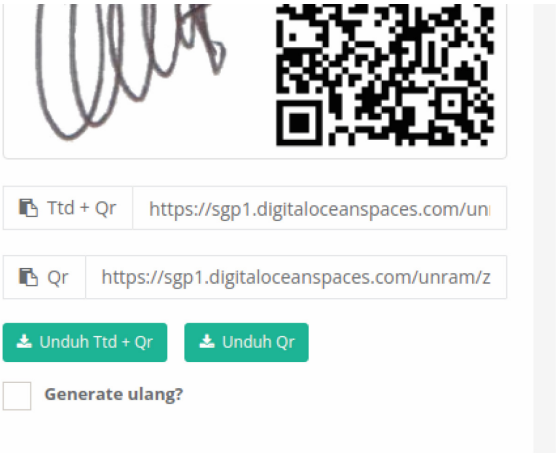

Fig. 6. Embedding QR code object through URL

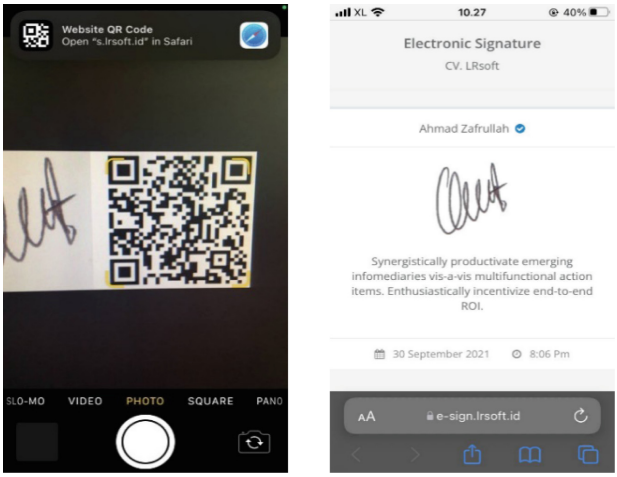

Fig. 7. Scan and validation page of QR code object

by a smartphone. The URL displays a page of the E-Sign object description, including the user's information for signing.

Some older versions of smartphones do not have a feature to detect QR code objects automatically. For that case, a QR reader application is required to be installed first. There are many QR reader applications available on PlayStore (Android) and AppStore (iOS).

4 Experimental Results

The development of this platform consists of two main aspects, technical and non-technical aspect. The non-technical phase related to user experiences (UX). In this platform, level of user satisfaction while using the application can be measured using the User Experience Questionnaire (UEQ) [21–23]. UEQ can also measure level of efficiency, effectiveness, and user satisfaction in general for specific application.

In UEQ, the assessment is divided into two aspects, namely Pragmatic and Hedonic. The Pragmatic quality aspect is the perception of technical matters, such as appearance, features, and efficiency. While the Hedonic quality aspects tend to be user emotions, such as stimulation to use applications or features and the influence of other emotions.

Based on Table 2, the UEQ measurement uses 8 items with each assessment mark from 1 to 7. This study uses the UEQ form to determine user experience while using E-Sign to 399 respondents consisting of lecturers and students.

Figure 8 is a benchmark for computing the assessment of UEQ using the tools provided. Each quality aspect has a varying scale, according to the available data. In general, the final assessment results of the two UEQ aspect scales get an excellent score.

Table 3 is the result of calculations from the scale of Pragmatic and Hedonic aspects. The assessment of the Hedonic aspect scale has the highest score of 1.74. The high value of the Hedonic aspect is supported by two items in the Novelty assessment category. In

Table 2. UEQ category scale

No.	Category	Negative	Positive	Scale
1	Dependability	obstructive	supportive	Pragmatic
2	Perspicuity	complicated	easy	Pragmatic
3	Efficiency	inefficient	efficient	Pragmatic
4	Perspicuity	confusing	clear	Pragmatic
5	Stimulation	boring	exciting	Hedonic
6	Stimulation	not interesting	interesting	Hedonic
7	Novelty	conventional	inventive	Hedonic
8	Novelty	usual	leading edge	Hedonic

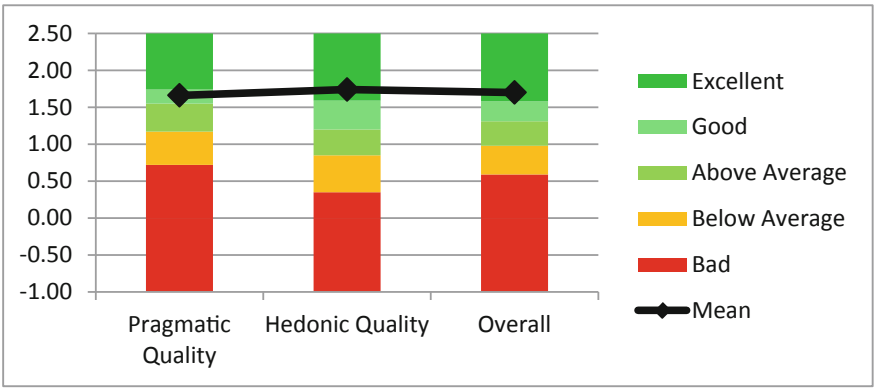

Fig. 8. UEQ benchmarking results

Table 3. UEQ scale category results

Scale	**Mean**	**Benchmark**
Pragmatic	1.661027569	Good
Hedonic	1.739974937	Excellent
Overall	**1.70**	**Excellent**

the Novelty category, users state that E-Sign is a new thing in document signing activities. Users also stated that E-Signs are easy to use compared to conventional document signatures and have a fairly high level of security.

The quality of the Pragmatic aspect gets a value of 1.66 and is still classified in the good category. The value of the Pragmatic aspect tends to be lower than the value of the Hedonic aspect. The assessment factor that affects the value of the Hedonic aspect in this study is Perspicuity, namely users feel confused in using E-Sign in signing

documents. The factor in the Pragmatic aspect that gives a large portion of the assessment is Efficiency, where users feel that using E-Sign can increase efficiency in signing documents.

Overall, the use of E-Sign received a positive response from users in the Mataram University. However, to comply with applicable regulations, the E-Sign platform needs to get space for regulation and certification, which are currently not available at Mataram University.

5 Conclusions

Using the UEQ in general gets result of 1.7 or is in the excellent category. In the Hedonic aspect, the test got the highest result, namely 1.74. The category of assessment that contributed the most in the value portion was Novelty. This shows that users are happy to use a new way of signing documents.

In the Pragmatic aspect of the test, the result is 1.667, but this result is still in the good category. The category that has the lowest score is Perspicuity, which means that users still find it difficult to use E-Sign.

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