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MOBILE-BASED E-WALLET PROTOTYPE TO SUPPORT ELECTRONIC PAYMENTS IN CAMPUS ENVIRONMENT

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ABSTRACT

Electronic wallets (e-wallets) are currently considered to solve problems that often arise from the use of cash, especially in terms of convenience and security in transactions. The application of e-wallets in the campus environment is still rare, even if there is usually a third-party (non-official) provider. Many students using cash as a payment instrument on campus can be at risk of transmitting the COVID-19 virus and other diseases, so there is an urgency to use other alternative mechanisms. This study aims to design a mobile-based e-wallet prototype that can specifically handle electronic payment transactions in the campus environment. Especially single tuition payments (UKT), payments at public service places (cooperatives, canteens, photocopying places), and fundraising for donations or events by using the QR Code as the transaction medium. System requirements exploration is carried out through questionnaires distributed to target users (students) to get a list of functional requirements. The method used in developing the application is an iterative rational unified process (RUP) model, which divides the stages into inception, elaboration, construction, and transition phases. In its implementation, the application is developed on the Android SDK mobile platform as a front-end technology using a model view presenter (MVP) architecture and the Laravel web framework as back-end technology. The e-wallet prototype that has been developed is then tested for functionality and evaluated based on user experience testing using the user experience questionnaire (UEQ) method. Based on the results of the UEQ measurements that have been made to the respondents, a positive evaluation was obtained with a value of over 0.8. This means that the prototype that has been developed is good in terms of attractiveness, functionality, display design, and comfort of use.

1. Introduction

The payment system has currently developed and changed the conventional payment pattern, which initially used cash as a payment instrument to become a non-cash payment system, better known as an electronic payment system. One of the electronic payment instruments is electronic money (e-money), where the value of money is stored in chip or server-based electronic media [1]. Server-based electronic money instruments, better known as e-wallets, can solve several problems that arise from cash, especially in terms of convenience and security in transactions [2]. Motivation in using e-wallets for the younger generation in Indonesia has increased along with the growth of e-commerce and the digital economy sector, and this is measured by several factors that influence motivation in using an e-wallet, such as perceived usefulness, ease of use, social influence, conditions facilities, lifestyle compatibility, and trust factor [3].

A large number of students on campus and the use of cash as a payment instrument is now starting to have to be minimized because, according to WHO, cash is one of the transmission media for the COVID-19 virus or other diseases [4], so there is an urgency to use alternative payments. Seeing the increasing trend of using e-wallet, campuses have good potential to implement this payment tool. Some payments on campus,

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such as payments for single tuition fees (UKT), payments at canteens, food courts, cooperatives, and photocopies, which are still relatively cash, can be replaced by implementing an e-wallet. In addition, transaction processes such as collecting donations and selling event tickets held by student organizations are also targets for implementing this e-wallet. The use of an e-wallet as a means of payment in the campus environment is still relatively rare, even if there is a third-party (non-official) provider.

The current electronic payment system in e-wallets has been integrated with supporting technology, one of which is by using a quick response code (QR Code) [5]. A QR Code is an image in the form of a two-dimensional matrix that stores data [6]. QR Code was chosen because it can store more information and process data quickly. This makes QR codes an efficient data interaction medium in conducting transactions. In addition to maintaining their security, e-wallets are supported by a security system using a security code or personal identification number (PIN), which is used for the user authentication process, and a one-time password (OTP) code which is used to verify registered accounts [7].

This research aims to design an e-wallet prototype as an electronic payment medium in the campus environment and test user experience on the design results. The prototype was built on the Android mobile platform because it is considered the most widely used mobile platform [8]. Backend technology (API) is implemented using the Laravel framework to support various services needed by the application, and this framework was chosen because of its good usability level [9]. QR Code technology is used as a user identity when transacting. The software development model used to develop the application is an iterative rational unified process (RUP) model. The RUP model is used in accordance with the research stages needed to design an e-wallet prototype. The prototype that has been designed will then be tested functionally and evaluated based on the user experience through the user experience questionnaire (UEQ) method. The evaluation was carried out to determine the potential application of this e-wallet prototype for use in the campus environment. This research takes a case study in the Politeknik Negeri Bandung as one of the studies supporting the implementation of a smart campus.

2. Research Method

The research methodology includes three stages, namely (1) the system requirement analysis stage, (2) the system prototype design stage, and (3) the system UEQ testing stage. At the system requirements analysis stage, the expected output is a list of the functional requirements of the system, the system prototype design stage has the output in the form of a prototype design technical document and the e-wallet application developed in this study, while the system UEQ testing stage has the output in the form of measurement results of UEQ on applications that have been developed. Figure 1 shows the research methodology carried out.

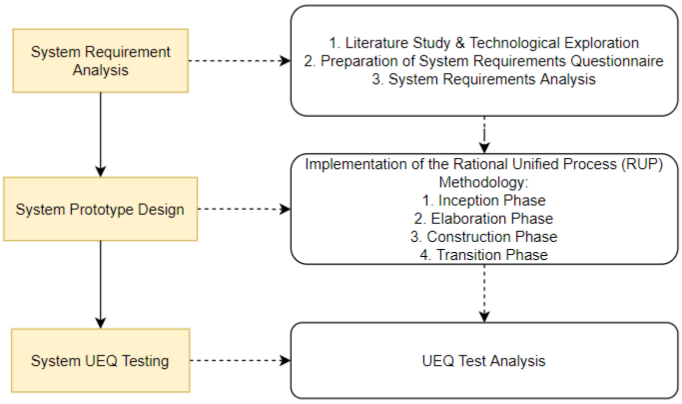

Figure 1. Research Methodology

At this stage of system requirements analysis, it begins with a literature study & technology exploration, which aims to collect information related to the e-wallet application domain, related research, QR Code technology, as well as the use of libraries needed in the development of application prototypes such as e-banking API / sandbox, SMS Gateway, and SMS OTP API. The next process is the preparation of questionnaires related to exploring system requirements and distributing questionnaires to target users (students). The results of the questionnaire are then analyzed to explore the functional requirements of the application prototype.

The second stage is the e-wallet prototype design stage. The activities carried out at this stage refer to the phases in the RUP software methodology. The stages of application development using the RUP methodology are as follows [10]: (1) Inception phase is the initial phase that aims to determine the requirements and scope of the application to be built. The output of this phase is the vision document, the initial use-case model, the initial business-case model, and the primary requirements of the system being developed. (2) Elaboration Phase is to analyze the problem domain, analyze the business processes (as-is and to-be), and build an architectural design from several points of view. The output of this phase is the use-case model, system architecture, business processes, and system technical design. (3) Construction phase aims to build a software product that has been designed as needed. In this phase, all functional features of the system are tested to ensure the application is running well. The output of this phase is a software product that has been in accordance with user needs. (4) Transition Phase aims to transition the products that have been developed by the organization to end-users. In this phase, testing will be carried out to validate the system against user expectations (beta-testing). The output of this phase is that the deployment process to users has been completed, and evaluates the final product whether it is consistent with the vision of the application development. Model View Presenter (MVP) is an architecture used to develop mobile applications in the construction phase. The MVP architecture is designed based on two main focuses, namely data management and user interface (UI). How to process data and how users interact with data [11]. Model is a layer that points to objects and data, View is an implementation layer to manage the user interface for users, while Presenter is a layer that aims to communicate between the Model and View layers. This architecture is considered quite effective because it can maintain application performance through the use of low memory resources [12], besides that the program code is separated based on its function so that the code structure becomes easier to manage and test.

The third stage is user experience testing. This process aims to test the e-wallet prototype based on user experience. The test was carried out using the user experience questionnaire (UEQ) method. The output of this stage is in the form of UEQ test results, which can describe the user's perspective on the prototype application that has been designed. The User Experience Questionnaire (UEQ) is a test based on the user experience of a product. The UEQ consists of 6 scales and has 26 question items [13] that can be adapted to the product to be tested to cover the overall impression from a user experience perspective. This test uses the UEQ questionnaire as an evaluation method. The following are the six scales of user experience [13]: (1) Attractiveness, whether or not users like the product being assessed. (2) Efficiency, whether users can use the assessed product efficiently. (3) Perspicuity, whether the use of the product is considered easy for users. (4) Dependability, whether the assessed product can interact well with users. (5) Stimulation, whether users are interested in using the product being assessed. (6) Novelty, whether the product is considered innovative and creative.

3. Results and Discussion

3.1 System Requirement Analysis

We analyzed the e-wallet needs survey to determine the functional requirements of the application to be built. The survey was conducted on the target users by collecting data through an online questionnaire. The questionnaire results obtained response data from several 117 respondents who are students of Politeknik Negeri Bandung consisting of various majors. The survey recorded that 92.9% of respondents used Android smartphones, and only 7.1% used iOS. The number of female respondents was 54% and 46% male respondents, with an age range of 20 to 23 years. The characteristics of the respondents are sufficient to represent the potential users of the developed application. The results of the respondents state that the types of electronic transactions needed in the campus environment are (a) payment at the food court canteen (83 respondents), (b) payment for tickets to student organization events (73 respondents), (c) payment for single tuition fees (70 respondents), (d) payment at cooperatives (67 respondents), (e) payment at photocopy (56 respondents), (f) donation raising (51 respondents).

Based on the as-is business process analysis results, electronic payments at point a,b,d,e,f are currently using cash. In contrast, for point c, the single tuition payment process (UKT) is paid via a bank teller or through automated teller machines (ATMs). We analyzed similar applications on some of the most widely

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used e-wallet applications, namely OVO, DANA, and GoPay [14]. There are two types of users in this application, namely regular users and merchants. The application's main features are user account registration, login, top-up, payment by scanning QR Code, transfer, and transaction history. These features are then explored as an analysis material for their data needs. In the to-be business process analysis results, the prototype e-wallet designed has two types of users, namely the student type user and the public type. The difference between the two types of users is that student users can access the UKT payment menu while public users cannot. However, for other facilities, both types of users can still access them. Public users can be identified as groups of employees on campus, such as lecturers and academic staff, as well as non-employee groups such as business managers, MSME outlets, etc. Both types of users, both students and public users can register their accounts as business accounts. Users can register business accounts for merchants, events, or donations. One user can only have one business account.

3.2 System Prototype Design

In the inception phase, the output of this phase is a list of the system's functional requirements and modeling it in the form of a use case. The following is a list of the functional requirements of the system:

- FR-01: System provides user account registration feature
- FR-02: System can validate users when logging in
- FR-03: System can provide a top-up feature
- FR-04: System can process payment transactions by scanning a QR code or phone number
- FR-05: System can make transactions in transfers between users, single tuition fees (UKT), student organization event tickets, and donations.
- FR-06: System can display transaction history

In the elaboration phase, prototype modeling is described in UML diagrams consisting of domain models, package diagrams, class diagrams, sequence diagrams, database models, architectural diagrams, user interface (UI) designs, and deployment diagrams. This modeling is used to implement the prototype in the construction phase. The prototype of the designed e-wallet is named DEKa, which stands for "Dompet Elektronik Kampus". The design of the domain model is carried out to represent objects related to the behavior and data of a domain. Figure 2 shows the domain model of the DEKa application, while the description of the interaction between the system components is modeled in the form of an architectural design shown in Figure 3.

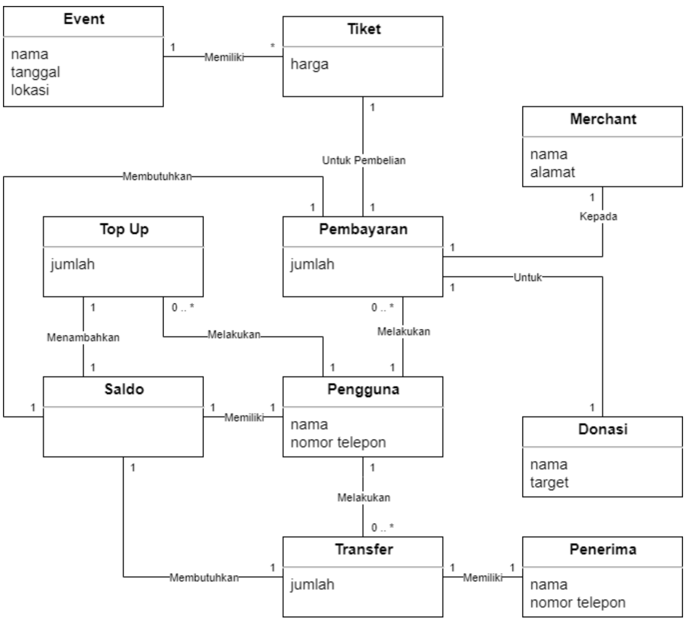

Figure 2. Domain Model of DEKa

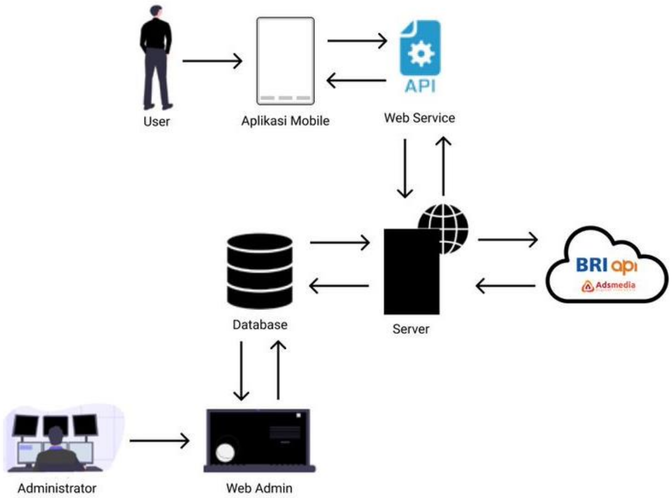

Figure 3. Architectural Design

The front-end app is implemented in a mobile application using native Java, while the back-end service contains the API from the DEKa application, which is used for internal application functions. Back-end services are published in the form of an API hosted on a dedicated server. Other libraries used are e-banking API and SMS Gateway API. The e-banking API (sandbox) is used to create a virtual account when a user makes a top-up transaction with a payment method via a virtual bank account. The SMS Gateway API is used to send the OTP code to the phone number registered by the user via SMS, which is required in the user account verification process. The database used is MySQL to provide application data storage services. In this study, the minimum hardware specifications that can be used are smartphones with the Android operating system version 4.4 KitKat. In the construction phase, the e-wallet prototype that has been designed is implemented through a model view presenter (MVP) architecture, as shown in Figure 4. The View package functions to display data and the interaction process to the user. The presenter package is a layer to accommodate functions in connecting Model and View packages. In the Model package, there are four other packages, namely the Adapter package, which serves to provide access to data items, the Models package represents the data model on the application, the APIHelper package connects the application with the API, and the APIResponse package, which accommodates responses from incoming or outgoing data in a JSON format.

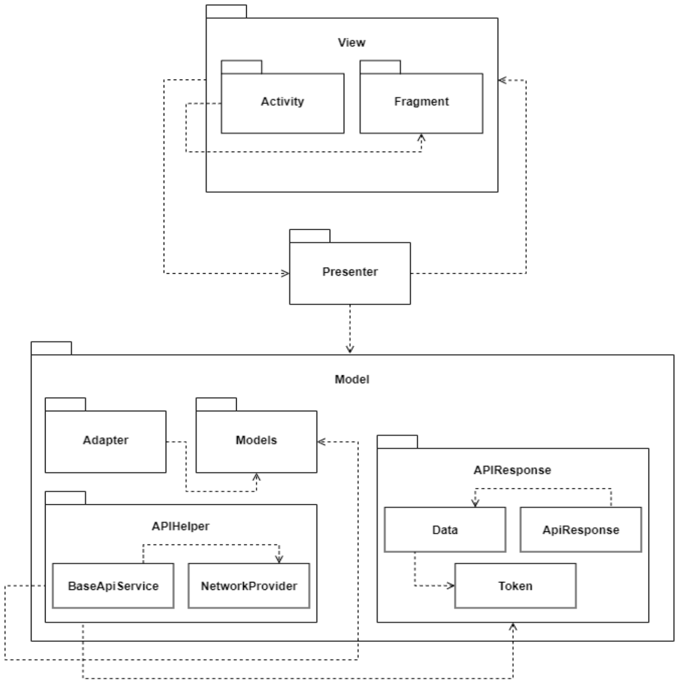

Figure 4. Application Package Diagram (MVP)

An example of the DEKa mobile application that has been built can be seen in Figure 5. Users can register by filling in their identity on the registration menu to register an account. The system will verify through the OTP code sent to the registered phone number so that the user's status becomes active. Registered users will be able to access the home menu. On this page, all the application's main features can be accessed, namely the balance top-up feature, fund transfer feature, payment transaction feature, transaction history feature, and other features that have been provided in the application. Users can make single tuition payments (UKT), donation payments, and purchase student organization event tickets in the payment transaction feature. Besides that, there is also a fund transfer feature that can be done by scanning the QR Code according to the user's code. Figure 5 is an example of a mobile and web application display for transactions on DEKa. Through the construction phase, the main features of the DEKa application have been successfully developed as needed.

In the transition phase, the e-wallet prototype that has been built is then functionally tested using the black box testing method. This method divides testing into several stages: test plan, test design, test case, and test procedure. The functional tests' results show that all the designed features have met expectations (passed).

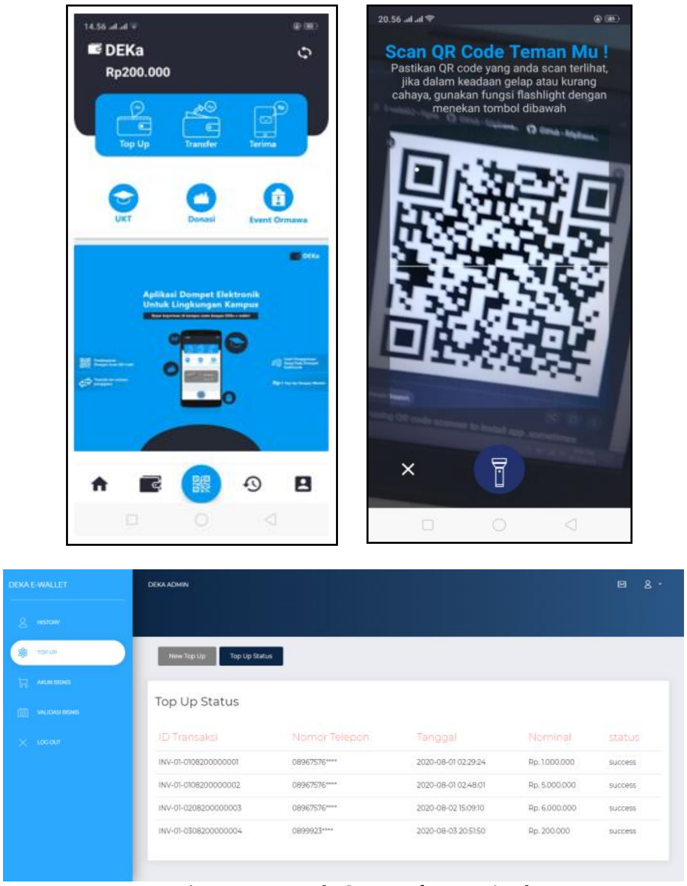

Figure 5. Example Screen of DEKa Application

3.3 System UEQ Testing

To test the prototype that was built in terms of user experience, user experience testing was carried out using the user experience questionnaire (UEQ) method. Similar to collecting the system requirements questionnaire, the distribution and collection of the UEQ questionnaire were carried out online. The data obtained from the results of this questionnaire are 113 respondents. To achieve UEQ testing on the e-wallet prototype, respondents have given 26 question items that have been adjusted to the scale and question items provided on the official UEQ website [15].

The first step is to analyze the inconsistency scale. Data inconsistency is checking the data entered by the respondent at random, filling out the questionnaire in a non-serious manner, or the respondent's lack of understanding of the test items [16]. In this test, the resulting inconsistency scale has no value greater than 3, meaning that each respondent has given a consistent answer. In addition, it is also necessary to confirm the reliability of the data by checking the Cronbach alpha coefficient. An evaluation data can have high consistency if the value of the Cronbach alpha coefficient is greater than or equal to 0.7. Figure 6 presents the reliability coefficient of Cronbach's alpha on each scale. The data shows that all scales get a value of ≥ 0.7, meaning that the answer items on each scale are consistent. Figure 7 shows a graph of the distribution of respondents' answers that have been grouped based on the scale of their UEQ.

Scale	Cronbach Alpha
Attractiveness	0,88
Perspicuity	0,81
Efficiency	0,85
Dependability	0,88
Stimulation	0,78
Novelty	0,76

Figure 6. Reliability Coefficient Of Cronbach Alpha

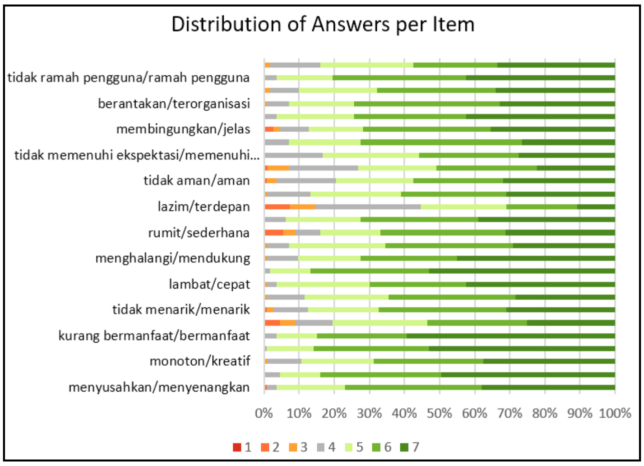

Figure 7. Distribution Graph of Respondents' Answers Per Scale

The next step, user experience testing, is done by calculating the response data's mean, variance, and standard deviation values . Then each calculation will be grouped into six scales on the UEQ. Figure 8 is the result of calculating the mean and variance in the DEKa application. The average value (mean) of respondents with a value range between -0.8 and 0.8 is a normal evaluation value, a value > 0.8 is a positive evaluation, and a value <-0.8 is a negative evaluation [16]. Of the six scales calculated, all resulted in a positive evaluation with an upward arrow in green, and the average value was 1.874. This means that the results of the respondent's evaluation of the application are positive, or in other words, that the application already has an adequate user experience. Figure 9 is a graph of the UEQ scale obtained from the conversion of the results of the calculation of the mean and variance, making it easier to read the evaluation results. This graph is drawn on a scale of -3 (horribly bad) to +3 (extremely good). It can be seen that all scales, which are represented by square bars, are in the positive area (green color) with all values above 1.

UEQ Scales (Mean and Variance)		
Attractiveness	1.975	0.52
Perspicuity	2.027	0.69
Efficiency	2.031	0.51
Dependability	1.796	0.77
Stimulation	1.748	0.69
Novelty	1.668	0.66

Figure 8. The Mean and Variance Values of DEKa Application

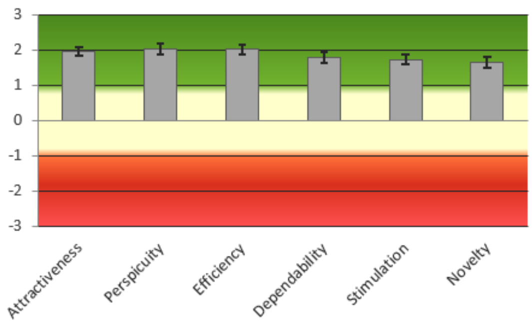

Figure 9. Graph UEQ of DEKa Application

Based on the UEQ testing carried out, it can be concluded that the calculation of the mean and variance on each scale on the UEQ produces a positive evaluation with the average value of the scale being 1.874 (more than 0.8), so the e-wallet prototype that has been developed is good in terms of attractiveness, functionality, appearance design, and comfort of use.

4. Conclusion

In this study, we developed an e-wallet prototype through the DEKa application that can manage electronic payment processes in the campus environment. The development process is carried out through several stages ranging from needs analysis, prototype design, and UEQ testing. From the results of the implementation that has been carried out, the RUP methodology is considered quite effective and dynamic to be used in developing this e-wallet prototype because each stage can be carried out iteratively, thus helping in providing an abstraction of the system to be developed (top-down process). MVP as the architecture used in the DEKa mobile application development, provides a clear division of responsibilities at each layer, making it easier for developers in the process of developing, testing, and maintaining it. In the final stage, the results of the DEKa application prototype were evaluated through UEQ testing. In this test, each UEQ scale produces attractiveness values of 1.975, perspicuity of 2.027, efficiency of 2.031, dependability of 1.796, stimulation of 1.748, and novelty of 1.668 with an average value of 1.874. This shows that the developed prototype is good in terms of attractiveness, functionality, appearance design, and convenience of use because it has exceeded the positive minimum scale of 0.8.

The research that has been carried out is more focused on the aspects of designing an e-wallet prototype and testing it based on the UEQ method. To be able to be applied to the campus environment, of course, several other studies need to be carried out, such as a policy study on the application of e-wallets in the campus environment, standard procedures or law protection to be applied, the organizational structure of the manager, and a study of the readiness of its IT infrastructure. This can be one of the research roadmaps that can be carried out further so that it can be a complement in the implementation of e-wallets in the campus environment and become a component that supports the realization of a smart campus.

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