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Localized eCommerce Development Using User-Centered Waterfall for Better SME Trade Processes

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Abstract−e-Marketplaces are one of the ways for SMEs to reach their market. Many marketplaces, such as Tokopedia or Shopee, provide marketplaces for SMEs. But, this kind of marketplace has a huge admin fee, which could reduce the SMEs' profit. A localized marketplace is needed to provide a way for SMEs to reach their intended market. POG is one marketplace that allows SMEs to reach their market using WhatsApp. But this tool is not suitable for trading goods. A localized website-based market is more appropriate. The combination of waterfall methodology and user-centered approach is used to develop the marketplaces. Waterfall is a methodology usually used to develop software that works like a waterfall from planning to implementation. User-centered design is a development process that heavily includes the user in planning to capture what the user needs. Using this methodology, many requirements were left out, especially the detailed requirements, such as constraints on the input. Blackbox testing as a test methodology is also inadequate to use if the test case is not thorough enough to test all of the system's possibilities. Therefore, using an iterative methodology is more suitable for marketplace development. Because all of the inadequate requirements and tests can be detected more easily and earlier. Therefore, it increases the development success rates. This research results in a localized e-commerce website that the POG can use to enhance its process.

Keywords: Black Box Testing, e-Marketplace, SMEs, Waterfall Software Development;

1. INTRODUCTION

Information technology utilization has become necessary nowadays, including in small and medium enterprises (SMEs). SMEs have become a pillar of the economy in many countries. The SMEs' growth in Indonesia is steady. Based on Kadin (Kamar Dagang Indonesia), the growth of SMEs in Indonesia was around 1.52% from 65 million to 66 million SMEs in 2023 [1], [2]. According to ASEAN data, this number is the biggest in ASEAN countries [3], [4]. SMEs also have a 61% contribution to the Indonesian Gross Domestic Product (GDP) [1]. Even though SMEs greatly contribute to Indonesia's GDP, many SMEs still struggle to reach the market. Therefore, SMEs need this technology to increase their market. One of the tools SMEs use to reach their market is e-commerce. Statista in 2024 conducted a survey in Indonesia. The result shows that the users of e-Commerce show a steady increase from 2020 to 2023, where in 2023 the number of e-Commerce users reached 58,63 million people and is predicted to reach 99,1 million users in 2029 [5]. Looking at these numbers, e-commerce has become a good strategy for SMEs. Indef also conducted research in 2024 which show that using e-commerce has a positive impact on SMEs in the form of an increase in workforce and earnings. The Indef research report shows that 24.42% of SMEs have increased workforce and 88.37% SMEs have increased earnings.

Unfortunately, using the marketplace can be an obstacle for SMEs because it has a mandatory admin fee and is not really suitable for the traditional market. The admin fee increased the commodity's price, and decreased the SMEs' profit from the marketplace [6]. This increase is mainly for the quickest delivered product, like food or household items. On the other hand, the consumer also doesn't want to go to the market to purchase it themselves. Another obstacle faced by SMEs is the inability to develop a good marketing strategy [7]. Therefore, having a localized e-marketplace that is managed by the market itself can be an answer to this challenge.

Perumahan Grand Nusa Indah (GNI) Cileungsi is one of the housing areas in Bogor, West Java. A lot of their residents have an SME as their way of doing business. Their business ranged from food and crafting to household items. At this moment, the SMEs' local marketplace is managed using WhatsApp. This local marketplace is managed by POG (Pasar Online GNI). POG's primary goal is to serve the residents of the housing area by meeting their needs without the need to come to the stores. Similar research has been conducted in several locations. The first research was conducted in Ngargoyoso Tourism Village by Oktaviani et al. [8]. The research results show that using a localized marketplace could increase the income of the SMEs and the exposure of these SMEs' products. The second research was conducted by Tarmizi et al. [9]. In their study, they found that local marketplace have their own culture. Therefore, these local marketplaces must have their own way to market their product. Their research found that a localized marketplace could help the marketing process and increase their profit. Looking at this success, we see that using a localized marketplace could help SMEs improve their profit and market.

This research tried to develop a localized e-marketplace for UMKM, specifically in a housing area. Localized e-marketplaces, as discussed before, have a positive impact on their community. However, only a few papers have discussed this kind of e-marketplace. Many papers discussed the development of e-commerce, but only for specific SMEs or companies. The research conducted by Fadillah et al. [10] aimed to develop an e-

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marketplace for Electronic Stores specifically. Saputra et al. also conducted the development of an SME e-marketplace specifically for the Bakery and creative Minangese food [11]. Research by Fenando tried to develop an e-marketplace for Donuts Shop [12]. Suriyana et al. also tried to develop an e-marketplace for a kids' clothing store [13]. The last paper by Panca et al. also tried to create a specific e-marketplace for restaurant SMEs [14].

This research used Waterfall methodology. Waterfall methodology itself is a traditional methodology that consists of several steps. The steps are: Planning, Analysis, Design, and Implementation [15]. This methodology was chosen because it is suitable for predictable system requirements and has a set development time [16]. This localized eCommerce is predictable, and since we have limited time, the waterfall methodology became the most appropriate methodology. But, one of the disadvantages of using waterfall is that it can redo the previous step's work. To minimize this disadvantage, we incorporate the user-centered design (UCD) approach in the requirements gathering step. UCD is an approach that emphasizes user involvement in analysis and design, including requirement gathering and elicitation [17]. Incorporating the UCD in the analysis and design of the waterfall methodology could improve the quality of the analyzed requirements and design of the system.

2. RESEARCH METHODOLOGY

2.1 Research Stages

This research tried to develop a localized e-marketplace using the waterfall methodology. Waterfall methodology is used because the condition of the case is suitable, where the system's requirements are fixed, easy to gather, and can be done in a fixed time, since this project has a limited time. Waterfall is also conducted systematically, making implementation easier, where the steps are Requirement Definition, Design, Implementation, and Testing [18], [19], [20]. We also tried to combine the user-centered requirements engineering approach developed by Ehn et al. [21]. The complete steps of this research can be seen in Figure 1.

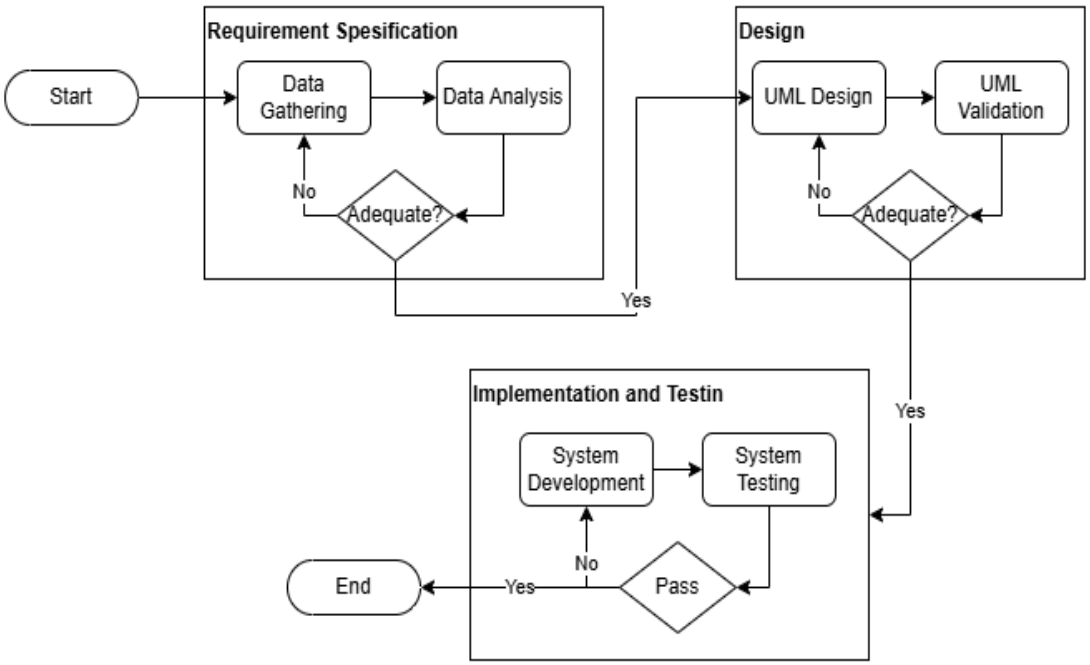

Figure 1. Research Steps

2.2 Requirements Specification

According to Ehn et al., the user-centered requirement engineering approach consists of two steps. The first step is to conduct the requirements elicitation process. This process consists of identifying the user groups and conducting interviews and observations of the current business process. This elicitation process was important because we can not guarantee the success of the development without proper requirements elicitation [22], [23], [24]. The second step of user-centered requirements engineering is data analysis. We categorized the requirements and developed the system models in the design step as seen in Figure 1. The requirements specification is conducted iteratively. Since the waterfall methodology can not accommodate redoing the steps when they are done, we need to ensure the clarity of the requirements.

2.3 Design, Developments and Testing

We design the flow of the systems using UML. UML is a framework that visualizes and documents information from the requirements specification phase to the system's conceptual models [25]. This step will develop four

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models: use case, class diagram, activity diagram, and sequence diagrams. After the design process, the next step is to develop the e-marketplace. This e-marketplace is web-based since using a web-based system could make the accessiblity of the system broad. We developed the system using the Laravel framework and MYSQL as the database.

The testing phase was conducted using two kinds of tests: black box testing and UAT testing. These two tests have different purposes. A black box test was conducted to check if the system's output is correct [26], where UAT is used to check if the user is okay with the system [27]. For both tests, we used several test cases to test the systems. The specific test will be discussed in the next section of this paper.

3. RESULT AND DISCUSSION

3.1 Results

We will present this section as the steps in the methodology: requirements specification, design, development, and testing.

3.1.1 Requirements Specification

The first step in this development is conducting data gathering. The data gathering process uses two methodologies, observation and interviews. The requirements will be arranged using the System Requirement Specification by ISO. We can collect the functional system requirements from the data gathering methods as seen in Table 1.

Table 1. Functional Requirements

Req No	Functional Requirements	Ranking
1	The system could enable the users to add, edit, or delete the products.	1
2	The system could group the products by food categories.	1
3	The system could group the products by beverage categories.	1
4	The system could group the products by snack categories.	1
5	The system could show the column for the product picture, description, price, and stock.	1
6	The system could provide a search and filter feature to ease the product search.	1
7	The system could provide a cart feature to save the products to buy.	1
8	The system could show the estimated time for delivery.	5
9	The system could trace the delivery status.	5
10	The system could provide the sales reports.	1
11	The system could export the sales report into document forms.	5
12	The system could provide several payment methods.	5
13	The system could enable the admin to validate the orders.	1
14	The system could give automated payment confirmation after the payment is successful.	1
15	The system could provide the order histories.	1

As can be seen in Table 1, we could gather 15 requirements from our users. In this case, the POG admin that manages the current systems. From the interview and observation, we saw that the main concerns of the POG management are in the product discoveries and sales reports. The payment methods and delivery status did not become the main concern because, from the viewpoint of the management, it can be handled by them using messaging apps like WhatsApp at this moment. Looking at this concern and our limited time to develop this system, we prioritized the requirements contributing to the management concern. Therefore, the requirements to be developed are those we gave rank 1 in the ranking column. After confirming that the requirements are adequate for the next step, we proceed to the design step.

3.1.2 Design

In this step, we develop the system's conceptual model using UML. As mentioned in section 2, we develop four models: use case diagram, class diagram, sequence diagram, and activity diagram. For convenience, we only show some of the diagrams. We attach the link to the complete diagram and another resource of this research in this link: https://bit.ly/ResourceUCDW.

1. Use Case Diagram
   A use case diagram shows what the user could do in the system. From our analysis, we found 10 main features for the systems. The features are Product Management, Product Grouping, Payment Confirmation, Show Sales Report, Manage User Access, Show Product Information, Product Search, Product Filter, Show Order Histories, and Add Product to Cart. The use case diagram also shows that in order to use some of the features, the users need to log in first. The use case diagram can be seen in Figure 2.

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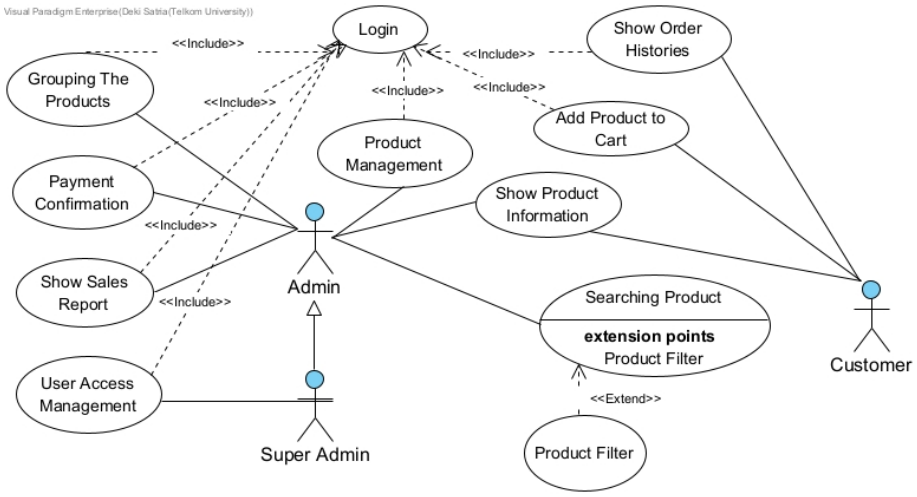

Figure 2. Use Case Diagram

2. Class Diagram
The class diagram is a model that shows how the program code will be developed. The main intention of using this model is to show how the code structure will be programmed. Figure 3 shows the class diagram of the e-marketplace.

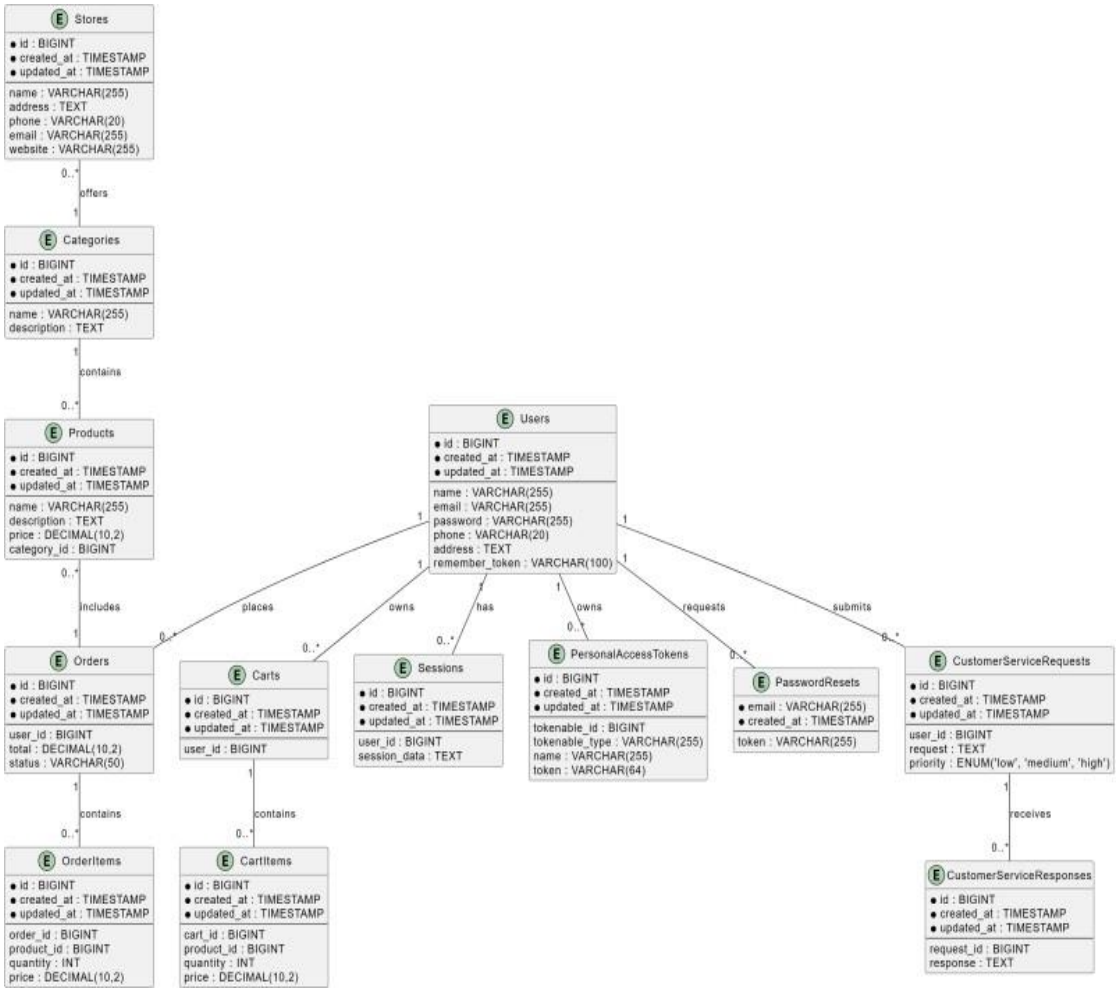

Figure 3. Class Diagram

3. Activity Diagram
We developed 13 activity diagrams from the analysis diagram. As mentioned before, we can not show all of the diagrams in this paper because of the limitations of the paper. Therefore, the resources can be accessed through the link provided. As a snippet, we provided two sample activity diagrams that we had developed. The

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activity diagram in Figure 4 shows the activity of payment confirmation, and Figure 5 shows the user access management.

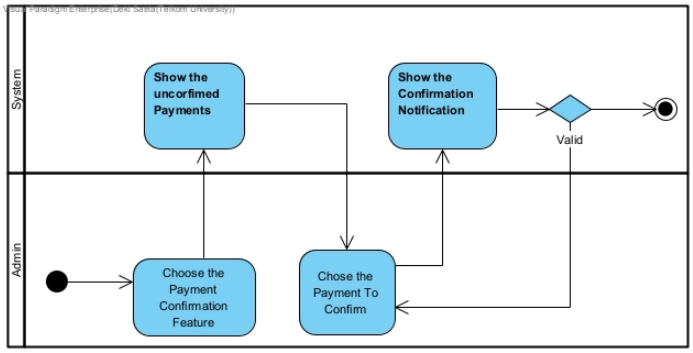

Figure 4. Payment Confirmation

Figure 4 shows the payment confirmation activity. Payment in this e-marketplace was conducted manually, not using any payment gateway, since the user of this e-marketplace was localized only to the housing area. Therefore, the management decides to make the payment manually. In the payment confirmation process, the admin will input the data for the payments already made. This activity can only conducted by admin. The admins are people in charge of the SME store. Before confirming the payments, the system will notify the admin about the input data.

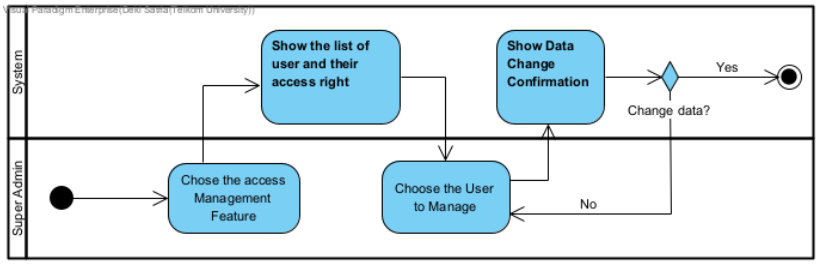

Figure 5 User Management Activity

The user management activity can only be conducted by the super admin. The super admin is the POG staff who manage all the stores. Figure 5 shows the steps to manage the user of the e-marketplace.

4. Sequence Diagram

The sequence diagrams we developed were the same as the activity diagrams. There was a sequence diagram for each of the activity diagram. In this section, we will show one of the sequence diagrams as a snippet of our developed sequence diagram. This sequence show the process of user management in the system. The sequence diagram in Figure 6 process can only be accessed by the super admin.

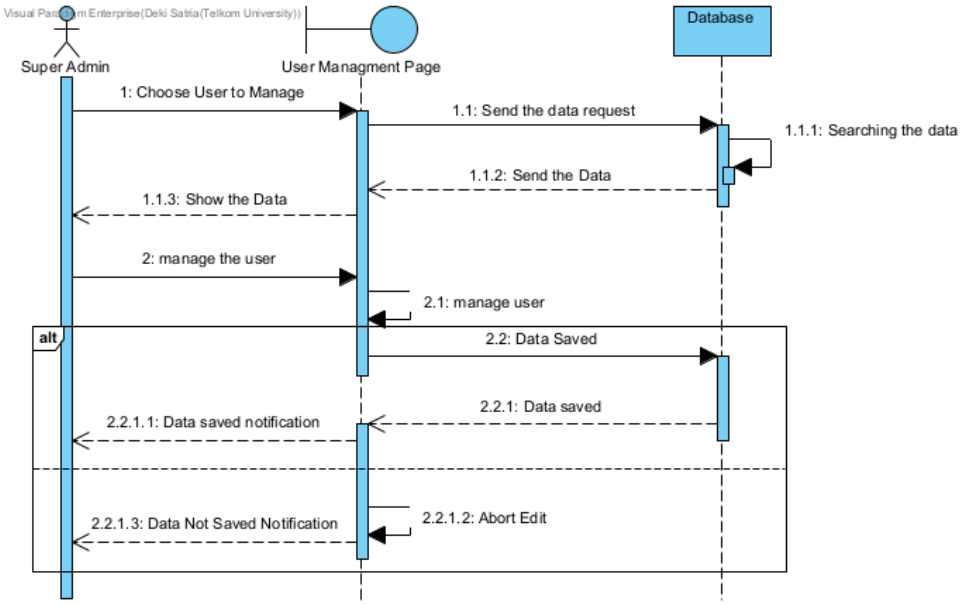

Figure 6. User Management Sequence

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3.1.2 Development and testing

We will only show some of the system's UI. The system development was conducted using Laravel as the PHP framework and MYSQL as the database. Figures 7 and 8 show snippets of the developed main page of the website.

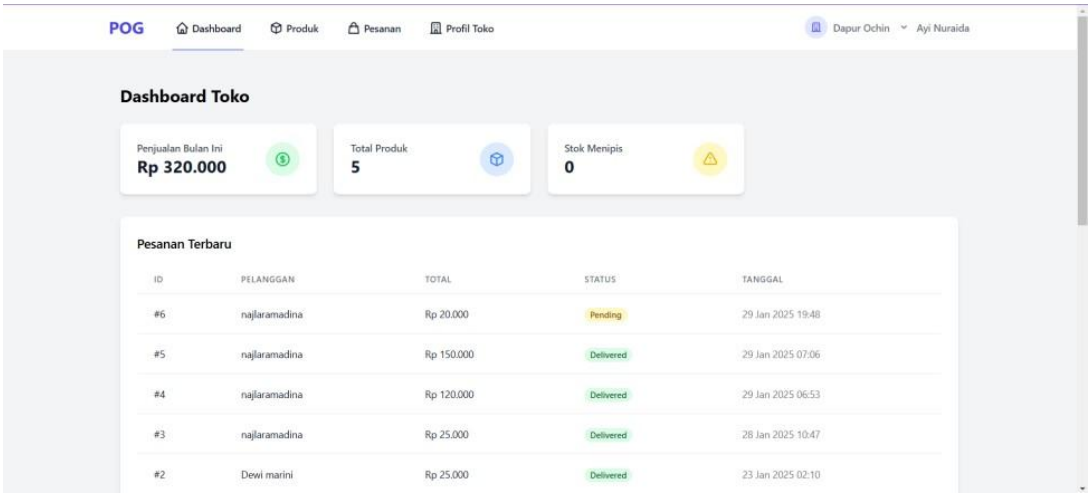

Figure 7 Store Admin Dashboard Page

Figure 7 shows the admin dashboard page. In the dashboard page, the user, in this case the admin, could see all the orders that come into their store. On this page, the admin could see the buyer's total payment needed to complete the delivery status and the date and time of the order. Figure 9 shows the page that the admin can use to edit the store's information. On this page, the admin can change the store logo, name, description, address, and other information about the store. The complete website page can be accessed at the link provided above.

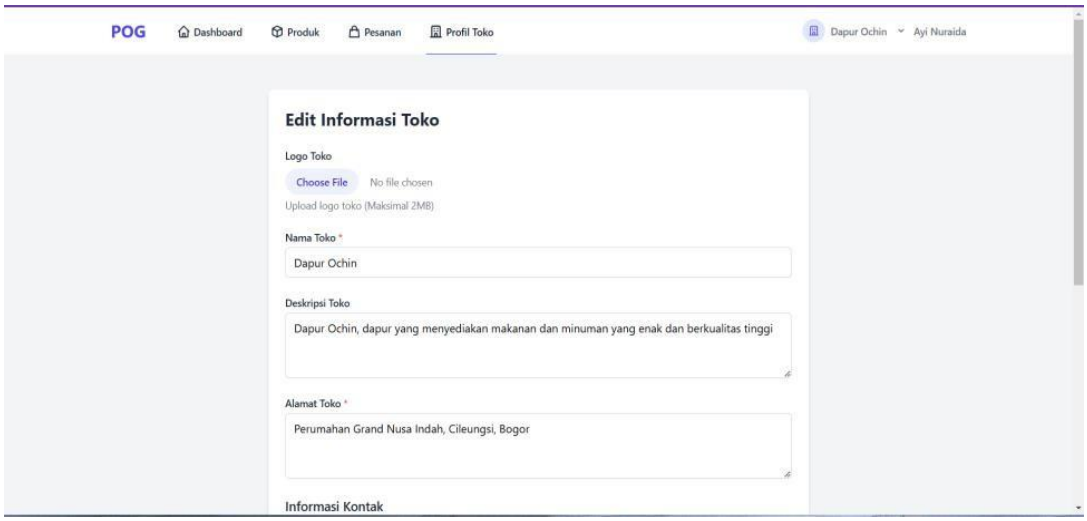

Figure 8 Store Information Edit

The testing of the e-marketplace website is conducted in two phases. The first phase is black box testing to test if the process is right, and the second phase is the user acceptance test to determine the users' acceptance. The black box testing was conducted on all the features of the websites. We have 25 test cases in both the black box and UAT testing. The black box and UAT test case consisted of several columns. The test cases can be seen in Table 2.

Tables 2 Test Case Samples

Scenario ID	Case ID	Test Scenario	Type	Test Case	Pre Condition	Steps Description	Expected Result	Stasus
TS.001	TC.001.001	Pengujian Login Pengguna	Positif	Input user name yang valid	Mengakses website POG	1. Mengakses website POG 2. Memasukan	Berhasil masuk dan diarahkan ke halaman dasboard	Pass

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Scenario ID	Case ID	Test Scenario	Type	Test Case	Pre Condition	Steps Description	Expected Result	Stasus
						username dan password 3. Tekan Tombol Masuk		
TS.001	TC.001.002	Pengujian Login Pengguna	Negatif	Input username yang tidak valid	Mengakses website POG	1. Mengakses website POG 2. Memasukan username yang tidak valid dan password 3. Tekan Tombol Masuk	Tidak berhasil masuk dan diminta untuk memasukkan ulang username yang valid	Pass

The test case above uses Bahasa Indonesia since this test case will be used as a scenario for users testing the e-marketplace website. All 25 test cases were passed, meaning that the intended function of the feature is met based on the test cases. After all the test cases have been passed in the black box testing, the next step is conducting the UAT. In this UAT, the users tried the application based on the test cases. The users are the POG admin and several store owners. From this test, we will get the response from the users. From this test, we got some feedback. The first feedback we got was about the error notification. In the login process, we found that the users wanted better notifications about the error. The user wants to know whether the error in login input is the pass or username. The next feedback we got was about the phone number length and character limit. In our development, we do not limit the phone number length. In Indonesia, the limit for phone numbers is 12 characters and only a number. However, the field accepts more than 12 characters and can accept other characters instead of only numbers. The next feedback is about the character limit in product stock. The user found that the text field could accept characters, whereas the correct way is only numbers can be accepted. The next feedback we got from the user was about the store name limitation. The user wants to limit the length of the store to around 30 to 50 characters.

Another finding from the UAT is a bug surrounding the picture on the website. In our first test, we could show and save the picture inputted by the user. However, in our UAT, the user found that the picture was not loaded properly and shown as broken. This finding is crucial because this bug needs to be corrected. If the picture is not loaded properly, then the main purpose of this website will not be met.

3.2 Discussion

This research found that Waterfall is suitable for e-marketplace development. However, the rigid development process hinders any change usually found in the process. Standish group studies also found that the waterfall methodology has a twice higher chance of failure [28]. This finding is related to our own experience in the development programs. As we mentioned, the users found a bug in our website, which we did not find in our development process. This kind of bug can be detected earlier using agile or another iterative methodology. Agile methodology is more open to change and accommodating change in the development process [28]. Even though we tried to decrease the chance of incomplete requirements using user-centered requirement engineering in our elicitation process, this step was not enough. As mentioned in Kanaparan et al.'s research, we found that communication is essential in the process where the waterfall could limit it [29].

Another finding we found is about the testing process. Testing only the final product can prove to be fatal. Our test found that a lot of details were missing from our website. The requirement elicitation process should include something like the character limit and input constraint. However, we found this in the UAT phase. This kind of limit should be found in the black box testing. One of the black box tests is that the results depend on how many test cases are conducted [30]. With inadequate test cases, not all constraints can be found. Therefore, we conclude that black box testing and waterfall testing are doable but not the best methodologies for developing complex systems like e-marketplaces. An iterative method will ensure that errors and inadequate test cases are found early in development.

4. CONCLUSION

e-Marketplaces, especially localized ones, can improve the income of the SMEs affiliated with the e-marketplace. POG is one of the marketplaces in Bogor that serves the SMEs around the Grand Nusa Indah Bogor housing area.

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In order to accommodate the need for SME products in the housing area, POG used WhatsApp as the tool, but this tool was not effective as the selling platform. Therefore, e-marketplaces need to be developed. Waterfall is one of the SDLC methodologies that can be used in software development. From the research conducted, we found that using waterfall has several downsides, such as incomplete requirements and test cases and late identification of bugs. Even though the user-centered design approach is integrated into the requirement specification process. The lack of detailed requirements also proved to be fatal in the development process. A lot of details were missed from the development, which the user found during the testing process. This kind of finding can be prevented if the testing process is conducted iteratively. Therefore, iterative methodology, such as Agile, is more suitable for this kind of system. We also found that using black box testing really depended on the quality of test cases. Many things will be missed if the test cases are inadequate or lacking depth. Therefore, when using the black box, we also need to check the thoroughness of the test case to ensure all of the bugs identified before UAT and deployments.

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