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Integration of Design Sprint Method into Mobile Development Application Life Cycle to Create MobilePQI Application Prototype

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ABSTRACT

This study aims to create a mobile-based learning application that can be used to support blended Learning. Blended Learning is carried out synchronously, either online using Zoom, Google Meet, or offline in the classroom. Asynchronous Learning is implemented using MobilePQI Apps. MobilePQI Apps was developed using the Kotlin programming tool and MADLC methodology (Mobile Application Development Life Cycle). MADLC consists of seven stages: Identification, Design, Development, Prototyping, Testing, Deployment, and Maintenance. We use the design sprint method, Figma to create a design prototype, and Kotlin development kit. The testing method used heuristics evaluation, which tests 10 usability principles. The number of questions asked was 115, with 5 respondents consisting of 3 students and 3 lecturers. The results of the heuristics evaluation score were 89% of respondents answered YES. It can be concluded that the 10 usability principles of the Prototype were **acceptable**. The SUS results show a score of 74, which means the application's user interface is in the Good and acceptable category.

Keywords: *mobile application; kotlin development kit; blended learning; heuristics evaluation*

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1. INTRODUCTION

UIN Syarif Hidayatullah's vision is to become a world-class university that excels in the integration of science, Islam, and Indonesianism. In line with this vision, every UIN student is encouraged to be able to realize one of the goals, namely developing and spreading the Islamic religion [1]. Therefore, the ability to read and write the Al-Quran must be mastered by all UIN Jakarta students. However, based on research conducted by the Ministry of Religion through Lajnah Pentashihan Mushaf Al-Qur'an (LPMQ) in 2019, the ability to read the Qur'an of UIN Syarif Hidayatullah Jakarta students was ranked 4th with a score of 3.68. Meanwhile, the ability to write the Qur'an is ranked 7th with a score of 3.46 [1][2]. Efforts that UIN Syarif Hidayatullah Jakarta has made include holding a webinar to improve competence in reading and writing the Quran, which was held at FDIKOM, and the launch of the Center for Al-Quran Taklim Literacy Studies (PUJI TAKLIM) [3].

The main causes of less effective online Learning that teachers typically experience are time limits, signal constraints, and delayed feedback. These are examples of learning obstacles. Therefore, blended Learning is expected to be the solution [4]. In blended Learning, material can be provided asynchronously in the form of learning videos, electronic books, independent assignments in the Learning Management System (LMS) that have been provided, and synchronous (live) meetings used for discussions and discussing material that participants have studied independently in the LMS[5]. When developing a blended learning design, one must pay attention to both interaction models. Teaching material designs can be developed using the ADDIE model, which consists of five phases: analysis, design, development, implementation, and evaluation [6].

One of the electronic-based learning media that is widely used to support blended Learning is mobile-based applications. Afandi Nur Aziz Thohari has developed a mobile learning application as a learning tool at Diponegoro University. The term E-Learning contains a very broad meaning, so many experts have explained the definition of E-Learning from various points of view. One definition that is quite acceptable to many parties is, for example, Darin E. Hartley, who states that E-Learning is a type of teaching and earning that allows teaching materials to be delivered to students using the internet, intranet, or other computer network media. The benefits of E-Learning, according to Bates and Wulf [7], consist of four things, namely: (a) Increasing the level of learning interaction between students and teachers (enhanced interactivity); (b) Allowing learning interactions to occur from anywhere and at any time (time and place flexibility); (c) Reaching a wide range of students (potential to reach a global audience); (d) Making it more accessible to refine and store learning materials (easy updating of content as well as archivable capabilities)[8], [9].

Based on this theory, an application needs analysis is carried out consisting of functional and non-functional needs, namely as follows [10], [11], [12]:[13] (1) Functional Needs: division of users into three groups (students, lecturers, administrators); lecturers can upload materials, add classes and lecture materials, make evaluations; students can download via mobile device (smartphone), carry out evaluations and see their learning results; administrator for E-Learning maintenance. (2) Non-Functional Requirements consist of operations and security. Operational means clients can access it from various browsers and smartphones. Security can be applied by using a password in the login form to differentiate user types and their respective access rights.

2. METHODS

Mobile Application Development Life Cycle (MADLC) is part of a research report that contains information about the methods used to develop mobile applications. MADLC consists of seven stages: (1) Identification, (2) Design, (3) Development, (4) Prototyping, (5) Testing, (6) Deployment, and (7) Maintenance [15], [16]. Identification is the first stage of the mobile application development process, which aims to identify ideas or concepts that will be developed into an application. This stage is carried out by collecting ideas from the development team and evaluating their feasibility using Brainstorming and Focused Group Discussion (FGD) techniques.

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Design is the next stage of the mobile application development process, which aims to design the scheme of the application to be developed and determine the features that will be embedded in the application. This stage is carried out using tools such as wireframes or flowcharts to describe the schematic of the application to be developed. Development is the next stage of the mobile application development process, which aims to write the program code needed to run the application that has been designed. This stage is carried out using a programming language appropriate to the application platform to be developed, such as Java for Android or Swift for IOS.

The prototyping stage in this research uses the Figma application to create a high-fidelity prototype of the MobilePQI application. This Prototype is a temporary version of an application that has been developed. It aims to determine the advantages and disadvantages of the application before further development is carried out. Testing is the final stage of the mobile application development process, which aims to test the application that has been developed and fix bugs or problems detected during the testing process. This stage is carried out using simulation in the Figma application, and users are involved in testing the application using heuristic evaluation. The deployment stage uses the Kotlin Development Kit to implement the design that was created with Figma. The maintenance stage was not carried out in this research because the main focus was creating a prototype of the MobilePQI application.

3. RESULTS AND DISCUSSION

3.1. Identification

Brainstorming involved lecturers and students of the "*Praktikum Qiro'ah dan Ibadah*" Course. The result of this stage is a list of features that must be in the MobilePQI application.

Table 1. *MobilePQI application features*

No.	Features	Description
1.	Forum	Discussions among students, between students and lecturers
2.	Comments	Students and lecturers can give questions and answers regarding the material or assignment presented.
3.	Change Language	Select the language to use
4.	Syllabus	Lecturers give syllabus information about the courses to students.
5.	Material	Students can access learning media (videos, documents, and picture explanations).
6.	Assignment	Students can evaluate the learning outcomes by submitting assignments and assessing the grades given.

3.2. Design

The design sprint method has 5 phases: (1) map, (2) sketch, (3) decide, (4) prototype, and (5) test [17], [18], [19], [20], [21], [22]. At the map stage, the team carries out activities to create sprint questions, How Might We Solve (HMWS), and user flow. The team maps the problem and determines the overall sprint goal. At this stage, the entire team must be involved in understanding users and their problems by creating sprint questions. Sprint questions are used to assist the team in developing innovative solutions to the problem. These questions help the team focus on predetermined goals and solve problems effectively and efficiently. These questions can also be used to evaluate the success of solutions that have been developed and gather feedback on prototypes that have been created. We use Miro design tools to create sprint questions and HMW.

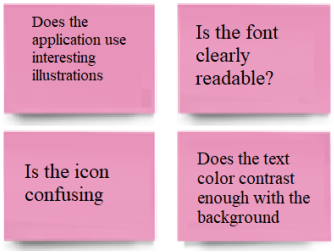

Figure 1. *Sprint question samples*

Figure 1 shows four samples of sprint questions. The team used sprint questions to discuss the application requirements and the user needs. In the next step, we create "How Might We Solve" (HMWS) questions to help the team develop innovative solutions to the problems faced. These questions are designed to help the team focus on the problem they want to solve and open their minds to more creative and innovative solutions. HMWS questions usually begin with "how" or "how" to invite the team to think of new ways to solve the problem. Figure 2 shows HMWS for students and lecturers. HMWS student "How to access course materials", will trigger alternative ways to

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access the course lessons. Next, the team created a user flow to answer the HMWS.

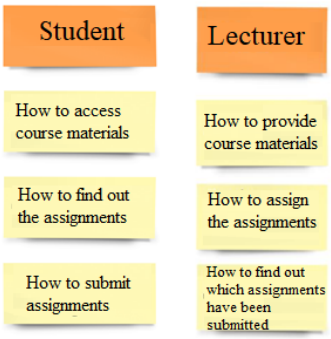

Figure 2. *HMWS for student and lecturer*

User flow is a user's path when interacting with a product or service, such as a website or mobile application. It is a way to map and describe the steps and actions taken by a user while completing a specific task or achieving a specific goal in a product or service. Figure 3 shows the lecturer opening the application, entering the "Syllabus" menu, and inputting the syllabus.

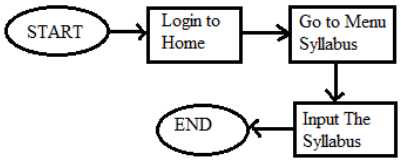

Figure 3. *User flow for lecturer (input syllabus)*

The second stage of the design sprint was sketch. The sketch stage involves exploring different design options and identifying the most promising direction for the product. The user needs, and requirements have to be considered in relation to the technical possibilities of the design and any constraints or limitations of the system. The sketch stage is important in the prototyping process because it allows the team to quickly and cheaply test different ideas and concepts before moving on to the more detailed and expensive prototype stage. This is the initial stage of the prototyping process, where a rough idea or concept for the product is developed and refined. During this stage, the designer or team will likely create several sketches or drawings that explore different ideas and approaches to the product. These sketches can be as simple as a rough pen sketch or as detailed as a digital rendering.

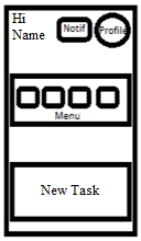

Figure 4. *Home page sketch*

Decide stage. The team makes the final decision about the design of the theProtoypee to be developed. Based on the sketch that was done previously. So, it was decided that the sketch design for the prototype is in Figure 5.

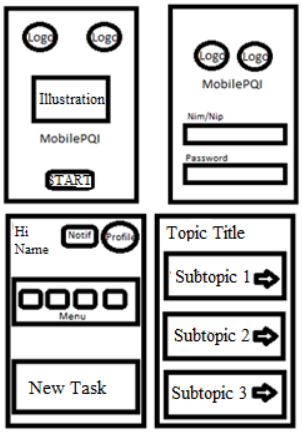

Figure 5. *The final sketch*

Sketches that have been decided to be developed into high-fidelity prototypes will be made into interactive versions using Figma software.

Figure 6. *The selected color palette*

3.3. Development

The development stage in application development is the stage where a prototype is created and developed. At the development stage, the team will build a prototype according to the approved sketch. First of all, we will create a task list for the mobilePQI application. A sample of the task list can be seen in the table below.

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Table 2. *Task list*

Task	Title	Requirement	Completion Criteria	Max time	Possible Solution Path
1.	Sign up	Open the App	on the home page	3 “	-
2.	Sign in	Open the app, Already have an account	on the home page	2”	-
3.	Create Syllabus	Open the app, Already have an account, Open the syllabus menu	A pop up appears "Perubahan berhasil disimpan"	5”	Homepage → Silabus → click icon (+) → write syllabus → click tick (v) icon

The first version of a high-fidelity prototype used the basic colors yellow and green. We chose the color of this application's interface design according to the color symbolization stated in the Qur'an. Six colors are mentioned in the verses of the Qur'an as inspiration, namely red, yellow, green, blue, black, and white[14]. Yellow is a symbol of the image of humans in the world, and green is a symbol of a fertile earth. In the second version of the design, the blue color was chosen, symbolizing the human condition on the Day of Judgment. Figure 7 shows the high-fidelity prototype for Splash and Login Page. The Figure 8 show The home page.

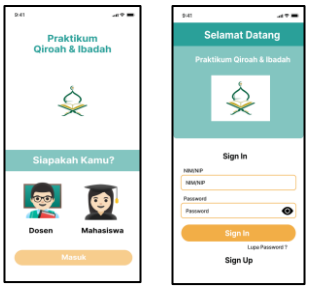

Figure 7. *Splash and login page design version 1*

Figure 8. *Home page design version 1*

3.4. Prototyping

Prototyping is an important stage in the development process because it allows the team to test and develop the application design before spending significant time and resources on building the final product. At this stage, we developed an interactive prototype using the Figma application (figma.com). We developed the version 2 design with a blue color to match the color of the logo and statutes of UIN Syarif Hidayatullah Jakarta.

Figure 9 shows a prototype of the interactive design Version 2. The design scenario from Figure (a) is the splash page when the user opens the application. Figure (b) Login page: after logging in, the user is on the main page (home), which has four main menus (c). Figure (d) is the display when the user selects the material menu.

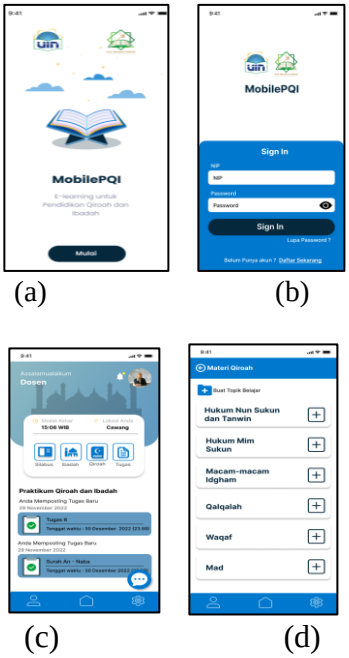

Figure 9. *Interactive prototype version 2*

3.5. Testing

Prototype testing aims to identify and fix bugs or problems that could affect the user experience or cause the application to fail. Remote user testing methods, interviews, and surveys were used in this research. Heuristic evaluation is used to see whether the prototype being developed meets the 10 usability principles. Online remote user testing method via Zoom with 5 users. Users are given the opportunity to explore the prototype according to the link provided in around 5 minutes. Then, the team asked several questions regarding

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usability and asked users to answer the heuristics evaluation questionnaire that had been prepared on Google Form.

Table 3. *Heuristics evaluation*

No	Question	Yes	No
1. Visibility of system status			
a.	Does each screen begin with a title that describes the page's content?	5	0
b.	If the user selects or changes the order of each object, does the system respond with changes?	4	1
c.	Do clickable elements have feedback when the element is pressed?	5	0
2. Match between the system and the natural world			
a.	Is the system designed according to custom?	5	0
b.	Are navigation instructions placed in a place that is familiar to the user? for example, like above or on the side	4	1
c.	Does the icon represent its use?	5	0
3. User control and freedom			
a.	Can users cancel the feature if they wish?	5	0
b.	Can users edit personal information?	4	1
c.	Does the page have breadcrumbs that provide nested navigation?	4	1
4. Consistency and standards			
a.	Is the page navigation similar to navigation on other pages?	5	0
b.	Is the title always on every page?	5	0
c.	Are the available icons intuitive? (For example, the search icon looks like a magnifying glass)	5	0
d.	Is the application consistent in its use of language?	3	2
5. Error prevention			
a.	Is the name of a field always visible?	5	0
6. Recognition rather than recall			
a.	Does the system or application not confuse users?	4	1
b.	Does the placement of components (home icon, etc.) follow a pattern that is familiar to users?	4	1
c.	Are the sizes and colors of components consistent throughout?	5	0
7. Flexibility and efficiency of use			
a.	Does the homepage display menus that users frequently use?	5	0
8. Aesthetic and minimalist design			
a.	Does the design displayed have aesthetic value?	5	0
b.	Does the color selection match the application theme?	5	0
9. Help user recognize, diagnose, and recover from error			
a.	Is there any indication when the button cannot be pressed?	2	3
10. Help and documentation			
a.	Is there a live chat feature in the application?	5	0
b.	Is there a help feature?	4	1
		103	12

From the table above, users answered the question **Yes,** as many as 103, and 12 answered **No**. Based on the assessment index table, the percentage of yes answers was 89%. It can be explained that the interactive prototypes has a good index. In other words, the phenotype meets 10 of the principles of heuristic evaluation.

Table 4. *Assessment index (AI)*

No.	Index	Percentage
1.	Good	> 66
2.	Average	33,1 - 66
3.	Poor	<33

$$\text{Assessment Index} = \frac{\text{Assessment Score}}{\text{Max Score}} \times 100\%$$

Max Score = number of users x number of questions

Max Score = 5 x 23 = 115

AI = (103 / 115) x 100% = 89,56%

3.6. Deployment

The deployment stage is implementing the design orPrototypee into a predetermined programming language, carrying it out on a server or hosting platform, and configuring the necessary settings so that users can access the application.

The programming language used to develop the mobilePQI application is Kotlin. Kotlin is a modern, statically visualized programming language that runs on the Java Virtual Machine (JVM) platform. Kotlin uses the LLVM compiler, which means it can be compiled into JavaScript code. Unlike the Java language, the Kotlin language is simpler, more responsive, and doesn't use too much memory.

One example is running the "Hello World" program in Kotlin by simply adding the print ln ("Hello World") syntax to the main function to print "Hello World". Kotlin was developed by a team of programmers from the Russian company JetBrains. Kotlin development is led by Dmitry Jemerov, who serves as head of JetBrains. JetBrains is a company developing an integrated development environment (IDE). Kotlin is usually used in Android Studio, which is an IDE for Android built on JetBrains IntelliJ IDEA software. Kotlin IDE is downloaded from the website: https://developer.android.com/studio It has a user-friendly GUI and is easy to install.

After the project has been created, the Google Cloud Platform is used as server-side hosting to be accessed by users, as shown in Figure 10.

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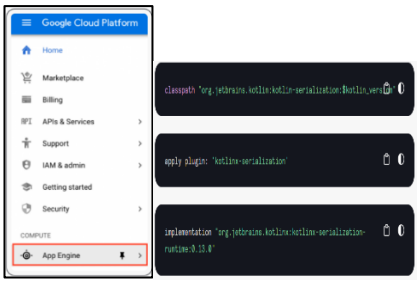

Figure 10. *Google cloud platform*

The application that has been deployed is then subjected to a user acceptance test. Developers create user scenarios. One of the lecturer user scenarios was"create assignment" for students. Student has user scenario "view and submits the assignments". User Acceptance Test (UAT) involves 3 lecturers and 3 students. User satisfaction is measured using the SUS (System Usability Scale) method by giving 10 questions to the testee after completing all tasks in the user scenario.

Table 5. *SUS question*

No.	Index
1.	I think that I would like to use this system frequently.
2.	I found the system unnecessarily complex.
3.	I thought the system was easy to use.
4.	I think that I would need the support of a technical person to be able to use this system.
5.	I found the various functions in this system were well integrated.
6.	I thought there was too much inconsistency in this system.
7.	I imagine that most people will learn to use this system very quickly.
8.	I found the system very cumbersome to use.
9.	I felt very confident using the system.
10.	I needed to learn a lot of things before I could get going with this system

In the table SUS question above, each odd number of answers the user receives is reduced by 1, while even number 5 is reduced by the score of the user's answer. The Score column is obtained from the total score (Total column) multiplied by 2.5. The SUS value results are obtained from the average user SUS value. The SUS test results for the six responders are shown in Table 6. SUS computation for question items 1, 3, 5, 7, and 9 in user 1's example is decreased by 1. The User's answer scores are shown in table 6. For each question item 1, 3, 5, 7, and 9 in user 1, the SUS computation is dropped by one. The scores from the responses to questions 2, 4, 6, 8, and 10 were deducted from the 5 score. The total score for each user is multiplied by 2.5.

Table 6. *User's answer score*

User	Question Item									
	1	2	3	4	5	6	7	8	9	10
1	4	2	4	1	3	1	5	2	4	2
2	3	1	4	1	2	3	3	1	4	1
3	4	1	3	3	4	1	5	1	3	2
4	3	2	4	1	3	1	3	2	4	2
5	3	2	4	2	4	1	4	1	3	3
6	4	2	3	1	3	1	3	1	4	2

Table 7 shows the results of the SUS calculation, which produces a SUS score of 74. The SUS score is compared with the SUS guide in Figure 11.

Table 7. *SUS score*

User	Question Item										Total	Score
	1	2	3	4	5	6	7	8	9	10		
1	3	3	3	4	2	4	3	3	2	2	29	73
2	2	4	3	4	1	2	2	4	3	4	29	73
3	3	4	2	2	3	4	4	4	2	3	31	78
4	2	3	3	4	2	4	2	3	3	3	29	73
5	2	3	3	3	3	4	3	4	2	2	29	73
6	3	3	2	4	2	4	2	4	3	3	30	75
SUS Score												74

Figure 155 below shows a red line crossing the SUS scale area. It refers to net promoter score (NPS) in the yellow area or Passive category[23]. NPS measures customer loyalty by looking for customers who are enthusiastic about using the product or services. The SUS Score provides that although they are pleased with the design, they are not happy enough to be considered promoters.

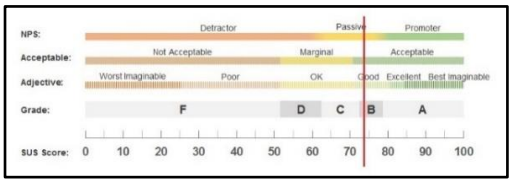

Figure 11. *SUS Scale interpretation*

The Acceptable scale is green, and the Adjective scale crosses the Good area, showing that the application is good and acceptable for users. The Grade scale shows a value of B, and the SUS score is 74. This shows that the application prototype still has the potential to be

maximized to Grade A, and the SUS score is in the range of 81 to 100.

Table 8. *The values from the graphic in Figure 9*

Grade	SUS Score	Adjective	Acceptable	NPS
B	74,16	Good	Acceptable	Passive

From Table 8, we imply that the SUS score shows an acceptable design, but the NPS value on the graph is Passive. We can suggest that acceptable design did not mean the user desired to participate in promoting the application to other users.

3.7. Maintenance

In this research, no maintenance phase was carried out because the deployment used the Google Cloud Platform.

In this research, the design sprint method carried out the user interface design process. In practice, there is an iterative process in creating designs that is carried out at the MADLC design and development stage so that the latest version of the design (version 2) is used at the prototyping stage.

Heuristic assessment is employed in the design sprint methodology to conduct design testing and investigate user experience. It was decided to employ a version 2 design during the deployment phase after discussing the findings and making color changes. The application is tested using SUS once it is complete and accessible through the Google Cloud platform. By integrating design sprints into MADLC, application development can be done in just 75 days.

CONCLUSION

The outcome of this research is a MobilePQI application that may be utilized to facilitate blended Learning. The Mobile Application Development Life Cycle (MADLC) process consists of seven stages—identification, design, development, prototyping, testing, deployment, and maintenance—followed when developing applications. Ninety percent of users who tested the application agreed that it could facilitate blended Learning.

The design sprint approach was used in this study's user interface design process. The design process is iterative, beginning at the MADLC design and development stage and ending with using the most recent design (version 2) during the prototype phase. Based on the heuristic evaluation results, which have an index of 89,56% (Good) and a SUS value of 74.16, the application design has a positive user experience. In other words, good design will also provide good usability.

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