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Development of Financial Management Information System Based IoT Integrated Using Waterfall Model

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Abstract

Financial management is a core subject of the study program that must be mastered by students of the Sharia Financial Management study program. This course presents material about financial management in theory. Based on the results of initial observations that have been made, Sharia Financial Management students have not even tried to directly practice financial management using an information system in managing finances. This happens because several existing financial management information systems are closed systems so students cannot access the system. Therefore, this study proposes a financial management information system with the support of IoT technology as a simulation or practice medium for Sharia Financial Management study program students. The proposed method in this study uses Waterfall model. Based on the average value of TAM analysis, it is 81.72%, where this value is included in the Very Good for use to strengthen the Financial Literacy of Sharia Financial Management students.

Keywords: **Financial; Management Information System; SMEs; TAM (Technology Acceptance Model); Waterfall.**

1. Introduction

Technology is a result of human engineering that is used to make human work easier and less time consuming [1]. Technology has become very important in every aspect of human life, especially during the current pandemic. In fact, with the rise of technology today, a country can dominate the world. The increasingly rapid development of technology has led to the need for improvements in various areas of life, especially in the fields of services and education.

The learning process in higher education has experienced very significant changes, especially during the current pandemic. The media used by lecturers in the learning process certainly continues to change. Whiteboard-based media is usually used by lecturers as a means of delivering material from the COVID-19 pandemic onwards New Normal currently rarely used anymore. This situation makes the teaching and learning process in universities change to digital learning by utilizing several digital media, for example lecturers provide materials using Ms. Power Point or Ms. Excel and its kind. However, these media have limitations, namely they cannot provide a real picture of courses that require in-depth understanding, for example financial management courses.

Financial management is a core subject of the study program that must be mastered by students of the Sharia Financial Management study program. This course presents material about financial management in theory. Based on the results of initial observations that have been made, Sharia Financial Management students do not yet know, have not even tried to directly practice financial management using an information system in managing finances. Students cannot practice financial management directly due to limited tools. Actually there are tools to practice financial

management. However, specifically for personal financial management. In fact, students are required to be able to manage company finances, one of which is MSMEs. In fact, graduates of the Sharia Financial Management study program not only focus on independent financial management, but also focus on managing company or institutional finances. The financial management tool that is opened to the public is only the personal financial management system, while the company financial management system is a closed system. This means that students must have an account to be able to use the system. To be able to have an account, students must make a payment. This burdens students and cannot be used as an alternative solution.

The next problem is that students often use paper as a tool for calculating, for example to calculate company profitability. In fact, using this paper will cause several problems. For example, time and waste efficiency. When students use paper as a tool for calculating, it will take a relatively longer time compared to using other calculating tools.

In the field of economics, Financial Literacy is the scope of knowledge and skills of a person or community in formulating a policy and making effective decisions by utilizing all the financial resources they have[2]. In 2019, OJK conducted a survey to measure public understanding of access to financial services available, not limited to existing financial institutions, but also regarding the application of financial digitalization to make effective decisions and policies. The survey results show that the level of public understanding of financial literacy reached 38.08% [3]. This figure is quite good because it shows a significant increase from the previous survey results, namely 8.33% in 2016. However, if we look at the percentage of respondents' financial literacy based on the financial sector, Microfinance Institutions have the lowest percentage compared to other financial sectors, namely of 0.85%. On the other hand, if we look at the classification of how well the public understands financial literacy, the survey results show that 21.84% of the public are classified as Well Literate, 75,69% Sufficient Literate, 2,06% Less Literate, and 0.14%Not Literate. From these results it can be concluded that public knowledge alone is not enough in managing finances, but skills are also very important in using financial management products.

Several studies related to the development of media as a learning tool have been developed using computer technology. Rahardja et al. (2018) aims to develop accounting applications as a means of recording financial reports[4]. Susanti & Sagoro (2018) developed a mobile-based Mikuro. This application was developed as a medium for preparing accounting financial reports[5]. The results of this research indicate that the product is feasible with an accuracy level of 4.4. Finally, Kudiasanti & Sukirno (2017) developed a mobile-based application on the Android platform[6]. The application is a Financial Accounting application. It can be concluded from this research that the applications produced are categorized into the Feasible category with a feasibility value of 2.99. Asri, et al. (2024) developed a technology-based financial system to improve the accuracy, transparency, and efficiency of financial management.[7] The application used is a financial management application integrated with IoT technology. The results of the study show that this technology-based system provides real-time financial information through the cloud, automation, and data analysis, which improves the efficiency of management, transparency, and accountability of school financial governance. The last study conducted by Jaiswal, et al. (2024). This study explores the colorful IoT operations, including smart budgeting tools, automated savings programs, and real-time spending monitoring, which inclusively enhance fiscal knowledge and discipline. In addition, the paper discusses the potential of IoT to facilitate flawless transactions and robust fiscal advice, thereby promoting better fiscal health [8].

Some of this research is considered relevant to the proposed research, however, this research is limited to developing accounting applications with only 1 level of user. The weakness is that 1 user level does not allow for data sharing. Therefore, this research proposes IoT technology (Internet of Things) as a technology that can enable data sharing with more than 2 user levels [9].

Financial management systems, especially in companies, require an integrated system with all existing divisions. IoT technology allows integration of the needs of all divisions in a company. Therefore, this study proposes a financial management information system with the support of IoT technology as a simulation or practice medium for Sharia Financial Management study program students. IoT reduces the need for constant data transmission to the cloud, which lowers bandwidth costs and minimizes reliance on expensive data centers. This results in cost-effective, scalable solutions that optimize operations. The method proposed in this study uses Waterfall model. Waterfall is an approach to software development with a systematic development cycle[10]. Not only does it produce good quality software like the software developed by Sudrajat et al (2019)[11] namely the study of improving the quality of websites, with a gradual process Waterfall The model can minimize errors that may occur during software development. Additionally, documentation is in development software well organized, because each stage must be completed completely before moving on to the next development stage [12].

2. Method

In building an integrated financial management system with IoT technology, this research adopts research stages Waterfall developed by Ian Sommerville [13]. Waterfall is an approach to software development with a systematic development cycle. It means that it allows for departmentalization and control. The process of developing a gradual model one by one, thus minimizing errors that may occur. The model can minimize errors that may occur during software development. Additionally, documentation is in development software well organized, because each stage must be completed completely before moving on to the next development stage. The stages of system development include: (1)Problems Identification; (2)Requirements Analysis; (3)Designing Requirements; (4)Implementation; (5)Testing; and (6) Maintenance [14].

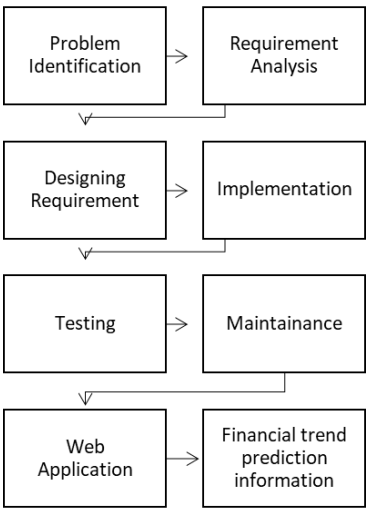

Figure 1. *Waterfall model's diagram.[15]*

This research identifies existing problems through direct interviews with lecturers who teach Financial Mathematics courses. Apart from that, this research also identifies problems through interviews with students who have taught the course. Requirement Analysis is carried out to obtain any needs in developing a system based on the results of the problem identification stage through *Focus Group Discussion* (FGD). In this research, system requirements are categorized into: (1) System users; (2) Details of the material to be entered into the system in accordance with the curriculum; (3) Media used in developing the system; (4) Media that will be used as a system platform; and (5) System design.

Based on the results of the system analysis, the system design has been well prepared along with its development flow. The system development flow is explained through *flow chart* so that

information at the requirement analysis stage is more clearly defined. The results of designing system requirements are not only the interface design, but also the way the system works [16]. The results of the design of system requirements will facilitate the system implementation stage (system coding) at the next stage. The system was developed using a website-based platform with the PHP 7.0 programming language. Based on the *Website* platform proposed in this research so that users can easily operate it (effective and efficient) [17]. At this stage, IoT technology is implemented according data sharing with other devices and users (multi user). Besides, IoT in this study used to obtain the Financial Trend Prediction Information. The application is designed using PHP and MySQL database. Hardware in this study uses sensor, IoT Gateway, Cloud Server & data base, and web application. The application is divided into 10 parts, namely the Dashboard page, Data Unit Menu, Data Usaha Unit Menu, Jurnal Umum Menu, Buku Besar Menu, Arus Kas Menu, Laba Rugi Menu, Perubahan Modal Menu, Neraca Menu, and Financial Trend Prediction Information page.

The type of testing in this research is *black box*. This testing is carried out only focusing on observing the input and output results without knowing the code structure of the software [18]. At this stage, researchers need feedback to improve the system that has been created by testing the system on users, namely resource persons who are qualified in their field. To determine the accuracy of the resulting system, this research uses TAM technique.

The Technology Acceptance Model (TAM) is a theoretical framework used to explain and predict user acceptance of new technologies. Developed by Fred Davis in 1989, TAM is based on the idea that the acceptance of a technology is influenced by two key factors such as Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) [19]. PU - The extent to which a person believes that using a particular technology will enhance their job performance or daily life. PEOU – The degree to which a person believes that using the technology will be free from effort. These two factors influence a user's attitude toward using the technology, which in turn affects their behavioural intention to use it, and ultimately leads to actual system use.

$$Indicator\ Achievement = \frac{Number\ of\ Respondent's\ Answer}{Ideal\ Score}\ x\ 100\% \quad (1)\ [19], [20], [21]$$

Table 1. *TAM Analysis Category Source: Umanailo, et al. 2022, Mulyanto, et. Al 2022, and Amalia, et al. (2020)*

Percentage	Category
0% - 20%	Very Poor
21% - 40%	Poor
41% - 60%	Fair
61% - 80%	Good
81% - 100%	Very Good

3. Result

This research will focus on: (1) how to design or engineer an information system based on *user* need such as students of the Sharia Financial Management study program to strengthen financial literacy; (2) how to implement or develop an integrated financial management information system using *Waterfall* model by applying IoT as technology for data sharing; and (3) how to measure the feasibility of using an integrated financial management information system *Waterfall* model by applying IoT as technology to strengthen financial literacy.

A. Problem Identification

This research identifies existing problems through direct interviews with lecturers who teach Sharia Financial Management courses. The results of problem identification are as follows: (a) The

media for supporting learning in class still uses Power Point; (b) Students can only listen and know theoretically about the material, without being able to practice directly; (c) Students find it difficult to understand the material without supporting media for practice; and (d) Students need simulations in the form of applications to understand the material.

B. Requirement Analysis

Requirement analysis is carried out to obtain any needs in developing a system based on the results of the problem identification stage through *Focus Group Discussion* (FGD). The results of the FGD in this research were: (1) Users of the MSME Financial Management system. System users are admins, business owners, and transaction users; (2) Details of the material to be entered into the system in accordance with the curriculum: (a) General journal; (b) Ledger; (c)Cash flow; (d) Profit and loss; (e) Financial reports; (3) The media that will be used as a system platform is a web-based information system; and (4) The media used in developing the system is the PHP programming language.

C. Designing

Based on the results of the system analysis, the system design has been well prepared along with its development flow. The system development flow is explained through *flow chart* so that information at the requirement analysis stage is more clearly defined. The results of designing system requirements are not only the interface design, but also how the system works. The results of the design system requirements will facilitate the system implementation stage (system coding) at the next stage.

D. Implementation

The system was developed using a website-based platform with the PHP 7.0 programming language. Based on platform *Website* proposed in this research so that users can easily operate it. At this stage, IoT technology is implemented according to *share* data with other devices and users (multi user).

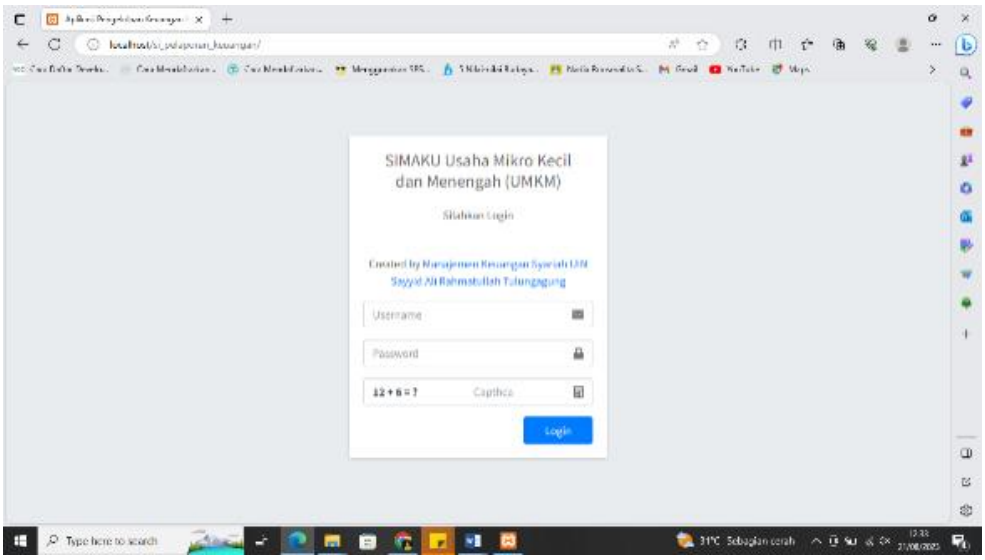

Figure 2*. The MSME financial management information system.*

E. Testing

This study purpose is to obtain Financial Management Information System and to know the user acceptance of technology. Based on this purpose, this study propose Black box testing and TAM Model. Testing using the Black Box in software development is to ensure a system works correctly. It focuses on checking the functionality of an application without knowing its internal code. The purpose is to ensure the software is free of problems. At this stage, testing is carried out by software experts.

After the developed system is ensured to run well, this study wants to know the acceptance of technology. To find out the acceptance of technology towards the developed system, this study adapts the TAM model.

4. Discussion

TAM is a theoretical model that explains how users accept and use technology [19], [20]. TAM in this study used to measure user acceptance of the system from 2 perspectives, namely PEOU and PU. At this stage, the subjects of the research are students of Islamic Financial Management. We invited 60 respondents consisting of Islamic Financial Management students to test the user acceptance of the system using the TAM. The test results using TAM with descriptive analysis are shown in Table 2.

Table 2. *Percentage of TAM analysis In PEOU Perception.*

Category	Score	Perceived Ease of Use						
		1	2	3	4	5	6	
Very Good	5	17	13	30	24	20	16	
Good	4	32	29	26	20	28	25	**Total**
Fair	3	11	18	4	16	12	19	
Poor	2	0	0	0	0	0	0	
Vary Poor	1	0	0	0	0	0	0	
R		**246**	**235**	**266**	**248**	**248**	**237**	**1480**
IS		**300**	**300**	**300**	**300**	**300**	**300**	**1800**
IA (%)		**82,22%**						
Achievement		**Very Good**						

Table 3. *Percentage of TAM analysis In PU Perception.*

Category	Score	Perceived Usefulness						
		1	2	3	4	5	6	
Very Good	5	19	17	21	19	21	23	
Good	4	32	25	26	20	22	17	**Total**
Fair	3	9	18	13	21	17	20	
Poor	2	0	0	0	0	0	0	
Vary Poor	1	0	0	0	0	0	0	
R		**250**	**239**	**248**	**238**	**244**	**243**	**1462**
IS		**300**	**300**	**300**	**300**	**300**	**300**	**1800**
IA (%)		**81,22%**						
Achievement		**Very Good**						

Testing with a descriptive analysis approach and referring to the 2 perceptions of the Technology Acceptance Model (TAM) method. The results of the analysis of 2 perceptions (PU and PEOU) using the TAM method show that the overall system accuracy is 81.72%.

Feasibility of an integrated financial management information system using IoT technology (*Internet of Things*) to strengthen the Financial Literacy of Sharia Financial Management students, they have gone through several trials, namely software tests and accuracy testing using TAM technique. Based on the average score of TAM, it is 81.72%, where this score is included in the Very Good category for use to strengthen the Financial Literacy of Sharia Financial Management students.

Based on these results, it can be seen that the Waterfall model is very effective for use in developing web-based information systems. The results of this study are also supported by research by Ratnasari, et al. [22], Rizaldy, et al.[23] and Absari, et al. [24]

5. Conclusion

Designing an integrated financial management information system using IoT technology (Internet of Things) to strengthen the Financial Literacy of Sharia Financial Management students using Waterfall model. The financial management information system was developed using IoT

technology (Internet of Things) with the aim of maximizing system performance, that is, it can be used by multi user so as to gather the whole record data from all registered MSME accounts. The feasibility of this financial management information system was measured through several trials, namely software testing, material testing and limited trials. Based on the average value, it is 81.72%, where this value is included in the Very Good category for use to strengthen the Financial Literacy of Sharia Financial Management students.

In this study, the system developed only functions to automate transactions and financial recording, without implementing AI or machine learning for financial predictive analysis. For further research, this study proposes machine learning for analyzing transaction patterns and detecting financial anomalies automatically.

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