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Website-Based Development of Learning Management System Using V-Development Method Model (Case Study: UNRI, Informatics Engineering Study Program)

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Abstract

Developers often use a software development model, namely the waterfall or classical models. Waterfall uses a systematic approach, so it tends to be archaic and will cause significant problems. The problems appeared when the process at the previous stage experiences happened, so the process could not go to the next stage. In addition, the tests were carried out for the solution to the problem. There was a need for a v-model development model. This model is the waterfall model development, then described in the form of *v*, and there was testing in each phase. This V-Model is an excellent model because it has good illustrations and clarity. The Website Learning Management System is built using the PHP programming language. Based on the results of the testing unit, the software used *whitebox*, and all units could run 100% well. Meanwhile, integration testing and testing systems using black boxes were 100% running well. Acceptance testing using ISO 25010 consisted of eight characteristics: functionality, efficiency, compatibility, usability, reliability, maintainability, security, and portability. These aspects could run well.

Keywords: Waterfall; V-Model; Learning Management System; ISO 25010.

1. Introduction

The most frequently used development model in system development is the waterfall model (Wahid A.A., 2020). Waterfall is an SDLC model that is considered as ancient and conventional model. Waterfall uses a systematic approach starting from the stage of system needs to the stage of maintenance (Saputra *et al.*, 2022). The dominant properties in waterfalls tend to have significant problems. The problem arises when the process in the previous stage have the problems, so the process is unable to move into the next stage (Murdiani & Hermawan, 2022). Based on these problems, fixing the previous stage is required so that there is no problem arise and can continue at the next stage.

Based on the identification of these problems, the use of the waterfall method in terms of cost and creation to approval of documents will certainly become expensive and will have very significant rework (Miharja *et al.*, 2022). Thus, if a small problem appears, most normal software developers put aside the problem. It can mean that the system is not running well and not according to the users' expectation.

According to these significant problems, it is necessary to use a method of repairing waterfalls. The v-model development method is an effort of the expansion by the waterfall method. This model is often considered an extension of the waterfall because its stages are similar to the waterfall model. In waterfall, the process is carried out linearly, while in the v-model it is carried out in branching. The use of v-model is often considered to minimize errors from waterfalls because each v-model phase has a testing phase.

Based on previous research from Graessler and Hentze stated that the v-model is an excellent model as the development design provides excellent illustrations and clarity. So, it is a kind of development method which can prevent project misunderstandings (Graessler & Hentze, 2020). Furthermore, the journal of Myklebust *et al.*, states that the v-model method can minimize safety, reduce time and costs, as well as improve quality in the products (Myklebust *et al.*, 2015). The next research conducted by Balaji about the v-model development method, if there are changing needs requirements, it could be handled properly, validation was carried out on each phase, and in software development

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tester, it is always involved (Balaji, 2012). Meanwhile, the researchers conducted by Nur Machmuda and Aspiranti revealed that the use of v-model development is an excellent development model to develop the software which was demonstrated by the performance of a very easy, simple, and uncomplicated system rather than the other development models (Nur Machmuda & Aspiranti, 2022).

This research was conducted to develop a learning management system that could easily perform learning activities outside the classroom (Sukmawati, 2022)ellyzab. The Learning Management System allows lecturers to conduct assessments of students, monitors student learning outside the classroom, and allows interaction between students and lecturers (Ellyzabeth Sukmawati et al., 2022; Fitriani, 2020). In designing this system, the researchers more concerned to the software quality and the usefulness of the system. Therefore, the researchers employed a lot of testing from the v-model development model. Testing consists of unit testing through *white box* testing techniques, then integration testing through *black box* testing techniques, and testing systems through *automatic black box* testing techniques. Meanwhile, acceptance testing used the latest software quality, namely ISO 25010 which consists of functionality, reliability, performance, operability, security, compatibility, maintainability, and transferability. In designing the research system, the researchers used the PHP programming language .

2. Methods

The research method used the method of v-model development as the improvement of the classic/waterfall development models. The V-model consists of two phases, the left side is called the verification side and the right side is called the validation side (Balaji, 2012). The v-model development model can be seen in Figure 1.

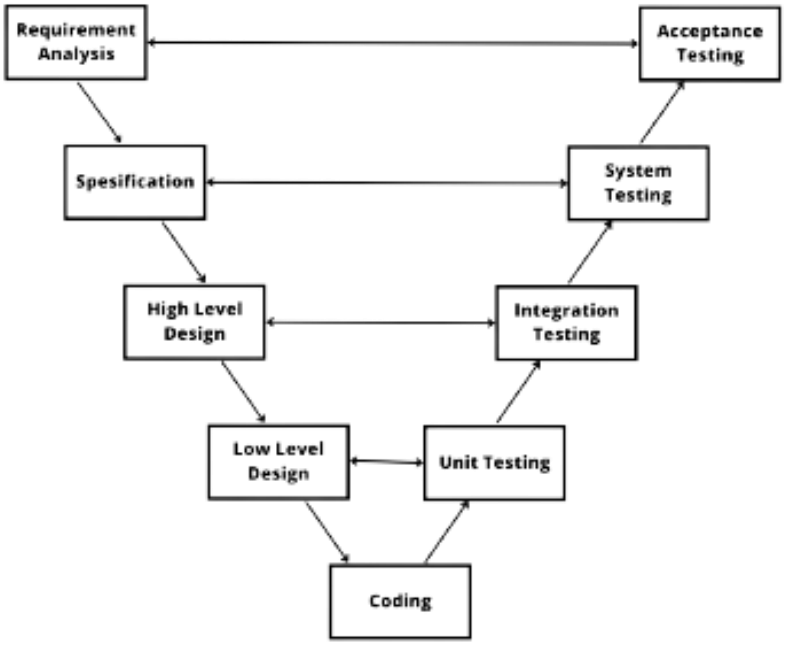

Figure 1. V-Model

3. Result and Discussion

3.1. Requirement Analysis

The stages of needs analysis include analysis related to the system developed. The system analysis that was built consists of stages of functional and non-functional needs. The needs analysis includes the following:

3.1.1. Functional Needs

Functional Needs is a service activity provided by the system. The following are the functional needs of the Learning Management System that must be developed in Table 1.

Table 1. Functional Needs

Id	Functional Needs	Explanation
001	Login Display	Login for lecturer, student, and study program levels
002	Study Program Dashboard	Contains account confirmation, online user, and detail of the number of system users
003	Lecturer Dashboard	Contains the lecturer's active class
004	Student Dashboard	Contains an active student class
005	Class Homepage Display	Can add, edit, and delete class activities
006	Exam Display	Contains a cbt-shaped exam display
007	Edit Profile Display	Can edit and delete profiles
008	Join Class Display	Can join classes with specific code
009	Message Display	Can communicate between friends, lecturers, and admins
010	Data Display	Can delete, edit, add and print lecturer data, class data, and student data

3.1.2. Non Functional Needs

Non-functional needs are the excellent features needed by the learning management system so that the system is better and will certainly satisfy the users. The following non-functional needs are shown in Table 2:

Table 2. Non Functional Needs

Id	Non-Functional Needs	Description
1	Availability	The application must be able to operate continuously and at any time
2	Reliability	Applications must be built with reliability
3	Ergonomic	The application must have a high comfort value
4	Portability	The application must be able to implement multiple computers
5	Memory	An application can hold multiple databases
6	Response Time	Database accessed within 2 seconds
7	Safety	The network has a firewall
8	Security	Strongly encrypted applications
9	Communication Language	Using English language

3.2. Specification

Based on the need analysis of users, the next stage is the determination of software and hardware as a supporting medium for the system. Hardware needs for learning management system implementation are a minimum Intel Core i5 processor, 4GB RAM, and 120 GB HDD. Meanwhile, software needs for system implementation is in the form of operating systems and web browsers.

3.3. High Level Design

In this phase, the process of designing software was developed. The researchers used an object-oriented approach using Unified Modeling Language (UML) in the design process. The UML models designed are use case diagrams, activity diagrams, and class diagrams.

a. Use Case Diagram

It aims to describe the interaction between one or many actors into the system to be created called a use case diagram (Ismail, 2020). The use case diagram of the Learning Management System can be seen in Figure 2.

b. Activity Diagram

The activity diagram illustrates the activation flow of the designed system and can describe as the activation flow of the designed system. It can often describe parallel processes that may occur on multiple executions (Kurniawan, 2020). Activity diagram for lecturers in the Learning Management System can be seen in Figure 3.

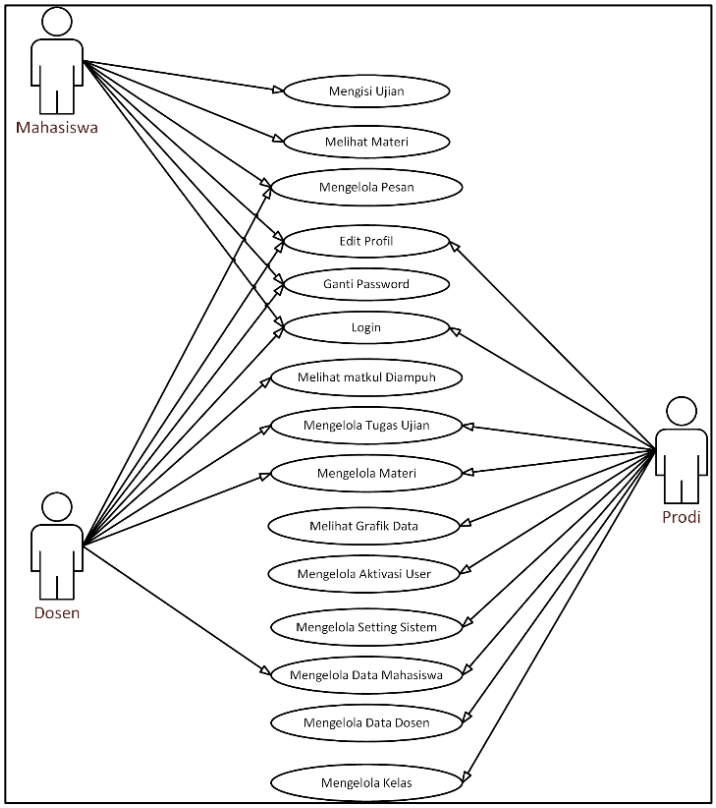

Figure 2. Use Case Diagram

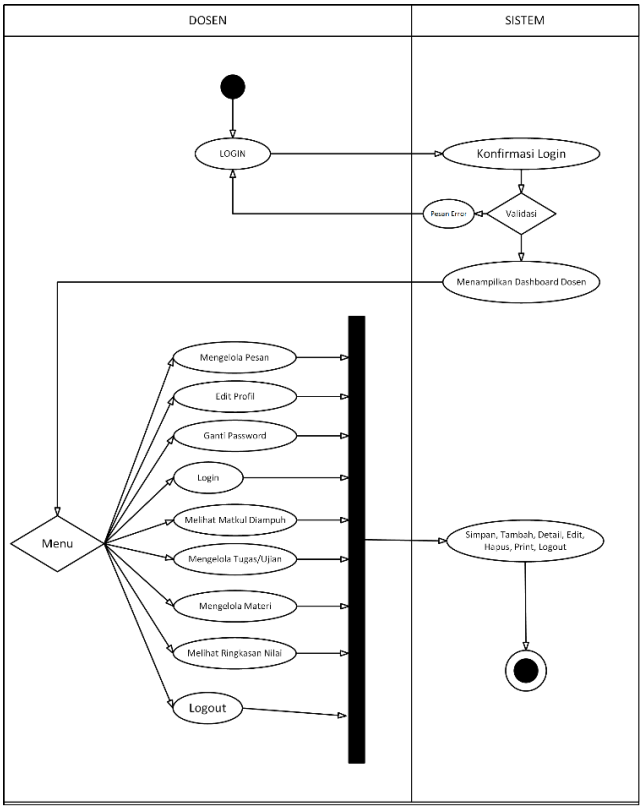

Figure 3. Activity Diagram

c. Class Diagram

The interaction by describing the structure of the classes in the system is called the Class Diagram (Suhendar, 2008). This diagaram describes attributes, operations, and relationships between classes. The following class diagram can be seen in Figure 4.

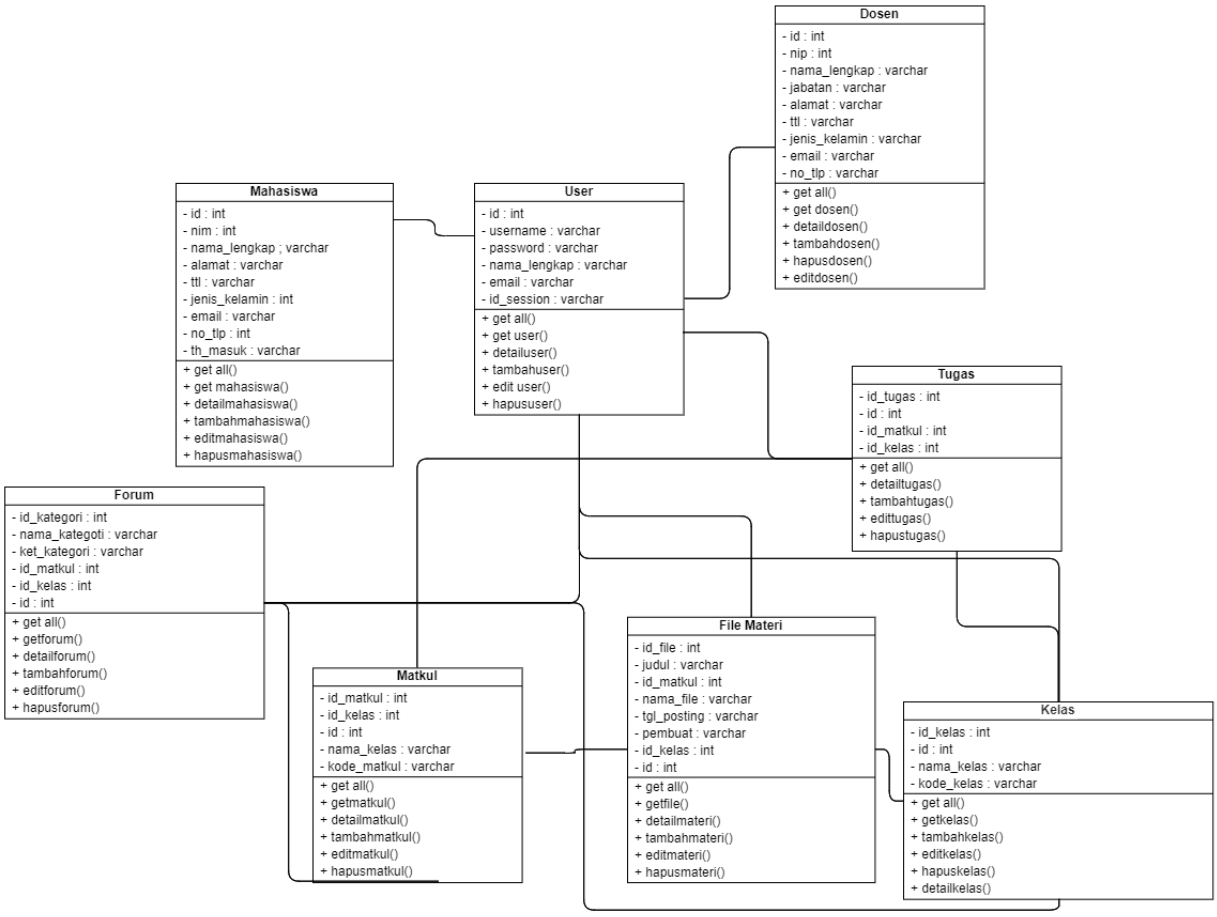

Figure 4. Class Diagram

3.4. Low Level Design

This level is in the form of creating designs on the learning management system in detail, namely the design interface (wireframe) based on the use case diagram and activity diagram that has been made. The following is the design of the login interface display shown in Figure 5.

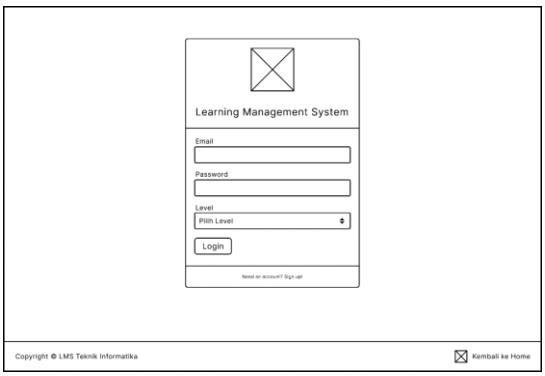

Figure 5. Wireframe Login

Figure 6 is the dashboard wireframe display on the lecturer.

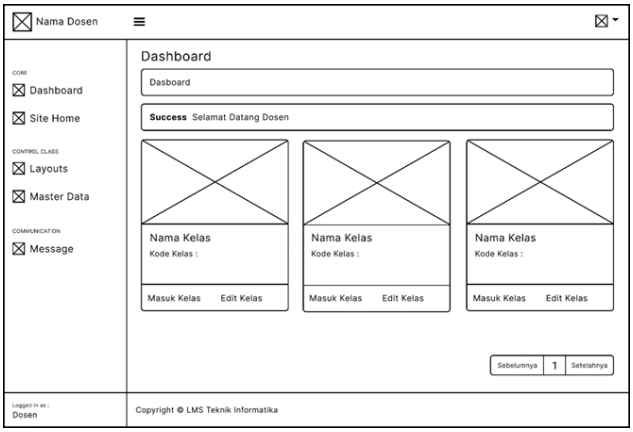

Figure 6. Lecturer Dashboard Wireframe

Here's the Homepage of each class in the Learning Management System can be seen in Figure 7.

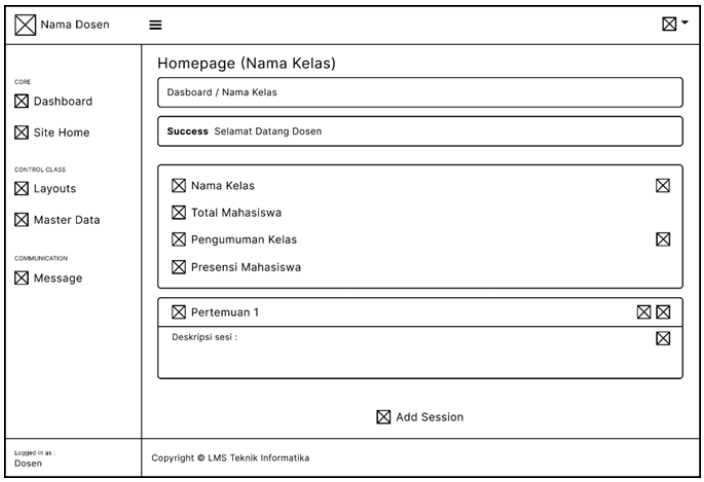

Figure 7. Wireframe Homepage Class

3.5. Coding/Implementation

The coding stage is the process of transferring the design results into the development of a software program. The coding stage of the program used the PHP (Hypertext Preprocessor) programming language and the MySQL (Structured Query Language) database as database management systems. The following are the results of the system implementation based on an adjusted design.

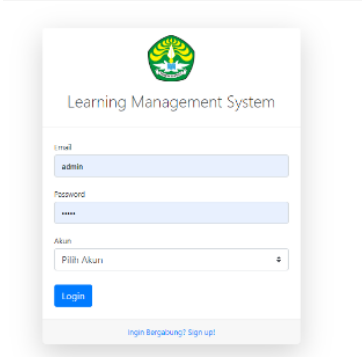

Figure 8. Login Display

Figure 8 is the login display of the application. The user level that can log-in in this system is the level of lecturer and students users.

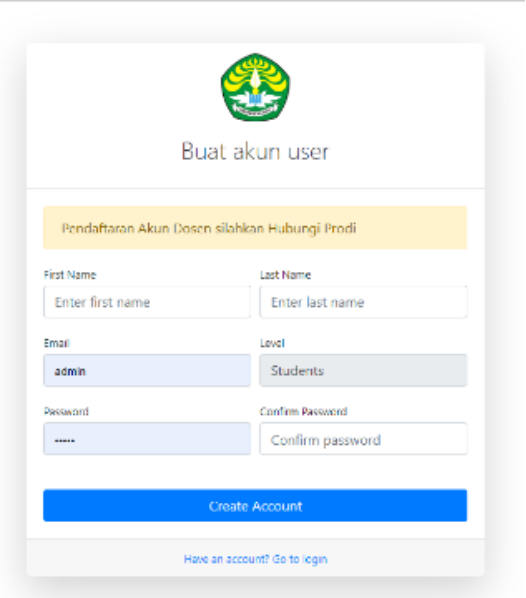

Figure 9. Register Display

Figure 9 is a register display for all students. Meanwhile, in order to activate the lecturer account, contact the study program admin for registration is necessary.

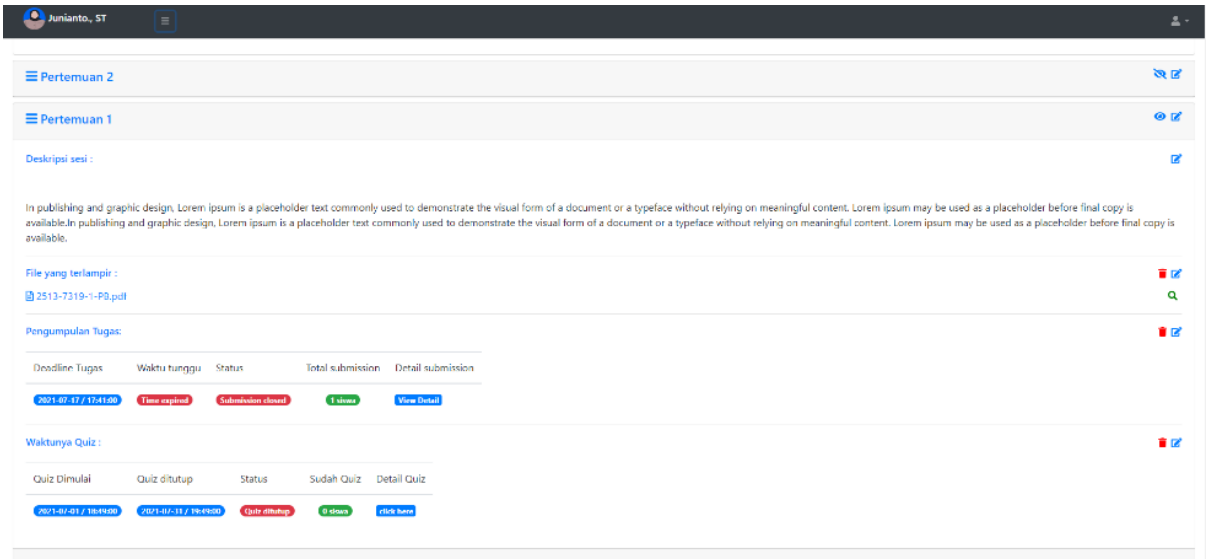

Figure 10. Class Homepage

Figure 10 is the homepage display of the class. The homepage of the class allows students and lecturers to distribute assignments and materials by lecturers, complete quiz sessions, and collect students' assignments.

Figure 11 is a session configuration for lecturers to be able to in providing material, make quiz sessions, and create a place for collecting assignments. This learning management system allows students, admin, and lecturers to communicate through the chat feature. Furthermore, the lecturer can make attendance automatically on the lecturer's page. Then, the admin page is used to confirm the student account to log in to the system. Therefore, this system allows all data, both teacher, lecturer data, test score recapitulation, and attendance recapitulation to be printed automatically. Another advantage is that lecturers and admins can see students online or not. In addition, lecturers can provide a time limit or deadline for counting on exams/quizzes, and for collecting student assignments.

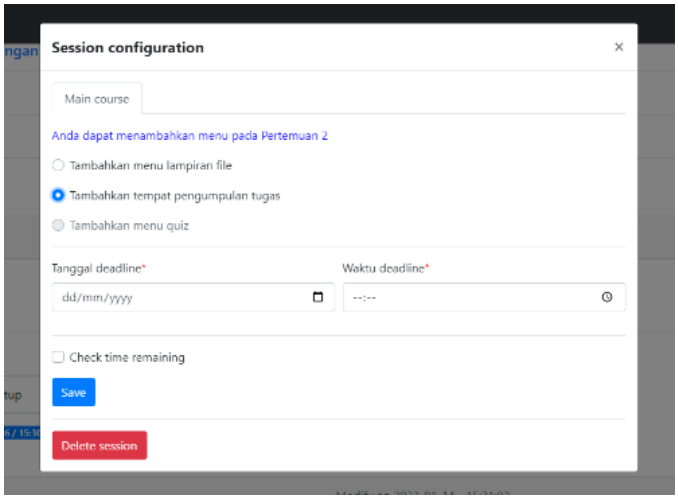

Figure 11. Session Configuration

3.6. Unit Testing

Unit testing is the process of testing verification each unit of code that is running well and in accordance with design (Hasibuan & Dirgahayu, 2021). Unit testing focuses on programming logic and structure in the components. Unit testing was carried out using the *whitebox* method. The results of unit testing can be seen in Table 3.

Table 3. Whitebox Test Results

No	Name	Expected Results	Results obtained	Attainability
1	Test Case 1	Exit the application displays session confirm	A notification appears when exiting the application	Reached
2	Test Case 2	Perfectly displays the create class menu	The create class menu runs perfectly	Reached
3	Test Case 3	The next and previous buttons run perfectly	The previous and next buttons run smoothly	Reached
4	Test Case 4	Info button on pean name displays class information	Notification of information class appears when pressing the button	Reached
5	Test Case 5	Inbound messages can add up nicely	Incoming messages increase if there are recent messages	Reached
6	Test Case 6	Displays online status is well	Online status when user signs in to the application	Reached
7	Test Case 7	Displaying student account confirmations	Account confirmation is increased if the student registers	Reached

Based on the test results in Table 3, it can be seen that the level of achievement results in the *white box* test percentage as follows:

Achieved = 7 /7 x 100%
= 100%
Failed = 0/7 x 100%
= 0%

Based on the scale of website-based software testing, the testing results of a learning management system using the *whitebox* method show an interpretation of "**Excellent**".

3.7. Integrarion Testing

Integration testing is the testing on unit software in a system. Integration testing is a good test in software architecture to find the smallest unit faults on a system (Wibisono & Baskoro, 2002). Integration testing will check the results of interactions between units that have been carried out. Integration testing was carried out by the *blackbox* testing. The following are the test results of the integration testing learning management system in Table 4.

Table 4. Blackbox Test Results

Testing Name	Objective	Action	Expected Results	Testing
Open the system	Knowing the system is running well	Open the system in a web browser	System can display the main page	Succeed
System login	Knowing the connected system database	Input true/incorrect username and password	System is able to display dashboard	Succeed
Page of log-in class	Knowing the system is integrated into the class page	Pressing the class sign-in button	Show the display of a class information detail page	Succeed
Quiz Page	Knowing the system can run the cbt quiz well	Open the quiz button	Display quiz in cbt form	Succeed
Data Page	View the entire database connected data	Open a data page	Display all existing data on the system	Succeed
Message Page	Knowing the system can send messages well	Message input	Messages are well delivered	Succeed

Based on the test results in Table 4, it can be seen that the level of achievement results in the *blackbox* test percentage as follows:

Achieved = 6 /6 x 100%
= 100%
Failed = 0/6 x 100%
= 0%

Based on the scale of website-based software testing, the results of learning management system using the *blackbox* method show an interpretation of "**Excellent**".

3.8. System Testing

System testing is a thorough and integrated testing process (Wibisono & Baskoro, 2002). The purpose of system testing is to verify that all systems are running well and in accordance with predetermined requirements. The testing system uses the automatic *blackbox* method using Kalon software.

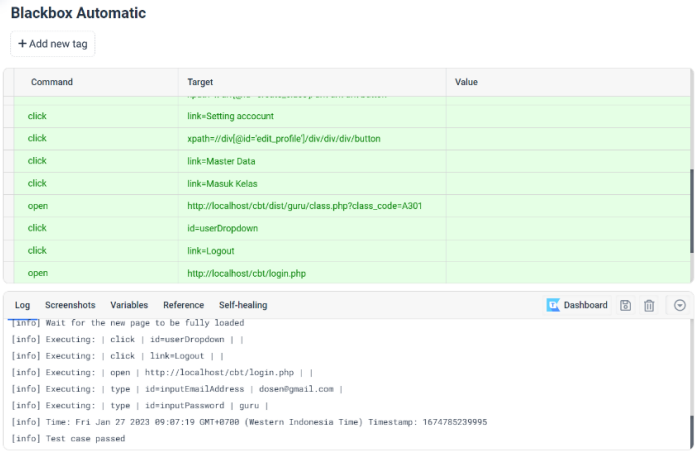

Figure 12. The Results of Testing System

Based on Figure 12, the results of *blackbox* testing of the system as a whole using automatic Kalon software, it was found that all functions on the system were 100% running well.

3.9. Acceptance Testing

Acceptance test is the feasibility testing and acceptance of the system by the users. This process is very important because it is the final stage before the user accepts the system (Chamida *et al.*, 2021). In determining the quality of good software, the researchers used a software quality model, namely ISO 25010. Besides to test the software quality, ISO 25010 can test the feasibility of receiving the system by users. Here are the characteristics of ISO 25010:

a. Functional Sustainability

The test was carried out by an expert system engineer with a checklist system in accordance with the design of the function, with a total of 26 main functions. These functions stated successful and 0 functions stated failed. The calculation is used as 1 (successful) or 0 (failed).

X = I/P
Description :
P = Number of designed functions
I = Number of functions successfully implemented

The results of functional testing are:

X= 26/26
= 1

Based on the results of functional calculations, it was found that the results of calculating numbers is close to 1, which means that most of the proposed features were successfully implemented properly.

b. Performance Efficiency

Efficiency testing was performed with the Gtmetrix tool in order to find pagespeed, Yslow, and response time. The following are the results of efficiency testing using Gtmetrix shown in Table 5.

Table 5. Efficiency testing using GTmetrix

No	Web Pages	PageSpeed Score	Yslow	Response Time
1	Main page of the website	75%	72%	2.8 s
2	Login page	74%	71%	2.5 s
3	Manage data page	74%	71%	2.5 s
4	Message page	74%	71%	3.0 s
5	Class page	74%	71%	2.6 s
6	Dashboard page	74%	72%	2.5 s
	Average	74,1%	71,3	2.65 s

Based on Table 5, the efficiency testing results using Gtmatrik found a pagespeed C score (74,1%), a Yslow C score (71,3%), and an average response time of 2,65 s. Based on efficiency calculations, the learning management system is declared good because the system response time is less than 5 seconds.

c. Compability

Compatibility testing was carried out using the Powermapper tool to see the system running well across a wide variety and versions of web browsers. The compatibility test can be seen in Figure 13.

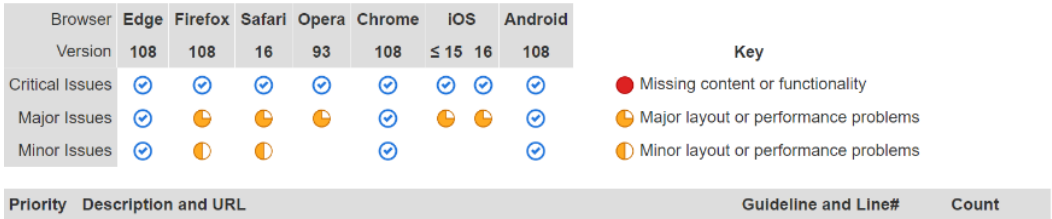

Figure 13. Compatibility Test Results

Based on Figure 13, the compatibility testing shows that the learning management system is compatible with all browsers and run well in compatibility testing.

d. Usability

Usability testing was carried out by distributing questionnaires and using the UEQ (User Experience Questionnaire) method which has 26 questions. The respondents consisted of 30 people from different batches in the UNRI, Informatics Engineering Study Program.

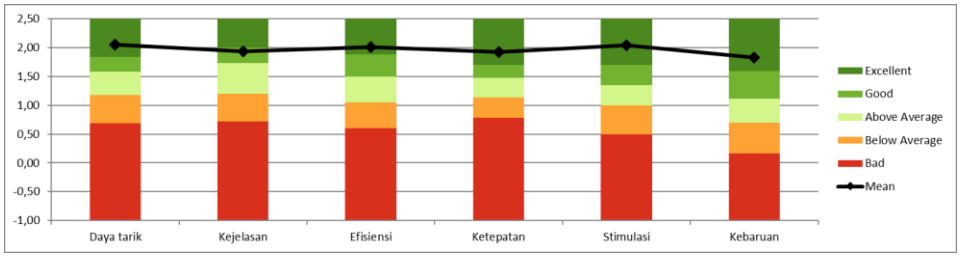

Figure 14. Benhcmark UEQ Scale

Based on Figure 14, the results of the testing process using UEQ tools are on the UEQ benchmark scale with the usability test results of "**Excellent"**.

e. Reliability

Reliability testing was performed using the k6.oi website tool. The test was carried out by running a website learning management system with fifty users for 10 minutes simultaneously. The method carried out in this reliability test employed the stress test method.

Figure 15. http failures

Based on Figure 15, it shows that *http failures* are zero or no failed requests from the fifty users running the application. From these results, the calculations were carried out using the Nielson formula equation 2, namely:

R1 = 1-ne/n ... (2)
Description :
R1 = Reliability value
Ne = Number of failed requests
N = Number of requests
So, the calculation of reliability is as follows :
R1 = 1 – 0/9773 = 1

Based on the results of Nielson's calculation, it was found that the reliability calculation is 1 or 100%. Therefore, from these calculations, it is concluded that the website learning management system is successfully running well in the reliability test.

f. Maintainability

Maintainability testing was carried out to check duplication of the code in the coding folder. Maintainability testing was done using the phpcpd tool. Here are the results of the maintainability test.

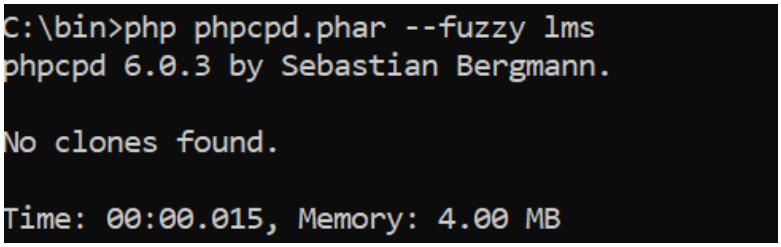

Figure 16. Maintainability Test Results

Based on Figure 16, it can be seen that there is no duplication of code on the learning management system website. Therefore, the website learning management system could run well in maintainability testing.

g. Security

This security test was carried out using the Sucuri Sitecheck web tool to check the system's security score.

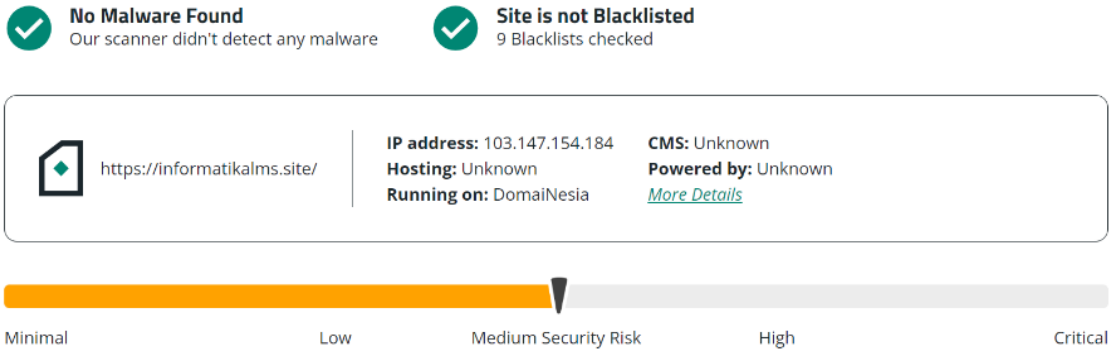

Figure 17. Security Test Results

Based on Figure 17, it can be seen that the learning management system website gets a medium security score. Therefore, the security aspect of the web learning management system is well accepted.

h. Portability

Portability testing is a test to try a learning management system website wether running well/not on different browsers both on desktop, android, and ios.

Table 6. Portability Test Results

No	Browser	Result
1	Google Chrome	Succeed
2	Mozilla Firefox	Succeed
3	Microsoft Edge	Succeed
4	Android	Succeed
5	Chrome Android	Succeed
6	Safari Iphone	Succeed
7	Safari Macbook	Succeed

Based on Table 6, it is shown that the system can run 100% properly on all web browsers.

4. Conclusion

Based on the results and analysis of the problems above, it was found that using the v-model development method is better than the waterfall development method. V-Model focuses on thoroughly testing the system, from unit testing up to acceptance testing. Using the v-model, the system can minimize the bug/error problems because each phase has a test. In the waterfall, if a bug/error is encountered in the middle of application development, the developer will find it challenging to find the bug/error. Conversely, using the v-model will easily find bugs/errors because each phase has documented testing.

References

Balaji, S. (2012). Waterfall vs v-model vs agile : A comparative study on SDLC. *WATEERFALL Vs V-MODEL Vs AGILE : A COMPARATIVE STUDY ON SDLC*, *2*(1), 26–30.

Chamida, M. A., Susanto, A., & Latubessy, A. (2021). Analisa User Acceptance Testing Terhadap Sistem Informasi Pengelolaan Bedah Rumah Di Dinas Perumahan Rakyat Dan Kawasan Permukiman Kabupaten Jepara. *Indonesian Journal of Technology, Informatics and Science (IJTIS)*, *3*(1), 36–41. https://doi.org/10.24176/ijtis.v3i1.7531

Ellyzabeth Sukmawati, Iwan Adhicandra, & Nur Sucahyo. (2022). Information System Design of Online-Based Technology News Forum. *International Journal Of Artificial Intelligence Research*, *1.2*. https://doi.org/https://doi.org/10.29099/ijair.v6i1.2.593

Fitriani, Y. (2020). ANALISA PEMANFAATAN LEARNING MANAGEMENT SYSTEM (LMS) SEBAGAI MEDIA PEMBELAJARAN ONLINE SELAMA PANDEMI COVID-19 Yuni Fitriani JISICOM (Journal of Information System , Informatics and Computing) JISICOM (Journal of Information System , Informatics and. *Journal of Information System, Informatics and Computing (JISICOM)*, *4*(2), 1–8.

Graessler, I., & Hentze, J. (2020). The new V-Model of VDI 2206 and its validation das Neue V-Modell der VDI 2206 und seine Validierung. *At-Automatisierungstechnik*, *68*(5), 312–324. https://doi.org/10.1515/auto-2020-0015

Hasibuan, A. N., & Dirgahayu, T. (2021). Pengujian dengan Unit Testing dan Test case pada Proyek Pengembangan Modul Manajemen Pengguna. *Automata*, *2*(1).

Ismail. (2020). Perancangan Sistem Aplikasi Pemesanan Makanan dan Minuman Pada Cafetaria NO Caffe di TAnjung Balai Karimun Menggunakan Bahasa Pemrograman PHP dan MySQL. *Jurnal Tikar*, *1*(2), 192–206.

Kurniawan, T. B. (2020). Perancangan Sistem Aplikasi Pemesanan Makanan dan Minuman Pada Cafetaria NO Caffe di TAnjung Balai Karimun Menggunakan Bahasa Pemrograman PHP dan MySQL. *Jurnal Tikar*, *1*(2), 192–206.

Miharja, M. K. A., Fikri, M. R. Al, Taringan, E., Suwarno, A., Mulyati, S., & Yulianti. (2022). *Pengembangan Aplikasi Berbasis Dekstop Penjualan Rumah dengan Metode Waterfall*. *7*(1), 190–194.

Murdiani, D., & Hermawan, H. (2022). Perbandingan Metode Waterfall Dan Rad (Rapid Application Development) Pada Pengembangan Sistem Informasi. *Jurnal Teknologi Informasi)*, *6*(1), 14–23.

Myklebust, T., Stålhane, T., & Hanssen, G. K. (2015). Important considerations when applying other models than the Waterfall/V-model when developing software according to IEC 61508 or EN 50128. *ISSC Symposium*, *August*.

Nur Machmuda, F., & Aspiranti, T. (2022). ARTIKEL PENELITIAN Pengembangan Pelayanan pada Ibu Hamil dengan Menggunakan V Model System Development Life Cycle (SDLC). *Jiks*, *4*(1), 75–77.

Saputra, D., Haryani, H., Surniadari, A., Martias, M., & Akbar, F. (2022). Sistem Informasi Bimbingan Tugas Akhir Mahasiswa Berbasis Website Menggunakan Metode Waterfall. *MATRIK : Jurnal Manajemen, Teknik Informatika Dan Rekayasa Komputer*, *21*(2), 403–416. https://doi.org/10.30812/matrik.v21i2.1591

Suhendar. (2008). Pemodelan Visual dengan Menggunakan UML dan Rational Rose. *Jurnal Teknologi Informasi DINAMIK Volume*, *XIV*(1), 23–29.

Sukmawati, E. N. (2022). PEMBELAJARAN DARING BERBASIS MASALAH DALAM PENINGKATAN MOTIVASI BELAJAR. *Juli*, *2*(2), 196–199. https://journal.amikveteran.ac.id/index.php/jurdikbud/article/view/299

Wahid A.A. (2020). Analisis Metode Waterfall Untuk Pengembangan Sistem Informasi. *Jurnal Ilmu-Ilmu Informatika Dan Manajemen STMIK*, *November*, 1–5.

Wibisono, W., & Baskoro, F. (2002). Pengujian Perangkat Lunak Dengan Menggunakan Model Behaviour Uml. *JUTI: Jurnal Ilmiah Teknologi Informasi*, *1*(1), 43. https://doi.org/10.12962/j24068535.v1i1.a95