

ANALYSIS AND DEVELOPMENT OF PROJECT MONITORING INFORMATION SYSTEMS USING RESTFUL API ECHO FRAMEWORK AT SMK NEGERI 2 KLATEN

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ABSTRACT

Based on the results of observations, project monitoring activities at SMK N 2 Klaten still use manual methods, so it is less effective to implement. This research aims to (1) streamline the monitoring, guiding, and storing of progress documentation in the SIJA department of SMK N 2 Klaten through designing and developing a project monitoring information system, (2) meet quality standards ISO/IEC 25010. The research was conducted using the Research and Development (R&D) method, developed using the SDLC (System Development Life Cycle) method with the Waterfall model, which consists of the stages of needs analysis, design planning, coding, testing, and management. Quality analysis is done using the ISO/IEC 25010 standard on several aspects, namely (1) functional suitability, (2) usability, (3) performance efficiency, (4) reliability, and (5) portability. The results obtained include: (1) A website-based project monitoring information system developed using the waterfall development model, using the Gorm, Echo, and Vue.js frameworks. (2) The results of testing the quality of the ISO/IEC 25010 system are the functional suitability aspect with a score of 1 (very good), the aspect of use with a proportion of 80% (feasible) with an Alpha Cronbach score of 0.957 (very good), the efficiency of the performance aspects with a score of 99.81% (very good) for performance and 98.9% (very good) for structure, aspect of reliability with a score of 100% (has met), as well as the aspect of portability has been fulfilled because it can be run on various browsers, both desktop and mobile.

Keywords: monitoring information system, project, waterfall, ISO/IEC 25010

INTRODUCTION

The project-based learning method is a learning method that is relevant to be implemented in a vocational school. This learning method can be implemented to help vocational schools achieve the educational objectives stipulated in UU No. 20 No 15 of 2003, that says, to prepare graduates who are competent to face the world of work. The application of the project-based learning method is expected to help students to be able to know the project description that will be faced in the industry of work.

The application of the project-based learning method is one of the learning methods that dominate the implementation of learning at SMK Negeri 2 Klaten, especially in the SIJA department. Based on the results of observations, 3 out of 6 productive subjects in the Information and Network Systems department of SMK Negeri 2 Klaten implemented project-based learning.

Applying project-based learning methods that are not carried out maximally can impact achieving the objectives of using these learning methods. One very influential aspect of

applying project-based learning methods is the monitoring and guidance process of the project. The monitoring and guidance process that needs to be carried out optimally will have an impact on the achievement of the objectives of this learning method.

Based on the results of observations made at SMK Negeri 2 Klaten, majoring in Network Information Systems and Applications in July 2022 - December 2022, several problems related to project management were obtained, including the need for more effective monitoring and guidance activities. Some of the problems encountered related to project monitoring and guidance activities include:

1. The project management and monitoring still use a printed journal record system.
2. The level of activeness of students in working on group projects still needs to be higher, where several students do not participate actively in working on group projects.
3. Identifying each learner's level of understanding and skills in group project practice activities takes a lot of work.
4. The project documentation process is still done manually using hard files.

5. The guidance process for project work has yet to be maximized due to limited face-to-face time.
6. Several projects still need to be completed according to the deadline.
7. Students work on several different projects based on various subjects at the same time.
8. The school still needs an information system for monitoring students' projects that meets software quality standards.

Based on several problems encountered in the observation process, an alternative solution can be implemented to minimize the impact of these problems. The development of an information system to monitor each learner's performance in real-time can be used to increase the activeness of learners in the project work process. An information system is a relationship between humans, tools or technology, media, and procedures that interact with each other and are related to achieving the objectives of the transaction process, management process, and the basis for making the right decisions. (Nash, 1995). The internet is one of the right choices to be implemented in developing these information systems to support real-time monitoring processes and fast and organized documentation storage.

The monitoring information system is designed to be able to assist students in documenting every progress that is made every week. A project monitoring information system is an information system that is built to monitor a process so that it is carried out according to the agreed path (on the track), identifying results that are not on track as soon as possible, and developing motivation and positive habits in project development (Amsler, Findley, & Ingram, 2009). Through this monitoring information system, project work can be better monitored and supervised to reduce the risk of projects that cannot be completed according to deadlines.

The development platform choice is one of the things that need to be considered in building an information system. This web-based project monitoring information system is developed using a client-server model, which separates the development of client components and server components. An architectural style is used to implement this client-server model, namely the Restful API, which uses the HTTP protocol as a tool for communication. RESTful API is a web application that follows the REST

architecture structure, which aims to prevent errors in data communication between systems. RESTful API is built to connect a data interaction between client and server (Yellavula, 2017). The choice of development method is motivated by reasons of ease of development. Hopefully, this information system can later be developed on other bases, such as mobile applications.

The development of project monitoring information systems must be well-designed and thorough to reduce failures and errors at each stage. Planning must be done carefully and adjusted to the needs of the real conditions in the SIJA department of SMK Negeri 2 Klaten. Testing this information system is a crucial stage in all stages of development. Testing this information system will later provide results that determine whether the information system is suitable for use. The information system built is hoped to solve problems related to monitoring student projects in the Network Information System and Applications department of SMK Negeri 2 Klaten.

RESEARCH METHODS

Research Design

This study uses the research and development (RND) research method as research method in building the project monitoring information system. According to Sukmadinata, RND is a process or steps taken to develop a new product and improve existing products, which can be accounted for (Zakariah & et al., 2020).

This research's development method is the System Development Life Cycle (SDLC) method. The stages in this SDLC development method start with system analysis, system design, system implementation, and system operation and maintenance. Several development models are included in the SDLC development method, one of which is a waterfall.

Time and Place of Research

This research was conducted from February to June 2023 at SMK Negeri 2 Klaten in the Network and Application Information Systems department.

Research Subjects

The research subject is used as the main actor who tests the functional suitability and

usability aspects of the information system software that has been built. The author uses 3 expert respondents in system development to test the functional suitability aspect. To test the information system in the usability aspect, the authors used research subjects, namely students and teachers in the SIJA (Network Information Systems and Applications) department at SMK Negeri 2 Klaten.

Taking research subjects is done using sampling techniques. The sample of this study was 35 people consisting of 1 teacher and 34 students. This sampling is based on the theory given by Jakob Nielsen (2012), which says that it takes at least 20 respondents to get statistically significant numbers (Nielsen, 2012).

Development Procedure

The system was developed with a waterfall model, a linear sequential development model in which each stage is carried out sequentially or sequentially, starting from the analysis, design, coding, testing, and maintenance stages (M. Shalahuddin, 2015). The stages in this development are as follows:

1. Requirements definitions

This stage collects data and information to define the information system's development needs. The purpose of this stage is to explore information about users' needs regarding the development of this system. The result of this stage is a project document containing user requirements, or a list of user needs for the system to be developed.

This process uses observation and interview methods. Observation is done by directly seeing and observing the learning process that occurs when the author practices teaching at SMK Negeri 2 Klaten, SIJA department in SaaS subjects. Meanwhile, interviews were conducted directly with class XI and XII students and teachers in the SIJA (Network Information Systems and Applications) department of SMK Negeri 2 Klaten.

2. System and software design

At this stage, the user requirements that have been obtained will be translated and analyzed into a software design so that it is easier to understand and implement into writing code (coding). This stage uses several design designs as a basis for development. The designs are:

a. System architecture design

The design used to describe the system's architecture uses UML (Unified Modeling Language) modeling. According to Rosa and Shalahuddin (2015), UML is a programming language for translating requirements, analysis and design, and architectural descriptions in object-oriented programming so developers can understand them.

b. Database design

The author uses ERD (Entity Relationship Diagram) modeling-type table diagram to describe the relationship between databases.

c. Interface Design

In depicting the interface design, the author uses the wireframing method to develop the system interface.

3. Implementation and Unit Testing (Coding)

This stage is the coding stage, which is the stage for implementing the system design to be developed into an information system software. Writing program code aims to build an information system that can be run under the functions and designs that have been designed.

The development of this information system uses a client-server development system where the client and server development of the information system is carried out separately. Server development is done using the echo framework with the Golang programming language. For development on the client, the Vue.js framework is used using the JavaScript programming language.

4. Integration and system testing

Testing is carried out at this stage using the black box testing method. Blackbox testing is done by testing the functionality of the system that has been built. Blackbox testing to analyze the quality of functional suitability aspects based on the ISO 25010 standard.

5. Operation and maintenance

The Maintenance stage is needed to maintain the quality of the information system that has been built so that it still has good quality for use by users. Maintenance is carried out to avoid the possibility of various errors or problems when used by users. This stage can also include adding features tailored to users' needs and the environment after the system has been built.

After the information system is successfully developed, then the system will be tested to see the quality of the system. The system quality test is based on the ISO / IEC 25010 standard with the following aspects:

1. Testing the functional suitability aspect

This test is to find out whether all functions that have been defined can run well or not. Functional suitability testing is done with a questionnaire with respondents who are experts in system development. The sub-characteristics in the functional suitability aspect measured are functional completeness (whether the function can run without constraints), functional correctness (whether the function meets user needs), and functional appropriateness (whether the function can be used to complete certain tasks).

2. Performance efficiency testing

It is characteristic to measure resource usage in relative performance under certain conditions in a system (Mulyawan, Kumara, & et al., 2021). Performance efficiency testing uses GTMetrix software. This test will measure several characteristics, including Time-behavior, resource utilization, and capacity.

3. Portability testing

This test is used to assess whether an information system can be accessed through various platforms or not. The information system is built using a website platform, so this test is carried out to assess whether the information system can be run on a laptop or Android to make it easier for users to use. The portability testing aspect has several sub-tests, including adaptability, installability, and replaceability.

4. Usability testing

Usability testing tests users' use level regarding whether a system can meet user needs effectively and efficiently and can meet user satisfaction. Testing this aspect uses a questionnaire with the respondent being the user of choice of the information system. Usability testing is carried out on several sub-characteristics, including usefulness, ease of use, ease of learning, and user satisfaction.

5. Reliability testing

This test determines whether the system can carry out functions following the objectives effectively and efficiently. Reliability testing uses K6.io software to calculate the number of

requests that exist, which are successful and fail.

Data Collection Method

Data collection methods in the design and needs analysis stage and testing of this information system software are as follows:

1. Observation

Observation activities are carried out by directly observing learning activities that apply the Project Based Learning method to determine and design user needs in developing this system. The observation process is to collect data in the software design process, as well as in the software testing process.

2. Questionnaire

The questionnaire technique provides several questions or statements with certain weights to respondents in writing to obtain certain data. Questionnaires to get data to perform quality analysis on usability and functional suitability aspects. The questionnaire method is used to test the prototype/system design that has been made. This study's questionnaire uses several testing scales, including the Likert and the Guttman scale.

3. Interview

The interview is a data collection technique by asking respondents / prospective users several questions directly. This technique supports the determination of the initial system requirements that have been obtained based on the questionnaire results.

The interview was conducted together with prospective users of the information system, in this case, a teacher conducted by Mrs. Atik Ariyani, S. Kom., and several students of class XII SIJA A and XII SIJA B at SMK Negeri 2 Klaten. The interview results are used to compile the functional and non-functional requirements of the system to be developed.

4. System Quality Measurement Software

Some software or software is needed in collecting data related to measuring the quality of a system in several aspects. Some of the software used to measure system quality include:

- a. GTMetrix, this software is used to take the results of measuring system quality in the aspect of performance efficiency.
- b. K6.io is software used to measure the system's quality in the reliability aspect.

- c. BrowserStack, is a web tool that can be used to test information systems on portability aspects.

Research Instruments

1. System Design Testing Instrument

System design testing using a UEQ (User Experience Questionnaire) questionnaire conducted by prospective users (teachers and students). Several aspects are tested in system design testing based on UEQ standards, including attractiveness, efficiency, perspicuity, dependability, stimulation, and novelty. System design testing to communicate the design that has been designed to the user to equalize the perception between users and developers of the system to be developed.

2. Functional Suitability Instrument

Measurement of the functional suitability aspect or the success of a function to run, using a function test case, the instrument used is a test case containing several functions on the system with a Guttman scale questionnaire. The answer choices in the Guttman scale are only 2 positive and negative (Pranatawijaya & et al., 2019).

3. Performance Efficiency Instrument

Quality analysis in performance efficiency uses a research instrument: the GTMetrix application. The GTMetrix application will produce test results based on PageSpeed rules. GTMetrix testing will produce total load response data from this final project monitoring information system.

4. Portability Instrument

System quality testing on portability is done by running the system through various browsers and platforms. In this test, the aspect observed is whether the information system can run well on different platforms. This test uses the web tool Browserstack.com. This test uses cross-browsing compatibility testing on desktop and mobile browsers.

5. Usability Instrument

Testing the usability aspect uses a standard USE Questionnaire using a Likert scale to measure user satisfaction with using this system. The Likert scale is a rating scale to measure attitudes, opinions, and perceptions of a person or group toward social phenomena (Lamada & et al., 2020).

Some aspects measured based on the USE Questionnaire standards include usefulness, ease of use, ease of learning, and user satisfaction.

6. Reliability Instrument

Testing the quality of information systems in the reliability aspect can be measured by the K6.io application system. This application system can help calculate how many requests there are, how many requests are successful, and the number of failed requests.

Data Analysis Techniques

1. Prototype/System Design Testing Analysis

Prototype testing measurements using UEQ tools. The results of the data obtained from respondents are then analyzed to obtain user experience information from the user. The data processing process is carried out through the stages described in Figure 1 below.

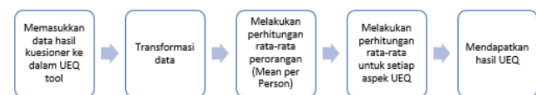


Figure 1. UEQ management process

The results of the UEQ value are adequate if each scale's mean value is above 1.75. Details of the interpretation results of UEQ in each scale are shown in Table 1 below.

Table 1 Interpretation of UEQ Results

	Daya Tarik (attractiveness)	Kejelasan (perspicuity)	Efisiensi (efficiency)	Ketepatan (dependability)	Stimulasi (stimulation)	Kebaruan (novelty)
Excellent	≥1,75	≥1,9	≥1,78	≥1,65	≥1,55	≥1,4
Good	≥ 1,52	≥ 1,56	≥ 1,47	≥ 1,48	≥ 1,31	≥ 1,05
	< 1,75	< 1,9	< 1,78	< 1,65	< 1,55	< 1,4
Above	≥ 1,17	≥ 1,08	≥ 0,98	≥ 1,14	≥ 0,99	≥ 0,71
Average	< 1,52	< 1,56	< 1,47	< 1,48	< 1,31	< 1,05
Below	≥ 0,7	≥ 0,64	≥ 0,54	≥ 0,78	≥ 0,5	≥ 0,3
Average	< 1,17	< 1,08	< 0,98	< 1,14	< 0,99	< 0,71
Bad	< 0,7	< 0,64	< 0,54	< 0,78	< 0,5	< 0,3

2. Quality Analysis of Functional Suitability Aspects

Measurement of information system quality test on functional suitability aspects using a Guttman scale. Testing using the Guttman scale will produce nominal data, where the positive / yes answer is worth 1, and the negative / no answer has a value of 0. The calculation formula using this scale is:

$$X = \frac{I}{P} \times 100\%$$

P = number of functions designed

I = the number of functions that work.

The value resulting from the measurement can be interpreted into a statement according to the following Table 2.

Table 2. Percentage Interpretation

No	Percentage of Feasibility	Interpretation Description
1.	0% - 20%	Very Bad
2.	21% - 40%	Poor
3.	41% - 60%	Fair
4.	61% - 80%	Good
5.	81% - 100%	Very Good

3. Quality Analysis of Performance Efficiency Aspects

Testing the quality of information systems in the aspect of performance efficiency is done by using how to test the performance of a web-based information system. Testing this aspect uses the GTMetrix website. Furthermore, all the assessment results of each parameter will be calculated on average to determine the score of the performance efficiency assessment. The score of the performance efficiency assessment will be interpreted into the grade in Table 3 below.

Table 3. GTMetrix Score Interpretation

No	Score	Terms Score	Description
1.	A	$90 \leq \text{Score} \leq 100$	Very Good
2.	B	$80 \leq \text{Score} < 90$	Good
3.	C	$70 \leq \text{Score} < 80$	Better than Enough
4.	D	$60 \leq \text{Score} < 70$	Enough
5.	E	$50 \leq \text{Score} < 60$	Poor
6.	F	$0 \leq \text{Score} < 50$	Very Poor

4. Quality Analysis of Portability Aspects

The quality analysis of the portability aspect is carried out considering the diversity of browser usage from prospective users. Testing to see if the system built can be compatible with several different browsers. Details of the testing in this aspect are presented in Table 4 below.

Table 4. Portability Aspect Testing

No	Aspect	Result
1.	Testing on Desktop-based browsers	The web-based information system can be run properly through several browsers tested. Tests were conducted on several browsers,

		including Mozilla Firefox and Google Chrome.
2.	Testing on Mobile-based browsers.	Website-based information systems can run well and are compatible with several browsers on mobile, including Mobile Browser and Google Chrome.

5. Usability Aspect Quality Analysis

The usability aspect is tested by implementing a Likert scale as a measurement scale in this test. In this test, researchers used a scale with 5 choices. The values of some of these options are described in the following table 5.

Table 5. Usability Score Table

Statement	Score
Strongly Agree	5
Agree	4
Undecided	3
Disagree	2
Strongly Disagree	1

After testing, all data collected will be analyzed and calculated using the following formula.

$$\text{Total Score} = (JSS \times 5) + (JS \times 4) + (JRG \times 3) + (JTS \times 2) + (JSTS \times 1)$$

Description:

- JSS = number of respondents who strongly agree
- JS = number of respondents who agree
- JRG = number of respondents who hesitate
- JTS = number of respondents who disagree
- JSTS = number of respondents who strongly disagree

From the results of these calculations, the value obtained will be processed to obtain the interpretation results of these calculations. The formula used to obtain the interpretation of the usability aspect test results is as follows.

$$\text{Percentage score} = \frac{\text{total score}}{q \times r \times 5} \times 100\%$$

Description:

- the total number of scores from the respondents' answers
- Total score =
- q = number of questions
- r = jumlah responden

After obtaining the percentage results from testing the usability aspect, then the value will be interpreted into a statement as follows:

Table 6. Usability Aspect Interpretation

No	Percentage Feasibility	Interpretation Description
1.	0% - 20%	Very Unfeasible
2.	21% - 40%	Not Feasible
3.	41% - 60%	Moderately Feasible
4.	61% - 80%	Feasible
5.	81% - 100%	Very Feasible

From the results obtained through testing using a questionnaire, the next step is to calculate the reliability test on the data that has been obtained. This reliability test calculation was done using Cronbach's Alpha using SPSS software. The interpretation of the calculation score can be seen in the following table.

Table 7. Cronbach's Alpha Interpretation

No.	Cronbach's Alpha	Internal Consistency
1.	$\alpha \geq .9$	Excellent
2.	$.9 > \alpha \geq .8$	Good
3.	$.8 > \alpha \geq .7$	Acceptable
4.	$.7 > \alpha \geq .6$	Questionable
5.	$.6 > \alpha \geq .5$	Poor
6.	$.5 > \alpha$	Unacceptable

6. Reliability Aspect Quality Analysis

Testing the quality of information systems in the reliability aspect is carried out using the K6.io tool. These tools will provide test results in the form of a description of the system's response. From these results, the data will then be calculated using a formula under the Nelson Model, as follows.

$$R1 = 1 - \frac{ne}{n}$$

Description:

R1 = reliability value
 ne = number of failed inputs
 n = number of inputs

The calculation results will then be compared with the Telcordia standard reliability test. According to the Telcordia standard, the test will be said to fulfill the reliability aspect if the resulting percentage is at least 95% (Hidayati, 2019).

RESULTS AND DISCUSSION

Information System Development

1. Needs Analysis

a. Functional Requirement Analysis

Data collection was carried out by researchers using field observation and interview methods. After the data has been collected, the data is analyzed to obtain a user requirement list for teachers and students of SMK Negeri 2 Klaten.

Researchers carried out field observations to obtain data on problems in learning activities at SMK Negeri 2 Klaten, especially in the Information Systems and Networking (SIJA) department. Interviews were conducted with Mrs. Atik Ariyani, S.Pd., the teacher of the System as a Service (SaaS) productive subject and several students of XII SIJA A and XII SIJA B classes. The following are the results of the functional requirements analysis of the Project Monitoring Information System of SMK Negeri 2 Klaten:

- 1) The information system can be used properly through various desktop, laptop, and mobile platforms.
- 2) The information system uses a database to store student progress data and teacher feedback.
- 3) Several different subjects can use the information system.
- 4) There are 3 types of users with their respective access rights to this system.

Some of the divisions of access rights of users are as follows:

1) Admin

Some of the access rights owned by the admin to carry out several functions are as follows:

- a) Log in using the registered email and password.
- b) Log out
- c) Display all user data that has been registered.
- d) Add user data according to their respective roles (students, teachers, and admins)
- e) Change user data (email and password)
- f) Delete user data.
- g) View all student account data.
- h) Change student data such as name, class, gender, and address.
- i) View all teacher account data.
- j) Change teacher data such as name, gender, and address.
- k) View all stored subject data.

- l) Add subject data.
- m) Change subject data based on ID.
- n) View all project data registered in the system.

2) Teacher

Some access rights owned by Teachers to carry out several functions as follows:

- a) Log in using the registered email and password.
- b) Log out
- c) Display user profile data.
- d) Change user profile data (name, address)
- e) Change password data by entering the old and new passwords.
- f) Display all student project submissions.
- g) Display details of student project submission data (background, project description, and group members.
- h) Approve student project submission.
- i) Reject the student project submission.
- j) Display all project data.
- k) Display project data based on subjects.
- l) Display student progress by the project.
- m) Displays detailed student project progress data.
- n) Display progress documentation files.
- o) Add feedback on student progress.
- p) Change feedback data that students have given.
- q) Delete feedback data that has been given.
- r) Display all student final project report data.
- s) Display the final project report data by subject.
- t) Display the student group's final project report file.
- u) Display the final documentation file of the student group.

3) Students

Some access rights owned by students are to perform several functions as follows:

- a) Log in using the registered email and password.
- b) Log out
- c) Display user profile data.
- d) Change user profile data (name, address)
- e) Change password data by entering the old and new passwords.
- f) Adding group project submissions
- g) Display all project submission data.
- h) Display project submission details.
- i) Change project submission data.
- j) Delete project submission data.
- k) Display all project data.

- l) Display project data based on specific subjects.
- m) Display data on all approved projects or based on certain subjects.
- n) Display data on all rejected projects or based on certain subjects.
- o) Display project detail data.
- p) Display data on all student project progress.
- q) Add weekly progress for student projects.
- r) Display all "my progress" data of the selected project.
- s) Display progress detail data.
- t) Display the progress documentation file.
- u) Change my progress data.
- v) Change my progress documentation file data.
- w) Delete my progress data.
- x) Display all report data.
- y) Display report data based on specific subjects.
- z) View the final report file data.
- aa) View final documentation file data.
- bb) Change the final report file data.
- cc) Change the final documentation file data.
- dd) Delete report file data and final documentation files.

b. Software and Hardware Requirements Analysis

- 1) Laptop / Computer / Smartphone with internet connection.
- 2) *Web Browser*

2. System Design

a. Unified Modeling Language (UML) Design

The entire functional design of the program can be described using the Unified Modeling Language (UML). There are 3 actors defined, namely: admin, teacher, and student. UML diagrams used for modeling and describing the system's workflow are Use Case Diagram, Activity Diagram, Class Diagram, and Sequence Diagram.

1) Use Case Diagram

The use case diagram of the project monitoring information system at SMK Negeri 2 Klaten, to describe all actor activities, is depicted in Figure 2 below.

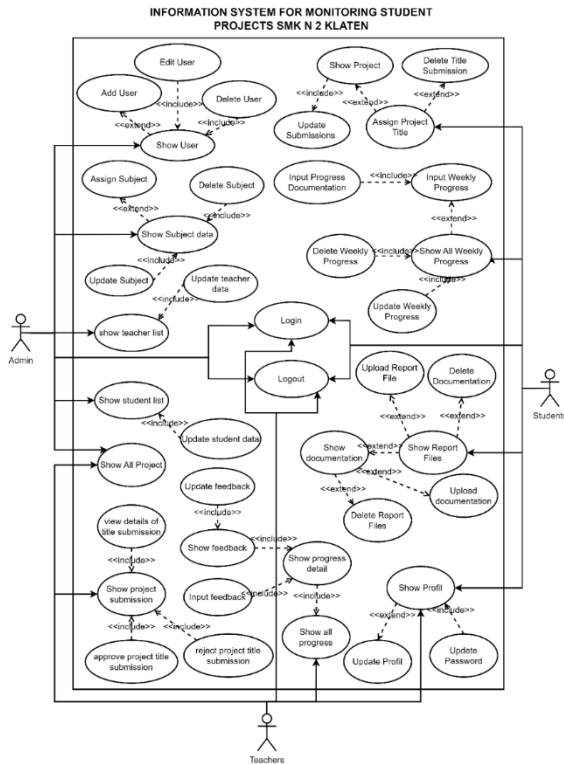


Figure 2. Use Case Diagram of Monitoring Project

2) Activity Diagram

Activity Diagrams will show the various activities to complete a particular data process. The sequence of activities will be clearly illustrated through the activity diagram. An example of the results of activity diagram modeling for the case of adding project progress from the information system to be developed is illustrated in Figure 3.

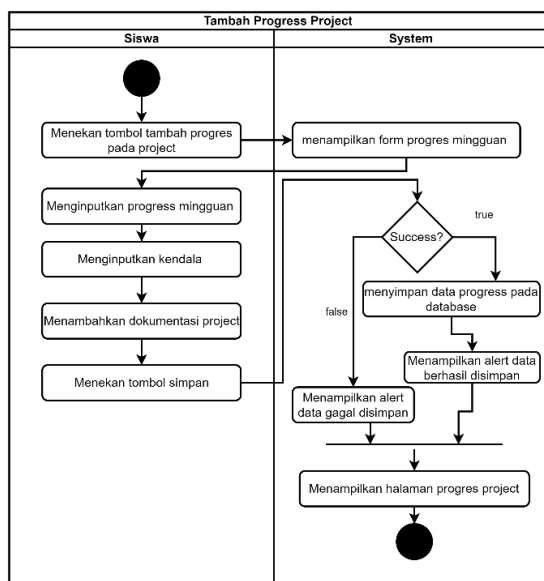


Figure 3. Activity Diagram Case Add Project Progress

The modeling results using activity diagrams produce 36 designs of all functions, including those found in Table 8.

3) Sequence Diagram

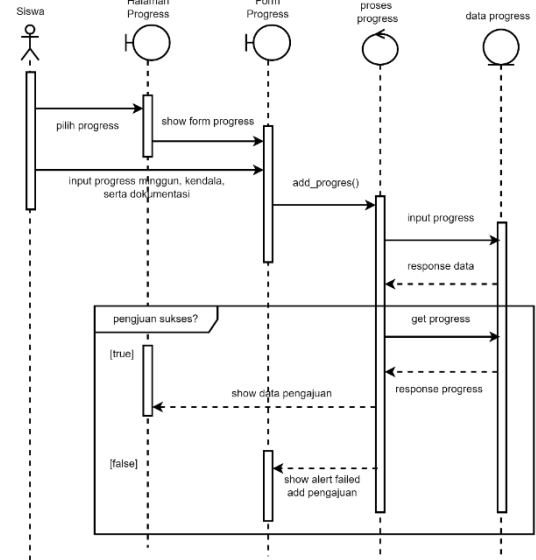


Figure 4. Sequence Diagram of Add Project Progress

After the system is described using an activity diagram, the activity diagram needs to be developed into a sequence diagram to find out the flow of events and processes carried out by each object. An example of the results of sequence diagram modeling for the case of adding project progress from the information system to be developed can be seen in Figure 4.

The sequence diagram generated from the information system modeling process produces 36 designs for each function. The list of sequence diagram designs is in Table 8 below.

Table 8. List of Activity Diagram & Sequence Diagram

List of Diagram			
1	Log in	19	View Progress
2	Log out	20	Add Progress
3	View User	21	Update Progress
4	Delete User	22	Delete Progress
5	Add User	23	Add Feedback
6	Update User	24	View Feedback details
7	View Teacher Data	25	Update Feedback
8	Update Teacher Data	26	Delete Feedback
9	View Student Data	27	View Profile
10	Update Student Data	28	Update Profile

11	View Subjects	29	Update Password
12	Add Subject	30	Add Submission
13	Delete Subjects	31	Update Submission
14	Update Subjects	32	Delete Submissions
15	View Project	33	View Report
16	View Project Submission	34	Add Report
17	View project submission detail	35	Delete Report
18	Project Submission Approval	36	View Project Details

processes that occur in the system. The ER diagram of the information system is as follows.

c. Interface Design

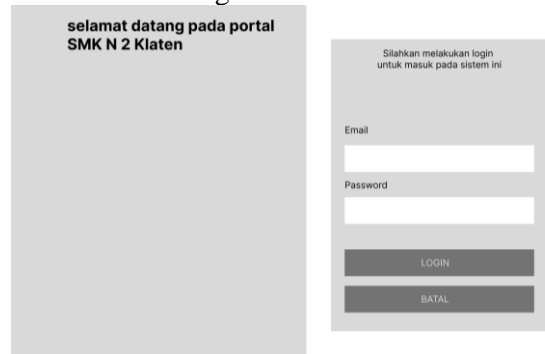


Figure 7. Wireframe login page

Interface design in the development of this information system is made using wireframes. The interface design results can be used as a prototype that can be tested on prospective users. There are 31 interface designs produced to describe several pages in this information system. Here are the results of the wireframe of the system's login page/landing page, which is depicted in Figure 7.

d. Prototype Testing

The data obtained from respondents were then analyzed using the UEQ Data Analysis Tools. This analysis results in the average value of each scale, described in Table 9.

Table 9. UEQ Analysis Results (Mean and Variance)

UEQ Scales (Mean and Variance)			
Scales	Mean	Var	Desc
Attractiveness	1.685	0.35	Good
Clarity	1.529	0.96	Good
Efficiency	1.936	0.39	Excellent
Accuracy	1.529	0.52	Good
Stimulation	1.743	0.66	Excellent
Novelty	1.314	0.70	Good

4) Class Diagram

Making class diagrams is adjusted to the concepts written in the use case diagram using the standard Gorm framework coding concept, which uses the Create, Read, Update, and Delete (CRUD) operation standard. The results of class diagram modeling of this project monitoring information system are depicted in Figure 5.

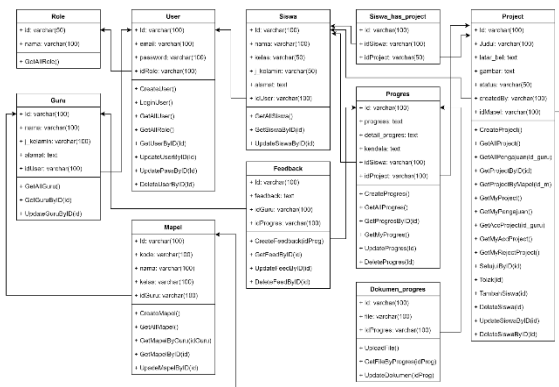


Figure 4. Class Diagram of Project Monitoring System

b. Database Design

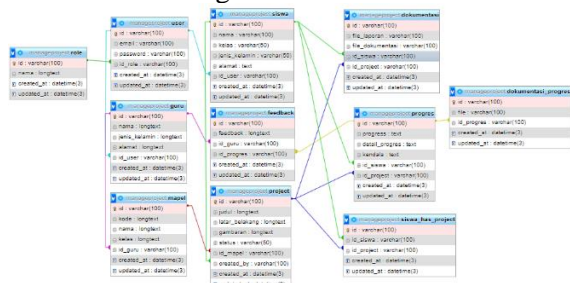


Figure 5. ERD of Project Monitoring System

The database is described using an ER diagram to show several entities' relationships. Through this diagram, the design of database usage can be seen to store all data from the

Based on the system design testing and prototypes analysis, the information system design prepared has met the standard user needs and is feasible to develop.

3. Coding/ Implementation

There are 3 parts of implementation: user interface, database, and program implementation.

a. User Interface Implementation

The client section's website-based project monitoring information system was built using the Vue.js framework. The interface of the

system is supported using the Bootstrap 5 CSS framework. Here are the results of the interface development on the login page/landing page.

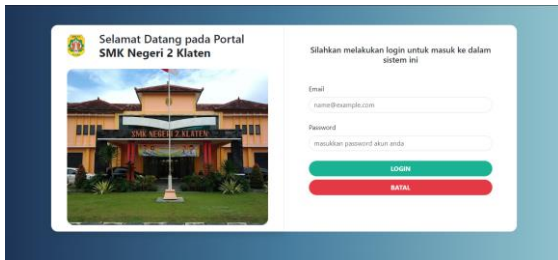


Figure 8. Login Page Interface

b. Database Implementation

After the database is designed using an ER Diagram, the next database is implemented as a table. Some tables used by the project monitoring information system are user tables, role tables, teacher tables, student tables, project tables, student_has_project tables, progress tables, and subject tables. Feedback table, documentation_progress table, documentation table. The following is an example of the results of the progress table database.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra	Action
1	id	varchar(100)	utf8mb4_general_ci		No	None			Change Drop More
2	progress	text	utf8mb4_general_ci		No	None			Change Drop More
3	detail_progress	text	utf8mb4_general_ci		No	None			Change Drop More
4	kendala	text	utf8mb4_general_ci		No	None			Change Drop More
5	id_siswa	varchar(100)	utf8mb4_general_ci		Yes	NULL			Change Drop More
6	id_project	varchar(100)	utf8mb4_general_ci		Yes	NULL			Change Drop More
7	created_at	datetime(3)			Yes	NULL			Change Drop More
8	updated_at	datetime(3)			Yes	NULL			Change Drop More

Figure 9. Implementation of the progress table

c. Program Implementation

The information system development process uses the golang programming language using the Echo and Gorm frameworks written using the Visual Studio Code text editor. The architecture of the program code contains structures, namely Entities, db, migrations, utils, config, and APIs that use the Model, Controller, and Router structures.

The program development process resulted in 48 APIs the project monitoring information system required.

4. Testing

Testing is done using the black-box testing method, namely by testing the functional suitability aspects of the developed system.

5. Operation

The system is run using several platforms, including:

- Netlify to deploy the client/frontend part
- Railway to deploy the database, and server/backend parts

ISO/IEC 25010 Quality Analysis

1. Functional Suitability Aspect

Functional suitability testing is carried out by involving 3 expert respondents who work as software developers. The tests carried out focus on the functions of the system.

The results of the data that has been obtained are then analyzed and included in the calculation with the following formula:

$$X = \frac{l}{p} \times 100\%$$

$$X = \frac{219}{219} \times 100\% = 100\%$$

Based on the results of analyzing system test data on the functional suitability aspect using certain calculations, the calculation result is 100%. These results are interpreted in the "Very Good" category.

2. Performance Efficiency Aspect

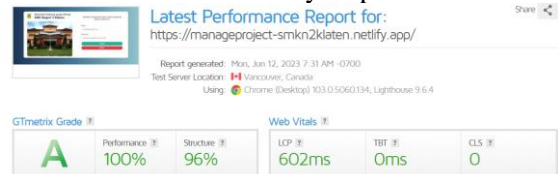


Figure 10. Results of Performance Efficiency Login Page

Testing on performance efficiency is done using the GTmetrix website to measure the loading speed of the system in more detail. The following are the test results of the project monitoring information system regarding performance efficiency using GTmetrix.

The test results that have been carried out produce an average value of 99.81% for the performance aspect, 98.90% for the structure aspect, and 0.582s for the average total time required. Based on these results, the performance and structure aspects fall into the **Very Good** categories.

3. Usability Aspect

The instrument used in usability testing is to use the USE Questionnaire, with a total of 30 test questions. The test used a Likert scale with 34 respondents, consisting of 33 students and 1 teacher. Based on the results that have been obtained, the data is then analyzed using the following formula calculation:

$$Total\ Score = 4080$$

$$Percentage\ score = \frac{4080}{34 \times 30 \times 5} \times 100\%$$

$$= 80\%$$

Based on the results of the data analysis, a score presentation of 80% was obtained. The value is then interpreted into the description, and the result shows that the information system is "Feasible" when viewed on the quality of the usability aspect.

Case Processing Summary			
		N	%
Cases	Valid	34	100.0
	Excluded ^a	0	.0
	Total	34	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.957	30

Figure 11. Alpha Cronbach Reliability Test Results

The results of the data that have been obtained are then analyzed for the reliability level of the data using Alpha Cronbach in SPSS software. The results of the reliability calculation of the data that has been obtained are shown in Figure 11. The results resulted in a reliability value of 0.957. This value is analyzed and included in the Excellent category, meaning that the results of the USE Questionnaire data obtained have met the reliability requirements.

4. Reliability Aspect

Reliability testing is done using the K6.io website tools to do stress testing. This test involved 40 virtual users who ran the system for 6 minutes. The test results for each role are as follows:

a. Admin Page

For 6 minutes, the total requests were around 2,377, with the number of failed responses totaling 0. The data is then processed using the following formula.

$$R1 = 1 - \frac{0}{2377} = 1$$

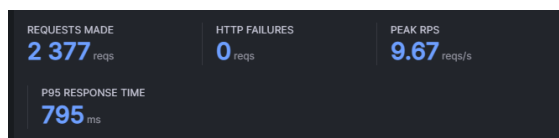


Figure 12. K6.io results on testing the admin page

b. Student Page

The total requests are around 4,237, with the number of failed responses totaling 0. The data is then processed using the following formula.

$$R1 = 1 - \frac{0}{4237} = 1$$

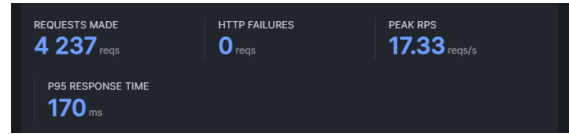


Figure 13. K6.io results on student page testing

c. Teacher Page

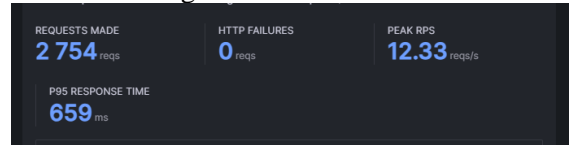


Figure 14. K6.io results on teacher page testing

The total requests are around 2,754, with the number of failed responses totaling 0. The data is then processed using the following formula.

$$R1 = 1 - \frac{0}{2754} = 1$$

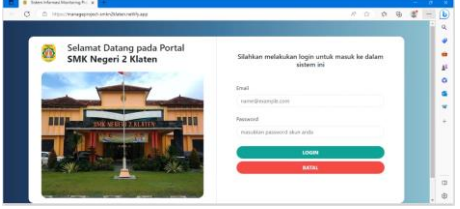
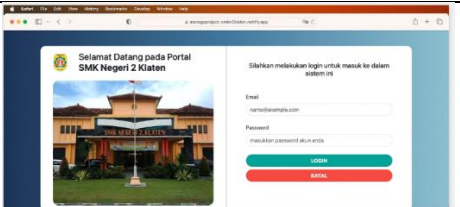
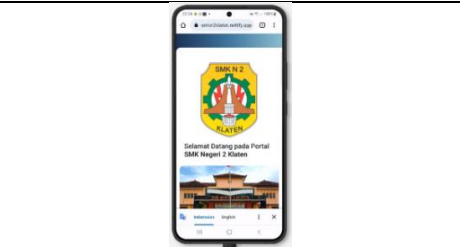
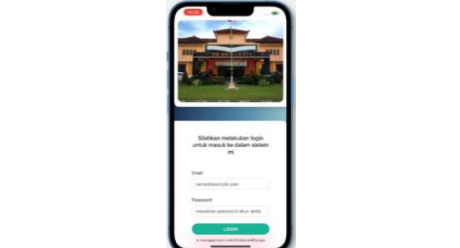
From the data processing results from all pages, a value of 1 or 100% is obtained. From this value, it can be concluded that the project monitoring information system has fulfilled the reliability aspect.

5. Portability Aspect

The results of portability testing are shown in Table 10.

Table 10. Portability Test Results

No	Result
1	<p>Figure 6. Results on Google Chrome</p>
2	<p>Figure 7. Results on Mozilla Firefox</p>
3	<p>Figure 17. Results on Opera Browser</p>

4	 <p data-bbox="347 443 703 470">Figure 8. Results on Microsoft Edge</p>
5	 <p data-bbox="347 689 703 716">Figure 9. Results on Safari Browser</p>
6	 <p data-bbox="347 999 767 1025">Figure 10. Google Chrome Mobile Results</p>
7	 <p data-bbox="347 1290 703 1317">Figure 21. Results on Safari Mobile</p>

Portability testing is done directly by running the system for several different platforms. In testing the portability aspect, the system is tested using the BrowserStack website to provide a virtual platform for various web browsers.

CONCLUSION

Based on the results of the research that has been done, it can be concluded the following points, including the following:

1. This research produces a project monitoring information system that can be implemented in project-based learning at SMK Negeri 2 Klaten. This information system was developed using the SDLC development method waterfall model, which consists of 5 stages, including (1) requirements definition, (2) system and software design, (3) implementation and unit testing, (4)

integration and system testing, and (5) operation and maintenance. System development uses the Golang programming language, JavaScript, and CSS, with the Gorm, Echo, Vue.js, and Bootstrap frameworks.

2. The project monitoring information system that has been developed is then tested based on ISO/IEC 25010 software quality standards. The test results on the functional suitability aspect show a value of $X = 1$ (very good), meaning that each function can run correctly. In usability, a value of 80% (feasible) was generated with the Alpha Cronbach reliability test result of 0.957 (excellent), in testing the efficiency aspect results in grade A with an average score of 99.81% (very good) for the performance aspect, 98.90% (very good) in the structure aspect, and 0.582s for the average load time. In the reliability aspect, it gets a value of 1 or 100%, which means that all functions can run well even though they are used by many users simultaneously. In the portability aspect, the information system developed can be run on various browsers both on desktop and mobile. From all the tests carried out, it can be concluded that the project monitoring information system developed has met the quality standards of ISO 25010.

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