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Design of *E-Monitoring* Application for Construction Project Program Evaluation Website Based

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ABSTRACT

A construction project is a series of interrelated activities to achieve certain goals (building/construction) within certain time, cost and quality limits. Rehabilitation and Reconstruction is one of the post-disaster disaster management projects. The success of a project can not only be seen from the completion time and final results of the project, but one important factor is the project progress report which is always monitored. E-monitoring is the supervision and monitoring of work processes through the use of information technology. In this research, the system development method used is the waterfall method and the system testing method uses black box testing. The monitoring and evaluation system for construction projects in rehabilitation and reconstruction at the Central Sulawesi Regional Settlement Infrastructure Center can display information about the progress of construction projects for rehabilitation and reconstruction at the Central Sulawesi Regional Settlement Infrastructure Center. This system can also speed up data searches, data processing and can process data.

Key words: Construction projects, Rehabilitation and Reconstruction, E-monitoring, Waterfall, Black Box.

1. INTRODUCTION

Monitoring and evaluation of construction projects is an important process in project implementation which aims to ensure that the goals and objectives are achieved [1]. Monitoring and tracking project progress is an important task in construction project management. All team members are required to know how the project is progressing in a timely and accurate manner, how it compares with the plan set initially, whether deadlines have been met, the budget has been met, and whether it has been implemented safely.

The main contractor is responsible for updating the Architect/Engineer, who, in turn, updates the owner. The successful completion of a project requires the integration of the project team's efforts to perform various project activities, and that is the project manager. The central project network is responsible for managing all construction processes. [2].

Planning and control consists of two senior planners and a junior planner [3]. A number of factors influence the success of a construction project, such as contractual arrangements, project complexity, project manager competence, relationships between project participants, and the capabilities of key project members. [4]. Human resources play one of the most important roles in monitoring and evaluating work. In a broad scope, monitoring and evaluation cannot be separated from a program. Monitoring is a step in collecting data on sustainable development which is demonstrated by progress and achievement of goals, while evaluation tends to provide credible and useful information as a basis for determining decisions [5].

Information Technology is now widely used in the construction industry [6]. This technology can be applied in the same construction project environment and on the same platform [7]. Monitoring progress in a project is an important factor in the success of the project being carried out.

Construction projects are complex and have many uncertainties [8]. However, when technology is applied to a reporting system, this is known as E-monitoring. E-monitoring is a tool that monitors the work of an electronic/online based system [9]. E-monitoring is the supervision and monitoring of work processes through the use of information technology. Monitoring on construction projects is carried out using Microsoft Excel software in both soft file and hard file form so that the data obtained can be lost at any time and cannot be accessed online . building and road construction which refers to the construction of office, educational and hospital buildings, as well as road construction [10].

The aim of this research is to determine the monitoring and evaluation system for construction projects in rehabilitation and reconstruction at the Central Sulawesi Regional Settlement Infrastructure Center and to create an e-monitoring application website-based construction projects so that you can monitor and evaluate construction projects online.

2. THEORETICAL FRAMEWORK

Several related concepts and literature reviews supporting the research objects are as follows:

2.1 Construction Projects

A project is an activity carried out with limited time and resources to achieve a specified end result. Construction projects are complex and time-consuming work. The total development of a project usually consists of several stages [11].

A construction project involves various stakeholders, including clients, architects, and other general contractors, subcontractors, material suppliers, equipment manufacturers, and so on [12].

The construction industry has characteristics that are very different from the manufacturing industry, which produces final products based on orders with certain designs in certain sites. The stakeholders involved in a project are organized based on the specifics of the project and selected through bidding. That works typical of the construction industry. Since recently, as construction projects have become increasingly complex, diversified, and have a greater degree of uncertainty about their success or failure [13], [14].

Construction projects are implemented in various countries at huge costs and some projects are relatively or completely unsuccessful and even face irreversible losses after construction. It may be due to project-related complexity or other socio- economic phenomena [15].

2.2 E-monitoring and Evaluation

E-monitoring and evaluation of project activities involves tracking, reviewing, managing technological progress to support data collection, analysis, and reporting [16] in meeting the performance objectives specified in the project management plan. Monitoring project implementation and real-time control of on-site construction is a growing field [17] [18], monitoring and control relates to the measurement of ongoing project activity variables against the project plan and baseline project performance determined at the start of the project or work assignment. Identifying and addressing problems and risks requires monitoring the project and approving changes to take corrective action. Whatever the stage of construction, measurable changes requiring adjustments in prior planning or proper design execution may occur.

In construction projects, risk monitoring and control are often poorly implemented due to identified risk management and monitoring failures [19].

3. RESEARCH METHODS

This section begins with an introduction to categorization and evaluation tools [20]. This section discusses the procedures for designing [21] website-based construction project monitoring and evaluation system. Factor Analysis with Principal Component Analysis Method is carried out to extract the important underlying factors [22].

3.1 System Development Methods

This research uses the Waterfall model system development method. In software engineering The waterfall model was formally introduced as an idea, through a paper published by Winston Royce in 1970 [23]. SDLC or known as the software development life cycle is a method for designing, building and maintaining information and industrial systems [24] [25].

The waterfall method in its development has several sequential stages, namely: requirements analysis, system design, coding and testing, implementation and system maintenance. The waterfall method can be seen in figure 1 below:

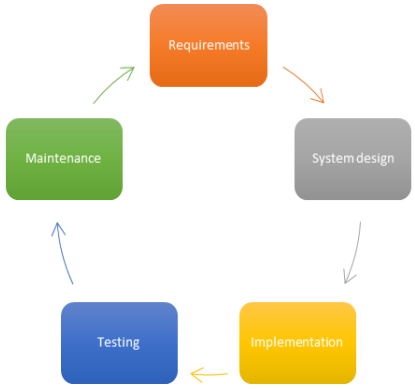

Figure 1 : Waterfall Method

The advantage of the waterfall method is that it allows for departmentalization and control. The development process is carried out one stage at a time, thereby reducing possible errors. The disadvantage of using the waterfall method is that if an error occurs in the process it is difficult to go back and change something that was not well documented at the previous concept stage.

3.2 System Testing Methods

Software testing is the most frequently used technique to verify and validate software quality [26]. The testing method in this research uses black box testing.

Black box testing is a software testing technique. Black boxes are used to determine application functionality. The focus of black box testing is the available input for the application and the expected output for each input value [27].

Figure 2 : Blackbox

Black Box Testing is testing without knowing the internal workings of the application being tested. Black Box is also known as input output driven testing or functional testing. A software testing technique in which the internal workings of the item being tested are unknown to the tester. The tester never checks the programming code and does not require any

further knowledge of the program other than its specifications. For example, in black box testing you only know the input and what the desired results are and how the program achieves these results. So, testers and programmers can be independent of each other, avoiding programmer bias towards their own work. This test design method applies to all levels of software testing: unit, integration, functional, system, and acceptance testing [28].

4. RESULTS AND DISCUSSION

This research was conducted to create a website-based construction project e-monitoring application so that it can monitor and evaluate construction projects. Based on the results obtained, the process of creating a construction project e-monitoring application is as follows:

4.1 System Design

System design can be defined as the depiction, planning and sketching or arrangement of several separate elements into one complete and functioning unit. At this stage, it includes several design stages. System design also helps develop systems by establishing harmony in system structure and design principles [29], [30].

a. Usecase Diagram

Usecase diagrams are one of various types of Unified Modeling Language (UML) diagrams that describe the relationship between interactions between systems and actors. Usecase can explain the type of interaction between system users and the system. This Usecase diagram explains what the system to be built will do and who will interact with the system. The use case diagram for the e-monitoring system can be seen in Figure 3 below:

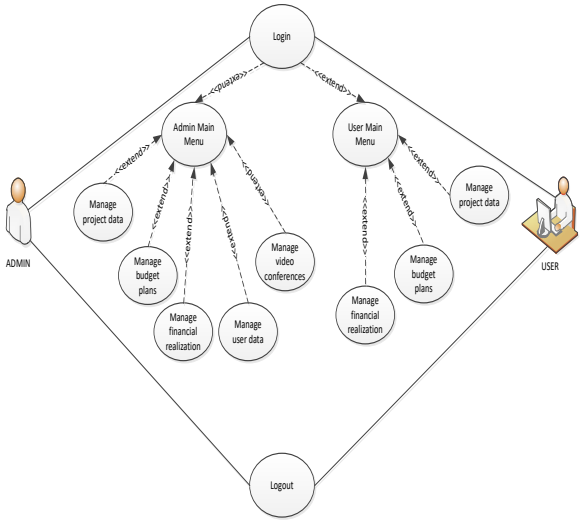

Figure 3 : Usecase diagram

Explanation of the Usecase diagram above is as follows: Usecase Diagrams Admins and users have access rights to the system. Admin adds user data so that he can log in to the system. Admins can add project data, budget plans, financial realization, and manage video conferences. Users will log in using the account entered by the admin. Users can only add project data, budget plans and financial realization.

b. Activity Diagram Login

Activity diagram, in Indonesian, Activity diagrams are a development of Usecases that have activity flows. Activity diagrams are diagrams that can model the processes that exist in a system. The process sequence of a system is depicted vertically. The login activity diagram for the e-monitoring system can be seen in figure 4 below:

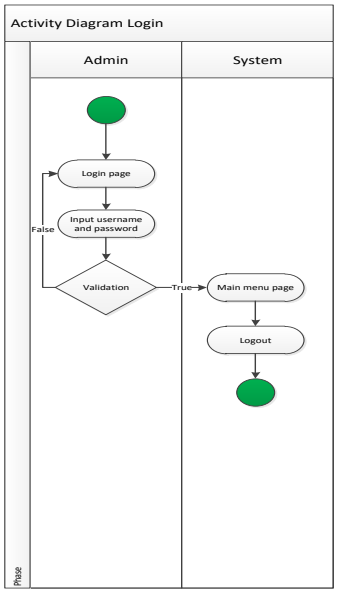

Figure 4 : activity diagram login

c. Project Management Activity Diagram

The project management activity diagram for the e-monitoring system can be seen in figure 5 below:

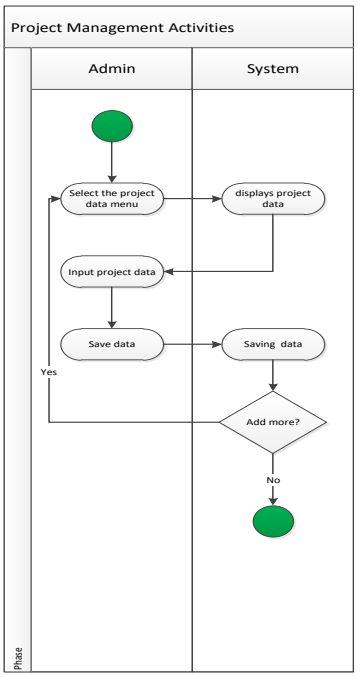

Figure 5 : Project management activity diagram

d. User Data Management Activity Diagram

The user data management activity diagram for the e-monitoring system can be seen in figure 6 below:

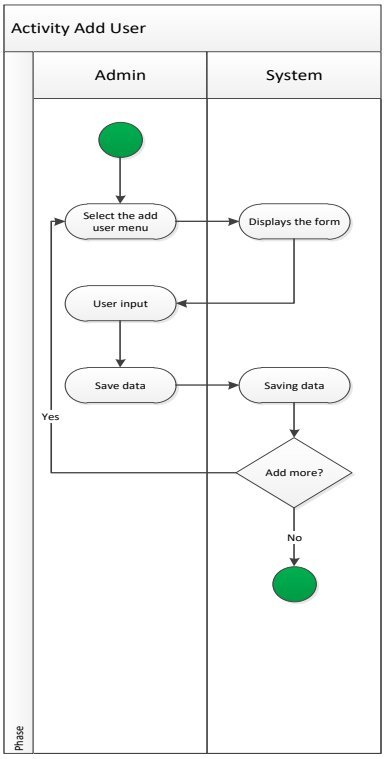

Figure 6 : User data management activity diagram

e. Login Sequence Diagram

A sequence diagram is an example of a UML diagram that shows the interactions between components in a process visually. This type of diagram will display the sequence of actions and communication of each component in the system, such as users and objects. The login sequence diagram for the e-monitoring system can be seen in figure 7 below:

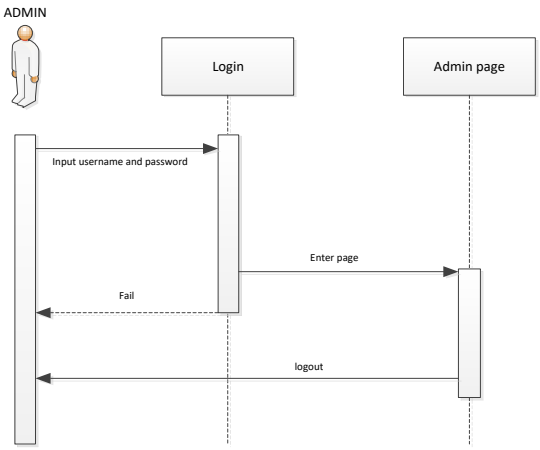

Figure 7 : Login Sequence diagram

f. Add Project Data Sequence Diagram

Sequence diagrams and collaboration diagrams certainly have differences in each diagram considering that the system and arrangement are also different. If Sequence diagram is a diagram system which is arranged by focusing on time sequence. The add project data sequence diagram for the e-monitoring system can be seen in figure 8 below:

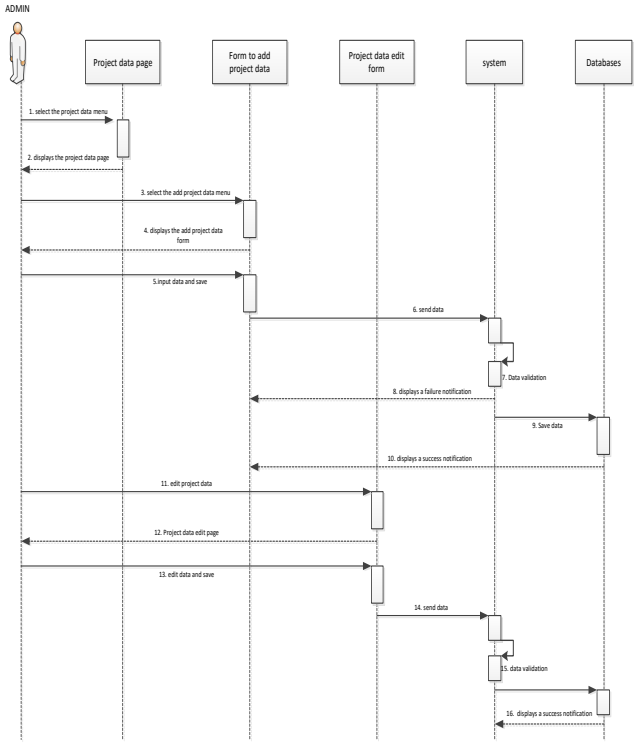

Figure 8 : Add project data sequence diagram

4.2 E-Monitoring Evaluation Using S-Curve

The S curve is a graph that represents the cumulative of all project activities. S curve visualization provides information about project progress by comparing the planned S curve with the realization. The S curve formulation is the sum of the cumulative percentage weights of each activity in a period between the project duration and is plotted on the vertical axis so that if the lines are connected, they will form the letter S. The flow of filling in the S curve module data is depicted in Figure 9 below:

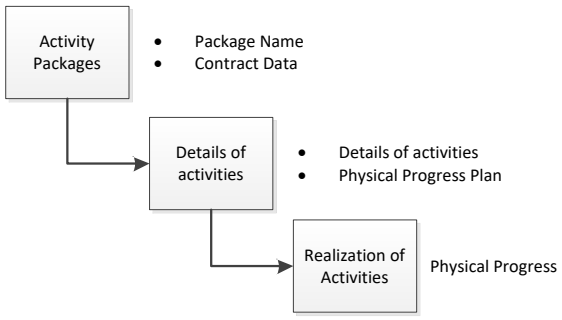

Figure 9 : Data entry flow

The project progress control technique which is commonly called the S curve is actually a combination of the S Curve, Bar Chart, and Earned Value Concept. The Result Value Concept (EVC) is the concept of calculating the amount of value issued

according to the budget according to the work that has been completed or carried out (Budget Cost of Works Performed/BCWP). When observed from the amount of work completed, this concept measures the size of the work units that have been completed at one time when assessed from the amount of the budget available for the work. Through this calculation, the relationship between what has actually been achieved physically and the amount of the allocated budget is known. Approach work progress with planned costs.

Equation: Outcome Value = (%completion) x Cost (1)

On most projects, resource expenditure per unit of time tends to start slowly, then build to a peak and then decrease gradually as the end approaches. In detail, the steps for constructing an S curve are as follows:

1. Determine the time for carrying out the work;

Regarding work execution time, it can be calculated based on the target time for completing the work or based on the volume of work to obtain the time needed to complete a job.

2. Create a table of job descriptions, job duration, costs, weights and time. The table created, in general:

a) The leftmost column contains work items;
b) The second column contains the price of each work item;
c) The third column contains the weight of each job;
d) In the fourth column, the duration of each work item is written.

3. Determine the sequence of activities

To sequence the stages of implementing activities for each work item, based on job characteristics and interdependence between jobs.

4. Set the duration of each work item

The duration of work is determined based on the estimated implementation time for each work item taking into account the volume of work, work methods/execution of available resources, environmental and weather conditions, as well as other assumptions.

5. Calculate Job Weight

Calculate the weight of each work item towards the total contract value, namely based on a comparative calculation between the cost per work item and the total work cost.

Equation :

Weight (%) = (Cost of each job/Total cost)x100% (2)

6. Create a Bar chart

Next, create a bar chart, the length of which corresponds to the duration of the work (working days/calendar days or weeks/months)

7. Determine the Job Progress Percentage

If the weight of each job has been calculated, then the percentage of daily/weekly/monthly work can be determined by dividing the total weight based on the predetermined time duration.

8. Vertically add up the work progress per unit time. Add up the weight of the physical implementation plan for each daily/weekly/monthly time unit vertically

9. Horizontal Accumulative Work Progress Per Unit Time

Cumulative percentage of work progress per unit time daily/ weekly/month horizontally which at the end of the schedule must be 100%. The relationship between the cumulative percentage (x-axis) and the percentage value from 0 to 100% (y-axis) is drawn by a curve that forms the letter S. The resulting curve is what is called the S curve, excluding value added tax (VAT).

Figure 10 : S-Curve.

4.3 Implementation

System implementation is the stage for implementing an existing system so that it can be operated.

a) Home Page

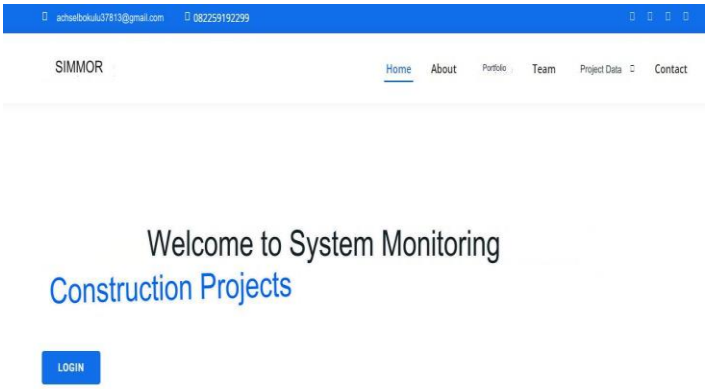

Figure 11 : Home page

Figure 11 above shows the default page which is used to attract visitors' attention and tell visitors what the website is about. This page is the main display of a website.

b) Login Form

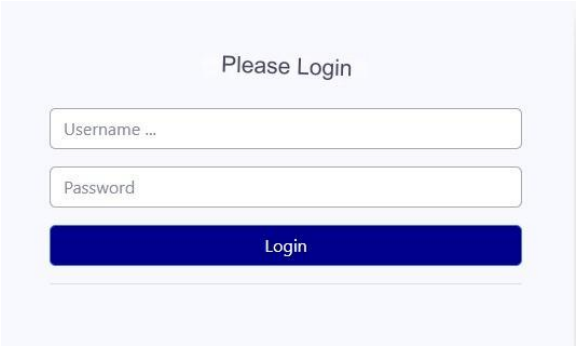

Figure 12 : Login form

Figure 12 above shows the page that provides access to enter the application. This page functions as the initial stage for admins and users to enter the system by entering the username and password that have been entered previously.

c) Admin Dashboard

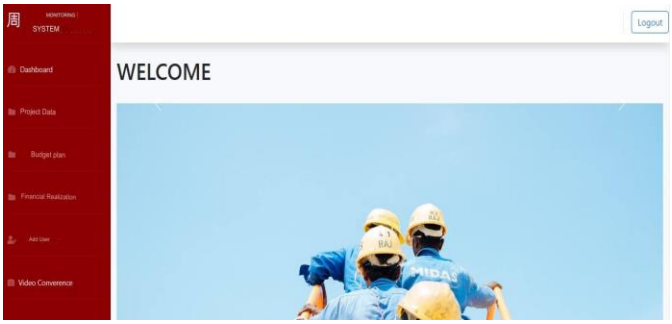

Figure 13 : Admin dashboard

Figure 13 above shows the page that functions as the admin's initial display when successfully logging into the website.

d) Add Project Data Form

Figure 14 : Add project data

Figure 14 above shows the page for adding project data to the website. Project data is entered according to data on the Rehabilitation and Reconstruction project for the Central Sulawesi Regional Settlement Infrastructure Center.

e) Add Budget Plan Form

Figure 15 : Add budget plan

Figure 15 above shows the page for adding budget plan data to the website. Budget plan data is entered to create a project progress percentage displayed with an S-curve

f) Add Financial Realization Form

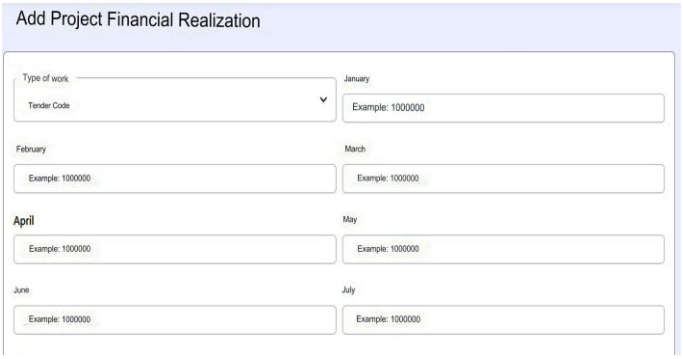

Figure 16 : Add financial realization

Figure 16 above shows the page for adding financial realization data to the website. Financial realization data is entered to create a percentage of project progress which is displayed with an S-curve.

5. CONCLUSION

The monitoring and evaluation system for construction projects in rehabilitation and reconstruction at the Central Sulawesi Regional Settlement Infrastructure Center can display information about the progress of construction projects for rehabilitation and reconstruction at the Central Sulawesi Regional Settlement Infrastructure Center. This system can also speed up data searches, data processing and can process data. Based on the black box testing method , all save button components and all login, add, edit and delete buttons can function as they should. Based on these results, this test is said to be successful with a score of 92.9% and this system can be categorized as "Very Good". So it can display data such as cost reports, project work progress and reporting in file form.

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