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ANALYSIS AND DESIGN OF WEB-BASED PROJECT MANAGEMENT SYSTEM

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Abstract

In the dynamic landscape of technology-driven business environments, software development companies need to adeptly address ambiguous customer needs. Flexibility in plans is crucial to accommodate unforeseen requirements, as changes in project requirements can inevitably impact project planning, potentially hindering project progress. A notable challenge currently faced by the company is the absence of a monitoring system for ongoing IT projects. This research develops an information system designed to streamline IT projects, managing tasks for programmers and monitoring project budgets from acceptance to completion. In this research, the waterfall model is employed for the development of the project management system, and black box testing is utilized to test the application system. The findings indicate that this project management system can offer the following benefits: (1) Efficient project management by overseeing budget, clients, projects, and task-based scope division. (2) Task scheduling from initiation to project completion. (3) Notification of project managers (PMs) and programmers to keep them informed about ongoing project tasks and progress. (4) Expenditure monitoring through graphs that compare the budget with actual expenditures.

Keywords: Information system, Monitoring, Project management system, Software project management.

1. Introduction

Companies involved in software development must be able to respond to ambiguous customer needs in today's dynamic technology-based business environment [1]. Achieving success in software development projects is a formidable task. Indeed, one of the most significant challenges in these endeavors is understanding how to improve the software development process to prevent failure [2]. Project planning and control is an essential part of project management and an important factor that contributes to either success or failure in meeting project objectives [3-8]. Plans must be flexible enough to accommodate unforeseen requirements. Project planning will undoubtedly be impacted by requirements that change in the middle of a project. The progress of a project may face obstacles when there are frequent changes in the project work processes, and such changes should be kept to a minimum [9]. Precise project planning can mitigate the need for changes in the project. By employing appropriate project management techniques tailored to the project's circumstances, it becomes possible to effectively handle emerging changes [10].

Managing software projects presents unique challenges. The process involves bringing the invisible into visibility, adding an extra layer of complexity to project management. Furthermore, software projects possess distinct characteristics, such as complexity and flexibility, setting them apart from other project types [9]. The failure rate of information system projects is the highest compared to other projects [11]. According to researchers [9] the development of information systems projects is not always successful because information systems development projects are usually complex, dynamic, and unstructured. As a result, it might fail or commonly occurring problems. The definition of failure of an information system project usually refers to an IS project that is not implemented or cancelled, and the project has been completed but did not achieve the project objectives [3, 4]. According to the Project Management Institute, the failure of an information system project is to exceed the budget, exceed the specified time, and not match the project objectives [10].

Building on that foundation, this study implements a software project management system within PT. Jamparing Masagi. PT. Jamparing Masagi (JMASAGI) is an ICT company composed of proficient professionals with expertise in Network Solutions and Software Solutions. The company is keen on expanding its horizons by creating cutting-edge ICT products and solutions customized for companies, academia, government, the private sector, and other institutions. PT. Jamparing Masagi provides a range of ICT Solutions, encompassing Network Solutions, Software Solutions, and Multimedia Solutions. Nevertheless, a significant challenge lies in the lack of a monitoring system for project management, especially for IT projects - from project initiation to the completion of the project scope. Addressing this gap is a critical requirement for PT. Jamparing Masagi. This has prompted the author to develop a web-based project management system application designed to assist project managers in overseeing IT projects. The application streamlines the management of allocated programmer resources and monitors project budgets until the completion of the project scope.

2. Project Management System

The system can be defined as a collection of components that interact and collaborate to accomplish specific objectives, or as a group of integrated elements

with a shared purpose to achieve a goal [12]. An illustrative example is the human digestive system, comprising components like the mouth, esophagus, stomach, intestines, and anus, which collaborate to digest food, absorb nutrients, and eliminate waste. Thus, in the context of systems, three crucial elements are involved: Component Circuit, Interaction and Cooperation, and Goal.

Information is the outcome of processing data (facts) into something meaningful and valuable for decision-making [12]. In our daily lives, the presence of information facilitates all our decision-making activities. Information is integral to various aspects of human life, as individuals often require information, regardless of who, when, or where they are. Quality information possesses characteristics such as reliability, relevance to user needs, timeliness, completeness, understandability, and verifiability [13, 14]. A statement lacking these qualities is akin to mere gossip, holding the potential to lead to misunderstandings and conflicts. Therefore, the information system is a series of components in the form of humans, procedures, data, and technology (such as computers) that are used to carry out a process to produce valuable information in decision-making [13]. A Management Information System is a systematically organized set of procedures for executing and transforming data into information, aiding decision-making and control within an organization [15]. The primary role of a Management Information System is to serve as a tool that facilitates decision-making for management. These systems find widespread usage across various sectors within organizations or institutions, including education, business, services, industry, and healthcare [15].

Information Systems is not primarily concerned with the technical and computational aspects of IT. Instead, it focuses on how technology is used and implemented to support the information needs and requirements of individuals, groups, and organizations to achieve specific goals and practices. Information Systems (IS) is a multidisciplinary field that draws on knowledge and concepts from various areas such as computer science, management, and organizational behavior [13]. The field of Information Systems is concerned with the study of the design, development, implementation, and management of information systems that support the efficient and effective functioning of organizations [14].

The Information Systems field focuses on understanding how technology can be used to support and enhance business processes and operations. This includes understanding how technology can be used to support decision-making, how to design and implement effective systems, and how to manage the resources required for these systems [16]. In essence, the Information Systems field is concerned with the strategic use of technology to support business processes and operations. It is a multidisciplinary field that leverages knowledge from diverse areas such as computer science, management, and organizational behavior [13].

2.1. Software development

The relationship between the two lies in the fact that Information Systems is a field that encompasses the utilization of technology to support business processes and operations, while software development is the specific discipline involved in creating the software that facilitates these processes and operations. In simpler terms, Information Systems represent the broader concept, with software development being a specific aspect of it.

Software development is the comprehensive process of designing, creating, testing, and maintaining software. This process necessitates the management of resources such as personnel, hardware, and budget, along with effective communication and collaboration among team members [17]. The software development process also incorporates the use of specific methodologies and techniques, such as Agile, Scrum, Waterfall, and others, to plan and execute the project [18, 19]. Furthermore, software development frequently entails collaboration among various team members, including developers, project managers, quality assurance, and stakeholders [19].

2.2. Project management

Management plays a pivotal role in efforts to mitigate risks and optimize the benefits of information systems. The primary objective of Project Management is to furnish precise and timely information, facilitating the decision-making process and empowering organizations to efficiently carry out their planning, control, and operational functions [16]. Project Management integrates human and computer-based resources to gather, store, retrieve, and communicate data for business management and planning, ultimately enhancing performance and productivity [20].

3. Research Framework and Methodology

A research framework is the theoretical and conceptual structure that steers a research study. It comprises a set of assumptions, concepts, values, and practices that delineate a study and provide it with guidance. This framework aids in defining the research problem, pinpointing key variables and their relationships, and deciding on the methods and techniques for data collection and analysis [12]. An integral aspect of the research process, a research framework furnishes structure and a logical progression for the study, enabling researchers to comprehend the collected data and draw valid conclusions. Research framework of this study is shown in Fig. 1.

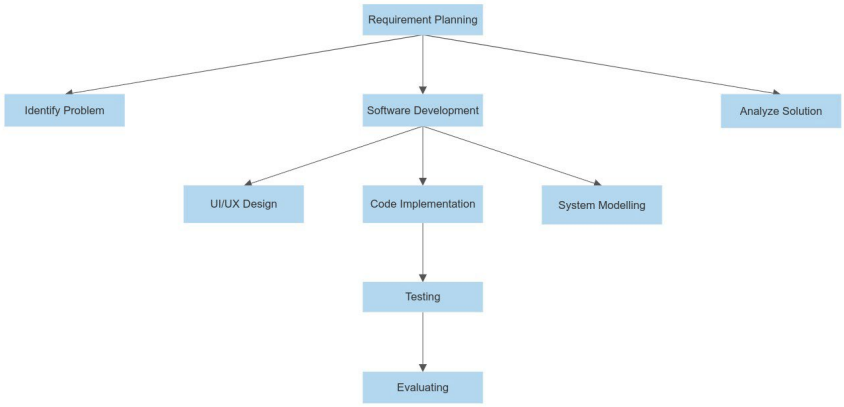

Fig. 1. Research framework.

The development of software necessitates a specific methodology and a system model for its development. The methodology typically involves a specific approach, or a series of steps followed in the software development process [20].

The system model, as depicted below, encompasses the structure and functionality of the system. The framework also includes the "UI/UX Design" stage, focusing on the design of the system's appearance and workflow. Following the design phase, the code is implemented during the "Implementation" stage.

In the "Implementation" stage, the code is crafted and integrated, while the concluding phase is the "Testing and Evaluation" stage is when the software is tested to ensure that it is functioning as intended and to evaluate its effectiveness in solving the problem. The work is closed with testing and evaluation. Overall, this research framework provides a clear and organized structure for the research, guiding us through the various stages of the software development process and ensuring that all necessary steps are taken to produce functional and effective project management software. It covers all the necessary steps for a software development process.

4. Methodology for Software Project Management

Traditional methods in today's business world are no longer efficient. In the traditional approach, projects often have lengthy timelines for completion. Moreover, this methodology does not readily accommodate timely changes, typically occurring towards the end of the project. This complex approach hinders the ability to meet customer targets. Modern methods have introduced a new perspective on project delivery, emphasizing the rapid achievement of success through the delivery of tangible products [21]. Traditional methods differ significantly from modern approaches, influencing the choice of a software development methodology [22]. Traditionally, the focus was on project scope to determine cost and time schedules. The waterfall method is well-suited for a predictable environment, whereas modern methods are adaptable to unpredictable circumstances. In today's global scenario, the waterfall methodology is less commonly used. This is because teams often spend extended periods on critical tasks, resulting in project delays and a backlog of unfinished tasks by the project's conclusion. Given the unpredictable nature of today's world, traditional methods are not as widely employed [21].

Modern project management methodologies, such as PRINCE2 and PMBOK, have evolved from the Waterfall approach [21] and are among the most extensively employed project management methodologies in Europe and North America. The Waterfall approach, distinguished by distinct phases and well-documented baseline requirement specifications, continues to be widely used, especially in contractual offshore software development projects [22, 23]. All projects included in this study chose to implement the Waterfall development method, thereby ensuring consistency in factors related to the development environment [22, 24].

Methodology in project management that is general and easy to apply for both small, medium, and large-scale projects is a traditional methodology or approach that has a sequence that must be passed in project management from start to finish [25, 26]. These stages are as follows:

(1) Initialization phase (Initiation stage).

Conduct a feasibility study before the project is defined, usually, this is done by the project owner and project sponsor. A project is said to be feasible if it meets the eligibility requirements, such as:

i) Provide benefits for clients.

ii) Provide solutions to problems that are being faced by project owners.

iii) Can be implemented following the expected time, available budget, and measurable activities and resources, as defined in the project management triangle.

(2) The planning or design phase

The implementation of this phase is more involving the project implementation team, although other parties such as the steering committee continue to carry out external control functions, namely, to produce plans and designs for information system development with more detailed analysis.

(3) The execution or production stage

In this phase, the activities carried out are carrying out the tasks that have been defined in the previous phase to produce software according to the requirements. Activities within the scope of information system management are:

i) Programming (Development)

ii) Testing

iii) Quality assurance (QA)

iv) Documentation

(4) Monitoring and controlling systems.

This phase consists of processes carried out for observing project implementation and project performance can be observed and measured regularly. Thus, if there is a deviation from project implementation against the plan and design, it can be anticipated immediately. This supervision and control consists of:

i) Measuring project activities that are being implemented

ii) Supervise project variables against agreed plans and designs

iii) Identify corrective action in case of deviation

iv) Direct central control so that only any changes to the approved project plan can be implemented.

(5) The Completion stage.

Previously in this phase, there was an additional stage or process, namely the delivery stage, in which the deliverables were handed over to the project owner. The delivery stage is divided into three main parts, namely deployment, training, and production.

In the completion phase or final phase, the software product has been installed, operated, and utilized by the client. There are two activities carried out in the completion phase, namely:

i) Project closure, i.e. stakeholders carry out evaluations, official handover, and end of SPK or contract.

ii) Entering a maintenance period which can be continued with a new SPK or contract. Maintenance is important considering that software products cannot be 100% free from possible errors or bugs.

5.System Analysis and Design

UML (Unified Modeling Language) is the de facto standard formalism for the analysis and design of software [27]. The Unified Modeling Language (UML), as presented by [28], offers a predominantly graphical notation for representing the artifacts of a software system. This notation has gained widespread acceptance as the standard notation for object-oriented analysis and design. UML incorporates notations to describe systems at various levels of abstraction. UML diagrams can be employed to model requirements, designs, implementations, and tests. Given that these diagrams serve as a means of communication among customers, developers, and other stakeholders involved in the software engineering and reengineering process, it is crucial that the diagrams convey information clearly. Proper layout of these diagrams can contribute to achieving this goal [28].

In the application design process, modeling is crucial, and this requires the use of a Use Case Diagram. A use case diagram, part of the Unified Modeling Language (UML), depicts the interactions between actors and use cases within a system. It is employed to represent the high-level requirements of a system and capture the user's needs and objectives [29, 30].

Use case diagrams are normally used to identify application functionalities. However, use case diagrams may also be used to identify interaction activities [31]. In Fig. 2's use case diagram, the application design for project management is categorized into two parts of the access page: PM (Project Manager) and programmer. The diagram illustrates the relationships between the actors, PM and Programmer, along with several use cases present in the Project Management application. Primarily, PM holds more control over the application, as denoted by the dashed line connecting the PM actor to the use cases. This signifies that the PM is the principal user of the application, initiating and overseeing various activities within the system. The PM possesses control because the application is designed to simplify their work. Conversely, the programmer has a more restricted role, with access limited to specific activities within the system.

Overall, the use case diagram in Fig. 2 provides a high-level overview of the interactions and activities that are possible within the project management application. It serves as a useful tool for understanding the user's needs and goals, and for designing a system that meets those needs. Some of the key use cases that are represented in the diagram include:

i) Scheduling tasks: This use case denotes the PM's capability to schedule tasks and assign them to programmers. The PM has the authority to create, edit, and delete tasks, as well as allocate them to specific programmers.

ii) Monitoring progress: This use case permits both the PM and the programmer to observe the project's progress and the status of individual tasks. The PM can gain an overview of the entire project and delve into the specifics of each task, while the programmer can view their assigned tasks and the progress made on them.

iii) Monitoring expenditure: This use case empowers the PM to track the project's expenditure and ensure it stays within the budget. The PM can view the overall cost of the project, along with the expenses associated with each task and each programmer. This functionality aids the PM in

making informed decisions regarding resource allocation and project budget management.

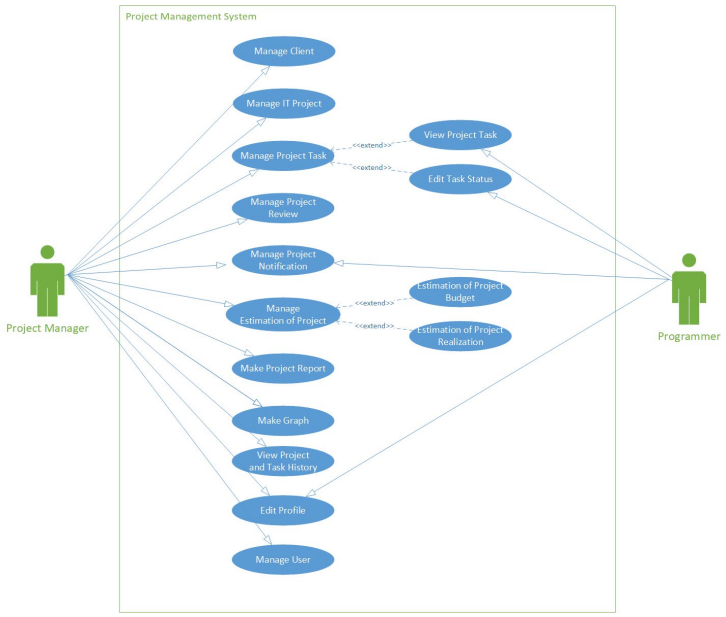

Fig. 2. Use case diagram for software project management application.

The implementation of the project management system was effectively carried out via a web-based application, leading to the generation of source code, data implementation, and interfaces that adhere to the design specifications. The program code was implemented using PHP, HTML, CSS, Bootstrap framework, Javascript, and CodeIgniter 3.1.10 framework. CodeIgniter was chosen for its user-friendly nature, speed, and lightweight architecture, allowing developers to avoid starting from scratch. The Bootstrap Framework was selected for its ease of use in constructing front-end web pages [10]. The system's database is implemented using the MySQL Database Management System (DBMS) with a localhost server for efficient data manipulation and storage. Access to the system implementation results is achieved through the Google Chrome and Mozilla Firefox browsers. Figure 3 illustrates an example of the implemented system interface.

The web design in Project Manager is a page that can only be managed by the Project Manager. On the Dashboard Page in Fig. 3, the Project Manager can choose the menus to be managed, including dashboard menu, client, project, task, review, notification, estimate, report, graph, history, profile, and programmer.

The dashboard menu allows the PM to view an overview of the project status and progress. The client menu allows the PM to view and manage client information and project details. The project menu allows the PM to view and manage project details and tasks. The task menu allows the PM to view and manage project tasks and their status. The review menu allows the PM to view and manage project reviews and feedback. The notification menu allows the PM to view and manage project notifications and alerts. The estimate menu allows the PM to view and manage project estimates and budgets. The report menu allows the PM to view

and generate project reports and analyses. The menu allows the PM to view project data in graphical form for easy visualization and analysis. The history menu allows the PM to view past project data and activities. The profile menu allows the PM to view and manage their user profile and settings. The programmer menu allows the PM to view and manage the programmer team and their tasks.

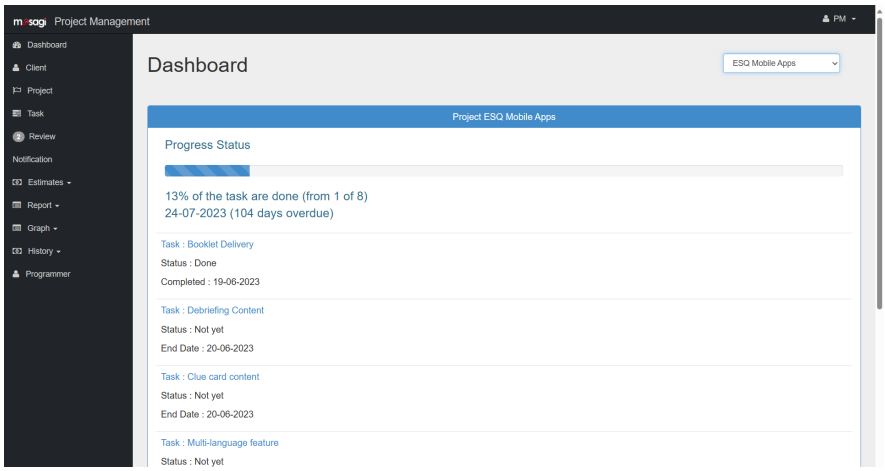

Fig. 3. Project manager dashboard page.

Overall, the web design in Project Manager provides a comprehensive and user-friendly platform for the PM to manage and monitor their projects effectively. The intuitive and user-friendly interface makes it easy for the PM to navigate and perform tasks efficiently. The integration of various tools and features, such as reports, graphs, and notifications, helps the PM to make informed decisions and stay on top of the project status. Overall, the web design in Project Manager enhances the productivity and efficiency of the PM in managing their projects.

When PM selects the Project menu, PM will be redirected to a page that contains a table containing a list of projects. On this page, PM can view project information, and add, change, and delete projects. The design of the Project Page can be seen in Fig. 4. There is a table that displays a list of projects currently being worked on. PM can add a project by clicking the "add project" button, and a pop-up will appear containing the project form. After filling in all the required information, the project data will be entered into the table. Project details can be seen by clicking the "show" button. If there are changes, the PM can also change project data by clicking the edit or delete button if the project is cancelled.

After managing the project list, the PM can manage the tasks of each project. On the Project Task Page in Fig. 5, we can see a table of task lists made by the project. These tasks will then be carried out by the Programmer.

It is important to manage tasks within each project effectively. This can be done by creating a task list for each project and assigning specific tasks to individual team members or programmers. The project task page in Fig. 5 allows the project manager to see all of the tasks associated with a particular project in a table format. This makes it easier to see what tasks are still pending, and which team members are responsible for completing them. Furthermore, the project manager can utilize

this page to monitor the advancement of individual tasks and implement any required adjustments to the project plan. Through efficient task management within each project, the project manager can guarantee the project's timely completion and adherence to budgetary constraints.

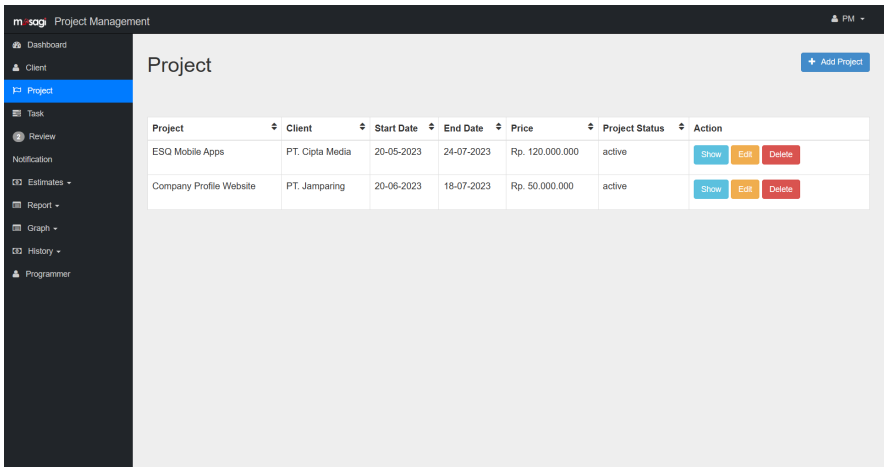

Fig. 4. Project page.

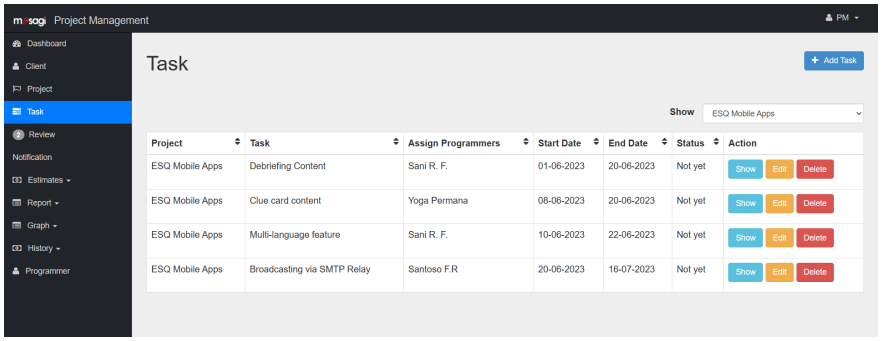

Fig. 5. Project task page.

In Fig. 6, on the Estimation Report Page, project managers can access, and review estimation reports along with information on actual time realization. These tools are commonly employed by project managers to monitor project progress and verify that it adheres to budgetary and completion goals. The estimation report provides information on the estimated costs of the project, as well as any potential gains or losses from the calculation of the project value. Report time realization information provides information on the actual costs and time spent on the project for making comparisons between the budget and project realization.

Estimation reports and information on actual time realization are crucial tools for project managers to monitor project progress and ensure adherence to budget and completion timelines. Through a comparison of these two aspects, project managers can pinpoint potential issues or areas for enhancement, enabling them to take proactive measures to maintain project alignment. This approach contributes to the timely and budget-conscious completion of the project, which is

indispensable for its overall success. Therefore, this page provided a "generate" button. If the generate to PDF button is pressed on this page, it will create a PDF version of the estimation reports and report time realization information for the project. This PDF can then be printed or saved for future reference. The ability to generate a PDF version of this information can be useful for project managers who want to have a physical copy of the reports, or who need to share the information with other members of the project team or stakeholders. In Fig. 7, there is an example of an estimation report that has been created in a PDF.

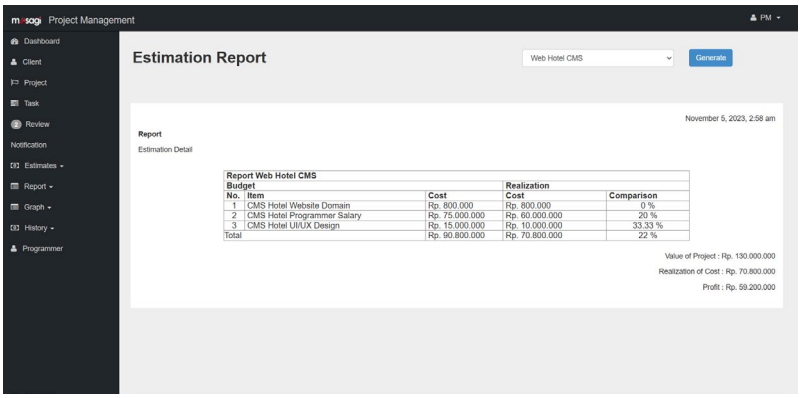

Fig. 6. Estimation report page.

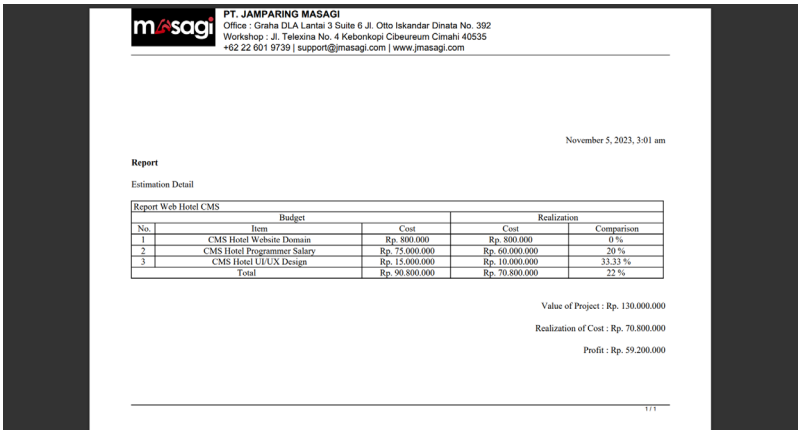

Fig. 7. Print estimation report page.

Visualization is an essential feature of project management tools and can help project managers ensure the success of their projects. Graph Visualization is a feature of a project management tool or software that provides the ability to create graphs based on the estimation reports and report time realization information for a project. The page is a page that provides facilities for making estimation graphs and graphs of time realization. Graph visualization is an important feature in project management tools because it allows project managers to quickly and easily see how their project is progressing in terms of budget and time. By utilizing visual representations of the project's advancement, project managers can effectively spot potential issues or delays, allowing them to take corrective measures before they

escalate into significant problems. Adding a visual representation of the project's progress, can help project managers identify potential issues or delays and take corrective action before they become major problems. Additionally, the ability to filter the graphs based on ongoing or completed projects allows project managers to focus on the specific information they need to make the best decisions for their projects. Overall, graph visualization is a valuable tool for project managers to help them better understand their project and make more informed decisions to ensure the success of their project. For further details, an example of an estimation report graph is shown in Fig. 8.

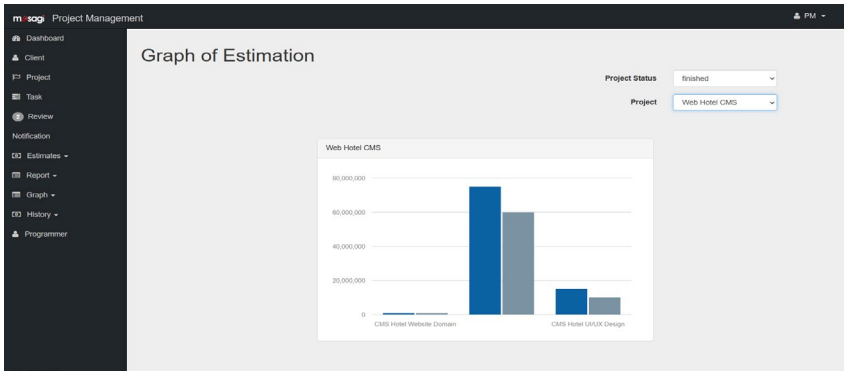

Fig. 8. Estimation graph page.

In Fig. 8, the estimation feature enables project managers to visually compare the estimated report. An estimation graph illustrates the comparison between the budgeted value and the realized value. By assessing the estimated budget value against the actual realization value, project managers can identify any deviations from the initial plan and take corrective action as needed.

In Fig. 9, the display on the time realization page features a comparative graph depicting the project period against the actual realization of the project period. The time realization feature enables project managers to visually assess the project's progression in terms of time. It aids project managers in ensuring that their project remains on schedule and adheres to its deadlines.

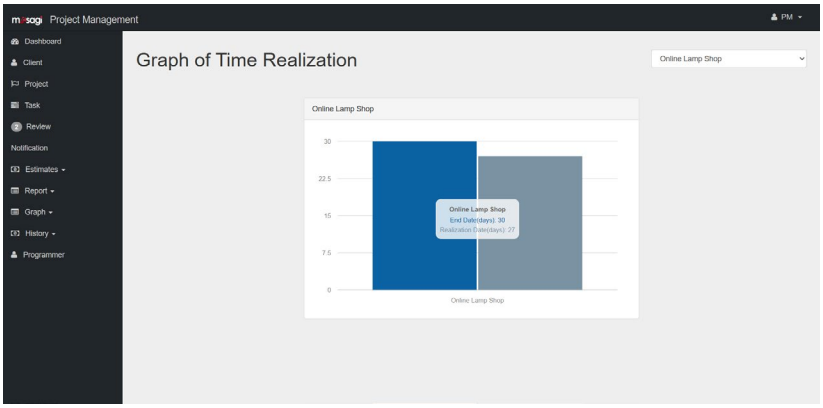

Fig. 9. Time realization page.

6. Conclusion

Based on the findings from observations and testing of the Project Management System at PT Jamparing Masagi company, it can be deduced that this application facilitates the following: (1) Conduct project management by overseeing the budget, clients, projects, and segmenting the scope into tasks. (2) Schedule tasks or activities until the project's completion. (3) Inform Project Managers (PMs) and programmers about tasks and the ongoing project's progress. (4) Monitor expenditures through graphs that compare the budget with actual expenditures.

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