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Development of Web-Based Project Tender Documents Application Using Extreme Programming Methods

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ABSTRACT

The application of technology is a need that is in demand in the industrial world today, especially in the field of contractors of goods and services that have implemented the use of applications to help the process of managing data and project documents in their companies. This study aims to optimize the web-based project tender document system using the extreme programming method. The extreme programming method consists of planning, design, coding, testing, and software increment. Research methods using extreme programming methods consisting of planning, design, coding, testing, and software increment. The planning stages obtain results in the form of functional and non-functional application needs. The design stage results in the design of applications using activity diagrams, diagram classes, use case diagrams, and flowcharts. The coding stages obtain results in the form of applications that can be built using web programming languages. The testing stage uses the ISO 9126 standard. Suitability test results are worth 1 (very good), security is not found to have viruses or malicious malware in applications (grade B), reliability is worth 0.99 (good), usability is worth 90.9% (very feasible), efficiency is worth 98% (grade A), maintainability meets the three standard aspects of assessment (good), and portability is worth 1 (very good). The software increment stage obtained results in the form of implementation and application trials on users who have functioned properly. Based on the results, it can be concluded that the development of web-based project tender document applications using extreme programming methods can function properly and be feasible to use.

Keywords*:* Extreme Programming, Project Tender Document*,* ISO 9126, Web Application

INTRODUCTION

Indonesia has now entered the industrial era 4.0, where the application of communication technology, information, and management administration is required to migrate from manual systems to digital systems. One form of application of digitalization technology is web-based applications. The use of this web-based application has been implemented by various companies such as industrial companies, services, finance, and contracting companies.

A contracting company is a company that accepts work in accordance with an employment contract and carries out work such as supplying goods or completing certain services, such as construction services, in accordance with an agreed contractual agreement. Umumnya kontraktor mendapatkan proyek pekerjaan dengan dua cara, pertama dengan ditunjuk langsung oleh pemilik proyek untuk mengerjakan proyek tersebut. Generally, contractors get project work in two ways, first, by being appointed directly by the project owner to work on the project. Secondly, through an auction organized by the project owner. The winner of the auction is a contractor who meets the criteria set by the project owner and submits the best price and quality products. In Indonesia, contracting companies are more engaged in the procurement of goods and services for construction implementation.

In the midst of the Covid-19 pandemic that hit the whole world, especially in Indonesia, led to an increase in the use of technology to help improve the efficiency of companies affected by the Covid-19 pandemic. Based on the results of a survey conducted by Permatasari in 2021 [1], it was obtained that the use of technology in

helping contracting companies during the pandemic increased by 93.33% compared to before the pandemic, which was 60%.

Contracting companies use many technologies, such as financial management applications, goods sales applications, and document management applications, that can facilitate companies in conducting data processing and managerial administration in a project. According to Simamarta [2], a web-based application is an information system that supports its users to be able to interact through a web-based interface. The use of web-based applications can increase the productivity of employees of the contracting company so that it can accelerate decision-making in the work of a project.

A website is a collection of pages on a domain on the internet that is created with a specific purpose and can be widely accessed through the front page (homepage) using a browser. [3]. The use of web-based applications can certainly make it easier to manage data and create documents at contracting companies. One of them is the CV. Anisa Indah Teknik.

CV. Anisa Indah Teknik is a contracting company engaged in the procurement of goods and services for building construction and road marking manufacturing. Until now, CV. Anisa Indah Teknik still uses project data management techniques using manual methods.

Some data and project reports are also still in the form of sheets and written books, making it difficult for the company to manage tender project documents, and it takes a long time to make tender documents.

Based on these issues, this research aims to develop web-based project tender document applications on the CV. Anisa Indah Teknik, with the application of web-based project tender documents, is expected to facilitate CV. Anisa Indah Teknik in conducting data management administration and doing the tender project.

Research by Nurkholis et al. [4] on the application of extreme programming in the development of public service management information systems. The problem that arises is that people cannot access the population information system and mail administration services in real-time, so research is carried out by developing an information system.

Research by Supriyatna [5] with the title Extreme Programming Method on Web Development of Job Training Participant Selection Applications. The purpose of this study is to create an application that can be used by job training participants using the Extreme Programming method. The results obtained are to make it easier for participants to get information related to job training centers, starting from registration to the selection test process.

Some previous studies, such as research conducted by Sati [6], discuss the application of procurement of web-based goods/services at PT Bhakti Unggul Teknovasi. This study produced a web-based procurement application for goods/services. The results of the research obtained are the implementation of applications that can help companies to manage documents related to the procurement of goods/services.

Then the research conducted by Purwaningtias [7] discusses the development project tender information system on cv. Nur Fiqri Pontianak. The result of this research is the result of designing a development project tender information system that can help CV. Nur Fiqri Pontianak in taking care of the project tender papers.

Research conducted by Teguh [8] discusses website-based project management information systems at PT. AKM. The problem that arises in this study is that the system uses a data management tool that is still simple and manual, namely Microsoft Excel. So that the information system is built on this research to facilitate work. The result of the research is the development of a project management information system that has met the needs of PT. AKM, such as contract submission features, project development, reporting, and project documentation.

Further research conducted by Karyaningsih [9] discusses designing web-based

home construction service information systems with prototype methods. The problem that arises in this study is that users of construction services have problems finding home construction services when building houses. So the website is used for marketing its service products online using the website. The result of this research is the design of information systems for construction service users to get a good and quality home construction service provider.

Research conducted by Suryadi [10] discusses the information system of trading goods and services of web-based contractors. The problem that arises is fierce business competition, so many companies improve the quality of information systems to support company performance. The results of this study are in the form of information systems for trading goods and contractor services on the CV. Mitra Bangun Sejahtera Purwokerto, which can make it easier for users and admins to find information so that it can improve the company's performance.

Based on previous research, it can be concluded that in a company, information about the company is in demand. This makes it easier for users to get information by using the website. This study aims to build a web-based project tender document application on the CV. Anisa Beautiful Techniques.

This research is expected to carry out the application design process, build application systems, and test the application of web-based project tender documents that will be used by CV. Anisa Indah Teknik in order to make it easier for companies to make project tender documents efficiently and reduce errors caused by human error factors. The process of managing the information system so far is still carried out manually, making it difficult for companies to manage tender project documents and requiring a long time to make tender documents.

METHODS

The development method used in this research is the extreme programming method. Extreme programming (XP) is a method that has a software engineering process using an object-oriented approach with a goal for small to medium-scale development teams. [5]. The advantage of the extreme programming method is that it can combine various simple ideas without reducing the quality of the software to be built [11].

The development team can also use extreme programming methods by creating systems with unclear requests or very rapid system request changes. The extreme programming method consists of 5 stages, namely the stage planning, design, coding, testing, and software increment [12].

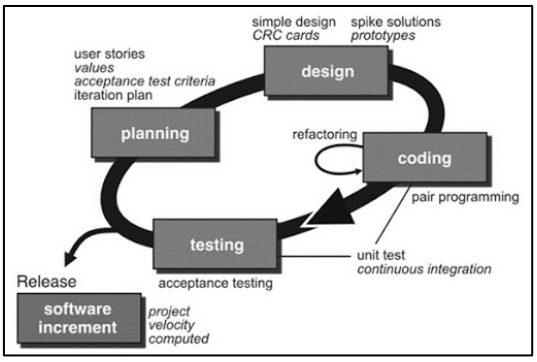

Figure 1. Extreme Programming Stages [12]

The planning stage of this research will be to carry out an analysis of the needs of the application functionally and non-functionally by collecting the data needed for application design and tailored to the needs of users [12]. Then at the design stage, will be made application system design using an activity diagram, class diagram, use case diagram, and flowchart. This research was built by designing a research plan, so it is easy to implement. Then the data collection techniques used related to the results of direct interviews with the director of CV. Anisa Indah Teknik.

Activity diagrams are graphical representations of workflows sequentially from the initial process to the end of a system or part of a system. [13]. Class diagrams are represented in a square form divided into three parts [14]. The use case diagram illustrates the relationship between actors/application users and the system [15]. A flowchart is an algorithm presentation

technique that uses images or symbols to describe the sequence of processes in solving a problem. [16].

Furthermore, at the coding stage, applications will be built using the PHP programming language and MySQL database. PHP is a server-side script programming language designed for web development. [17]. A database is a collection of interconnected data files grouped in a table or multiple tables and programs that allow users to access and modify that data file for the purpose of providing an abstract view of the data. [18]. MySQL is a program in the form of a data server that uses the SQL language (structured query language) with the aim of managing databases. [19].

Furthermore, at the testing stage, application testing is carried out using the ISO 9126 standard. The ISO 9126 standard was developed in an effort to identify the quality of the software. [20]. There are 6 ISO 9126 test indicators that will be used in this study, namely characteristics of functionality, reliability, usability, efficiency, maintainability, and portability [21].

The research instrument used in the functionality characteristics will use two sub-characteristics of testing, namely the suitability and security sub-characteristics. Testing on suitability sub-characteristics will use research instruments in the form of test cases against the functional specifications of the application. Then for the security sub-characteristics will use web testing tools, namely ssllabs.com and virustotal.com, to measure the security of the application.

Research instruments on testing reliability characteristics will use the K6 load test tool. Testing on usability characteristics will use research instruments in the form of questionnaires from Alfina [22] to measure the level of satisfaction as well as user responses. The research instrument on efficiency characteristic testing will use GTmetrix to measure the response speed of the application of web-based tender documents that have been created.

Testing maintainability characteristics will use Land testing instruments consisting of instrumentation, consistency, and simplicity aspects. [23]. The research instrument on testing portability characteristics will use the browserstack.com website to test web-based tender document applications in different browsers with different operating systems.

The data analysis techniques used consist of instrument and content validation analysis techniques, as well as analysis techniques on ISO 9126 testing. Validation results by instrument and content experts will be analyzed using the Likert scale. The Likert scale is used to measure the attitudes, opinions, and perceptions of individuals or groups [24]. After being measured using the Likert scale, the data obtained will be calculated using the eligibility percentage formula as follows [25]:

$$Eligibility\ Percentage = \frac{score\ obtained}{maximum\ score} \times 100\% \quad (1)$$

Testing functionality and portability characteristics will use Guttman scale analysis techniques. Guttman scale is a scale that wants a type of firm answer such as right-wrong, yes-no, positive-negative, and so on [26]. The results of the Guttman scale test will be calculated using the following feature completeness formula,

$$X = \frac{I}{P} \quad (2)$$

where:

I : Number of research instruments successfully implemented

P : Number of questions on the research instrument

Then the data analysis technique used on reliability characteristics uses the reliability formula of the following Nelson model [27],

$$R = 1 - \frac{f}{n} \quad (3)$$

where:

R : Reliability

f : Number of requests that failed to run

n : Number of successfully executed requests

Then at the software increment stage, the application will be implemented and tested by application users, namely CV. Anisa Indah Teknik. This study was conducted for three months, namely from November 2021 to January 2022. This study was conducted on a CV. Anisa Indah Teknik located on Jl. Pongtiku Lr. 3 No. 1, Makassar City, South Sulawesi.

RESULTS AND DISCUSSION

The results of this study are outlined at each stage of the extreme programming method consisting of planning, design, coding, testing, and software increment. (1) The planning stage is carried out by an analysis of the needs of the application functionally and non-functionally by conducting a joint interview with the director of CV. Anisa Indah Teknik, namely Mr. Ir. H. Muhammad Amin.

From the results of the interview, the results of data analysis about the functional needs of the application, namely first, the application can display the main page containing information along with contacts from the CV. Anisa Indah Teknik. Second, the application can log in to the dashboard page. Third, on the dashboard page, there are several pages that have the function of creating offer letters and administrative data on project tender documents, adding work packages from project owners, submitting project tender documents based on incoming work packages, adding and seeing the progress of a project, adding project data that has been completed.

(2) Furthermore, in the design stage, system design is made for applications using activity diagrams, diagram classes, use case diagrams, and flowcharts. In the activity diagram, there are 10 types of activity diagram design results consisting of login activity diagrams, offer letters, my account, managerial personnel data, main equipment data, package lists, incoming offers, project progress, project data, and account data.

The result of designing the diagram class has three user classes, namely the user director, user employee, and user owner of the project. The user directory can access all other classes. Then for classes that can be accessed by employee users, namely offer letters, project data, main equipment data, managerial personnel data, project progress, and entry offers. Then the classes that can be accessed by the project owner user are the package list, entry offers, and project progress.

The design results of the director diagram use case design can access all pages of the application system. Then employees can only access the home page, offer letter, managerial personnel data, main equipment data, package list, sign-in offer, project progress, project data, and my account page. Then the project owner can only access the home page, package list, sign-in offer, project progress, and my account page.

The results of the flowchart design have a flow that starts from the login process, then goes to the dashboard page consisting of 11 processes in it, namely the home page process, offer letter, managerial personnel data, main equipment data, package list, entry offer, project progress, project data, project data, my account, account data, and logout.

(3) Then, at the coding stage, the results of the application design are built using the PHP programming language and MySQL database.

Figure 2. Home View

Figure 2. is the user interface display of the main page in the home section. The view of this home contains the company name, the swipe-down button, and the menu on the header. Then in figure 3. is the user interface view of the dashboard page. On this page, there is a sidebar

menu and header that displays welcome greetings.

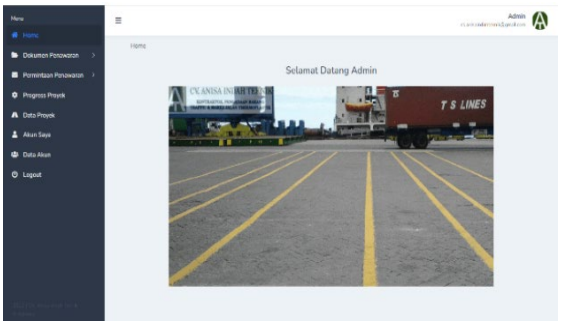

Figure 3. Dashboard Page

(4) The results of the testing stage are carried out through testing of applications that have been built using ISO 9126. Before testing using ISO 9126 on the application, it is first done validation of research instruments and validation of content on applications that have been built.

Validation of research instruments was carried out by two validators lecturers from the Department of Informatics and Computer Engineering UNM, Mr. Wirawan Setialaksana, S.Pd, M.Sc., and Mrs. Dwi Rezky Anandari Sulaiman, S.Psi., M.Si. Validation of research instruments was carried out on three types of instruments, namely content validation instruments, system validation instruments on functionality characteristics, and user response questionnaire instruments on usability characteristics. Validation results by instrument validators will be analyzed using the Likert scale. The results of the validation of research instruments can be seen in the following table:

Table 1. Instrument Validation Results

Validator	Percentage of Eligibility of Each Instrument		
	Content Validation	System Validation	Questionnaire
1	94%	92%	94%
2	100%	100%	100%
Average	97%	96%	97%

Table 1. shows results from the average percentage of eligibility on three validated research instruments. The content validation instrument obtained an average eligibility percentage of 97%. Based on the eligibility percentage scale, the content validation instrument can be categorized as very feasible. Then the system validation instrument obtained an average eligibility percentage of 96%. Based on the feasibility percentage scale, the system validation instrument can be categorized as very feasible. Then the user response questionnaire instrument obtained an average eligibility percentage of 96%. Based on the percentage scale of eligibility, the user response questionnaire instrument can be categorized as very feasible.

Content validation is done by two validators who are employees of the CV. Anisa Indah Teknik, namely by Mrs. Iviany Thaha, S.T. and Mr. Asri. Content validation is performed to assess the content of a web-based project tender document application on a CV. Anisa Indah Teknik. The results of the content validation can be seen in the following table:

Table 2. Content Validation Results

Validator	Obtained Score	Maximum Score	Eligibility Percentage
1	102	105	97%
2	101	105	96%
Average			96.5%

The table above shows the average percentage of eligibility from the content validation results obtained at 96.5%. Based on the percentage scale of eligibility, the results of content validation can be categorized as very feasible.

Testing of functionality characteristics uses two sub-characteristics of testing, namely suitability and security sub-characteristicsIn the conformity, sub-characteristics use a test case in the form of a system validation instrument validated by two validators, namely validator 1 and validator 2. The results of testing functionality characteristics in suitability sub-characteristics can be seen in the following table:

Table 3. Functionality Test Results on Suitability Sub-Characteristics

Validator	Value of All Functions	Successful Function Value	Feature Completeness Formula Results
1	56	56	1
2	56	56	1
	Average		1

The table above shows the average result of the feature completeness formula, which is worth 1. Based on a scale of $0 \leq X \leq 1$, the feature completeness value obtained has the maximum value so that the functionality characteristics test the suitability sub-characteristics of web-based project tender document applications on the CV. Anisa Indah Teknik can be stated to function very well.

Then in the security sub-characteristics, use web testing tools from ssllabs.com and virustotal.com to measure the security of the application. The results of the security sub-characteristics test can be seen in the following image.

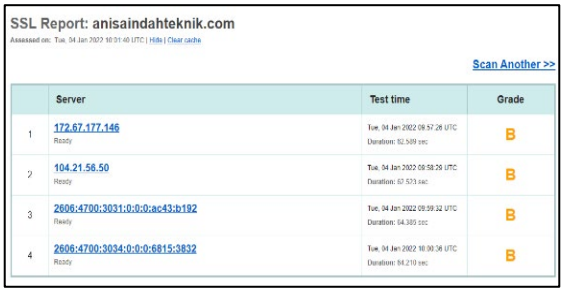

Figure 4. Security Results Using ssllabs.com

From the results of security testing using ssllabs.com, the test results obtained a grade of B. This means that the application created can be expressed well both in terms of security on the server used. Then from the results of security testing using virustotal.com, no viruses or malicious malware were found in the application.

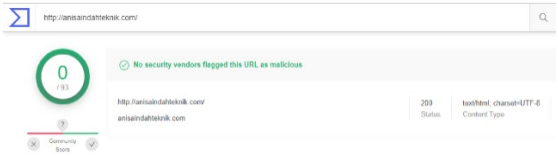

Figure 5. Security Results Using virustotal.com

Testing of reliability characteristics using the help of the K6 load test tool application. The K6 load test tool is used to test applications when receiving requests from multiple users simultaneously. Testing of the application using 30 virtual users who accessed the application simultaneously for 10 minutes with the results obtained in the form of the number of requests successfully executed, as many as 9,770 requests, and the number of requests that failed to run as many as 11 requests. Then the results obtained are calculated using the following reliability formula:

$$R = 1 - \frac{11}{9770} = 0.99 \qquad (4)$$

The results showed that the reliability value obtained was 0.99. Based on Telcordia standards, the results of reliability testing of the application of this tender project document can be categorized as good and meet the standard.

Testing of usability characteristics using user response questionnaires to web-based project tender document applications on the CV. Anisa Indah Teknik. The test was conducted on 7 respondents consisting of directors, employees, and project owners who used the services of CV. Anisa Indah Teknik. The following are the results of data analysis on testing usability characteristics.

Table 4. Recapitulation of Usability Characteristics Test Results

Respondent	Obtained Score	Maximum Score	Eligibility Percentage
1	95	95	100%
2	83	95	87,3%
3	89	95	93,6%
4	81	95	85,2%
5	77	95	81%
6	90	95	94,7%
7	90	95	94,7%
	Average		90,9%

Based on the results in table 4. , the average percentage eligibility of usability characteristic testing obtained is 90.9%. Based on the percentage scale of eligibility, the results of testing the usability characteristics can be categorized as very feasible.

Testing efficiency characteristics uses the help of the web testing tool, GTmetrix, to measure the response speed of applications that have been built. Furthermore, the results of testing efficiency characteristics on GTmetrix can be seen in the following table.

Table 5. Efficiency Test Result Recapitulation

No	Page	Performance Results						Score Percentage
		FCP	TTI	SI	TBT	LCP	CLS	
1	Main	792ms	991 ms	964 ms	13ms	975 ms	0	98%
2	Login	570 ms	570 ms	619 ms	0ms	623 ms	0	100%
3	Home	777 ms	777 ms	832 ms	0ms	840 ms	0	99%
4	My Account	743 ms	743 ms	810 ms	0ms	814 ms	0	99%
5	Offer Letter	1.3s	1.3s	1.3s	0ms	1.3s	0	93%
6	Managerial Personnel Data	826 ms	826 ms	869 ms	0ms	888 ms	0	99%
7	Main Equipment Data	1.2s	1.2s	1.2s	0ms	1.2s	0	94%
8	Package List	746 ms	746 ms	768 ms	0ms	780 ms	0	99%
9	Entry Offer	823 ms	823 ms	868 ms	0ms	877 ms	0	99%
10	Project Progress	890 ms	890 ms	926 ms	0ms	936 ms	0	98%
11	Project Data	764 ms	764 ms	837 ms	0ms	844 ms	0	99%
12	Data Account	726 ms	726 ms	792 ms	0ms	796 ms	0	99%
Average								98%

From the test results on the performance of the six aspects, an average performance score percentage value of 98%. Based on the efficiency score, the percentage of the score is included in the grade A category so that the results of testing the efficiency characteristics of the project tender document application can be categorized very well.

Furthermore, the test results on maintainability characteristics are carried out by measuring and observing directly applications based on instrumentation, consistency, and simplicity aspects.

Figure 6. is the result of testing aspects of instrumentation, in figure 6. It can be seen that the application provides an alert when not filling in the email and password when logging in and also an alert when entering the wrong password.

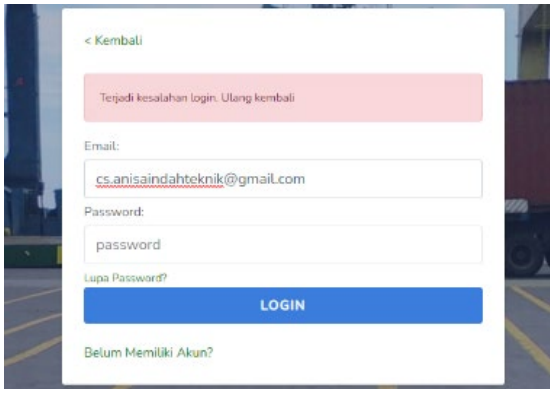

Figure 6. Warnings On the Login Page

Then in figure 7. it is seen that in each empty column, there is a warning to fill the existing column when it does not fill in the input column that must be filled.

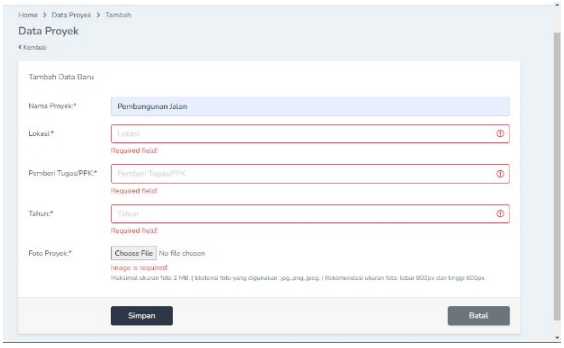

Figure 7. System Alert On Dashboard Page

Next up is figure 8. It can be seen that the system of the application uses a model and a consistent design display on each page.

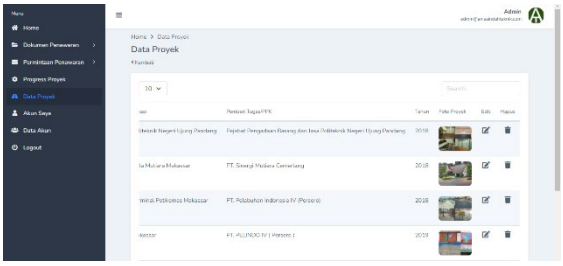

Figure 8. Consistency Each Page

Then on the management of the system architecture of the application using the concept of MVC (Model View Controller), where the concept of MVC separates between program code for database, layout display, and program controllers so as to facilitate managing, making

improvements, and making the system development process more efficient.

Table 6. Recapitulation of Maintainability Test Results

No.	Aspects	Result
1	Instrumentation	The application has an error warning system when an error occurs, along with the identification of the error.
2	Consistency	The application uses a consistent model and design layout on each page.
3	Simplicity	Applications are created using the concept of MVC (Model View Controller) so that they can be easily managed, and making improvements to the system, thus making the system development process more efficient.

From the recapitulation of the assessment in the table above, it was obtained that testing the maintainability characteristics met all three aspects of assessment consisting of instrumentation, consistency, and simplicity aspects so that testing of maintainability characteristics can be categorized as good and meet standards.

Testing the characteristics of portability using the help of web testing tools, namely browserstack.com. The results of testing portability characteristics using BrowserStack can be seen in the following table:

Table 7. Portability Test Result Recapitulation

No.	Browser	Operation System	Value
1	Google Chrome	Windows 11	1
2	Mozilla Firefox	Windows 10	1
3	Microsoft Edge	Windows 8	1
4	Opera	Windows 7	1
5	Safari	Mac OS	1

Results from table 7 were then calculated by using the feature completeness formula as follows:

$$X = \frac{I}{P} = \frac{5}{5} = 1 \qquad (5)$$

Based on the scale of $0 \leq X \leq 1$, the feature completeness value obtained has the maximum value, so the testing portability characteristics of the application can be categorized very well.

(5) Development of web-based project tender document applications using extreme programming methods that have gone through the testing stage will be entered at the software increment stage, where the application will be implemented to its users and in the future, will experience improvement and system development of the application in accordance with the needs of the user in the future. The app uses web hosting as well as a domain address with the domain name anisaindahteknik.com. For further research, researchers can develop existing methods by evaluating satisfaction with users.

CONCLUSION

Based on the results of research that has been done, it can be concluded that (1) the results of the development of web-based project tender document applications using extreme programming methods can be built using extreme programming methods and have functions and features in the form of inputting data and processing data into project tender documents, displaying project data and progress of a project's work, registering work projects, as well as sending project tender documents to the owner of the work project, (2) test results of application development of web-based project tender documents using extreme programming methods, obtained results in functionality characteristics for suitability sub-characteristics worth 1 (very good) and for security sub-characteristics there are no viruses or malicious malware found in applications (grade B), in reliability characteristics worth 0.99 (good), in

usability characteristics worth 90.9% (very feasible), in efficiency characteristics value 98% (grade A), in maintainability characteristics meet the standard 3 aspects of assessment (good), and on portability characteristics worth 1 (excellent), (3) user responses to the results of the development of web-based project tender document applications using extreme programming methods can be categorized as very feasible (90.9%).

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