Development of a Web-Based Assignment Information System by Applying *Leaderboard* and *Quest* Gamification Elements at SMK Negeri 2 Surakarta

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ABSTRACT

This study aims to find out how to build a web-based assignment information system by applying *Leaderboard* and *Quest* gamification elements at SMK Negeri 2 Surakarta TKJ Expertise Program and find out the level of eligibility developed according to ISO 25010 Standards. Information system development using *Laravel web application framework* using *Agile Development* software development model consists of 5 stages, namely Planning to produce functional and non-functional requirements. The research applies the Object Oriented Analysis and Design (OOAD) method in the analysis and design process. Analysis produces *use case diagrams*, Design produces *activity diagrams* and *class diagrams*. Implementation produces program code from development results. The system produces products that have been uploaded to the server, which can later be accessed online and in real-time. This information system has three levels of users, namely admin, teachers and students. The suitability test results using the ISO 25010 Standard on the three sub-characteristics of functional suitability, namely functional completeness, have an average value of 1 (Good). Functional correctness has an average value of 1 (Good). Functional appropriateness has an average value of 1 (Good). Characteristics of performance efficiency obtained an average result of GTMatrix Grade 85% (grade B). The average largest contentful paint is 1.423s (OK, but considering improvement). Average total blocking time 97.82ms (Good - nothing to do here). Average cumulative layout shift 0.023 (Longer than recommended). *Portability* characteristics have excellent results in that the system can run on desktop or mobile devices. *Usability* characteristics of 85% (Very Decent). The results of the respondent gamification test average score of 4.44 indicate that respondents are categorized as strongly agreeing with the existence of a web-based assignment information system by applying leaderboard and quest gamification elements. From the results of these tests, it can be concluded that the web-based assignment information system, using Leaderboard and Quest gamification elements at SMK Negeri 2 Surakarta TKJ Expertise Program, meets ISO 25010 quality standards.

Keywords : Information Systems, Web-Based Assignments, Gamification, Leaderboards, Quests

1. INTRODUCTION

Currently, almost every country in the world is being hit by the Covid-19 pandemic; Indonesia is a country that is also affected by this. The COVID-19 outbreak has resulted in changes in almost all aspects of human life, especially in the field of education (Hanifah Salsabila et al., 2020). In the educational aspect, the Indonesian government, through the Ministry of Education and Culture (Kemendikbud) in Circular Letter Number 4 of 2020 concerning the Implementation of Education Policy during the COVID-19 Emergency Period relates to the learning process being carried out using distance/online methods (*MENDIKBUD TERBITKAN SE TENTANG PELAKSANAAN PENDIDIKAN DALAM MASA DARURAT COVID-19*, 2020).

SMK Negeri 2 Surakarta is a school that has also felt the impact of the Covid-19 pandemic. Therefore, SMK Negeri 2 Surakarta also applies distance learning methods in its learning process. SMK Negeri 2 Surakarta is one of

the schools that offers Computer and Network Engineering Competencies. In the interview process, it was discovered that learning was carried out using the help of the Google Classroom platform, School E-Learning, Microsoft Teams, and WhatsApp to provide material and collect assignments.

TKJ Expertise Program at Surakarta 2nd State Vocational High School, the results of interview data processing and filling out questionnaires with eight TKJ Expertise Program teachers, it was found that 62.5% of teachers confirmed positive that students experienced boredom in doing assignments, 75% of teachers confirmed that students were often late in submitting the task. This happens because, from SMK Negeri 2 Surakarta, the economic level of students is evenly distributed, so some don't have laptops or smartphones; other reasons students experience online boredom is for a year and a half, students in classes X and XI have been doing online learning which delivery is only via WhatsApp, and E-Learning, this also causes students to prefer working rather than participating in learning.

Giving assignments to TKJ Skills Program teachers at SMK Negeri 2 Surakarta, it is known that 100% of teachers want a new atmosphere in providing lessons to students. This arises because E-Learning is still in the development stage, several features are not yet complete, the display is still simple, and collecting assignments uses two E-Learning, namely Vocational School E-Learning as the main one and Google Classroom, Teams, and Edmodo as optional. In utilizing the learning platform, it is known that 100% of teachers confirmed that the TKJ Skills Program does not yet have a unique assignment information system for majors.

With the rapid development of technology and information, modern trends lead to the socialization of various types of innovative technologies, including gamification, into the educational process (Desnenko et al., 2021). Gamification is an educational method that uses game elements to motivate students to play while learning. This ensures students have a fun and engaging learning experience (Krisbiantoro, 2020). Gamification has been seen as a potential solution to engagement and motivation problems in educational settings. The benefits of gamification have been praised in several studies. In short, gamification has a positive influence on engagement (Aldemir et al., 2017).

The application of gamification in the distance learning process is used as the right way to motivate students to learn. In applying gamification, students must be active when the learning process takes place because the presentation of the material is interactive. So, gamification is appropriate for use in the distance learning process while still paying attention to the learning motivation obtained by each student (Fadilla & Nurfadhilah, 2022). Gamification systems typically use motivational features such as immediate success feedback, continuous progress feedback, or goal setting through interface elements such as scores, points, badges, levels, or challenges and competitions; support of linkage, social feedback, recognition, and comparison via leaderboards, teams, or communications functions; and autonomy support through customizable avatars and environments, user choice in goals and activities, or narratives that provide an emotional and value-based rationale for an activity (Legaki et al., 2020).

One element of gamification is the leaderboard; the leaderboard or leaderboard is a direct comparison of player performance, encouraging students to assess their knowledge and win more points. The goal is to achieve a high ranking on the final leaderboard based on the points collected (Legaki et al., 2020). The introduction of challenges, sometimes called quests, can also function as an objective mechanism, where an overarching objective is broken down into specific sub-objectives (Krath et al., 2021).

2. RESEARCH METHOD

Research applies Research and Development (R&D). R&D is a research method for creating a product (Sudaryono et al., 2011). (Sugiyono, 2014) Research and development is one of the research techniques used to develop and test application product usability. Research and development methods are required to create valuable products or applications. This study aims to create a web-based information system by applying leaderboard and quest gamification elements that are used for the task management process of learning activities at SMKN 2 Surakarta TKJ and to test its feasibility.

Researchers apply the Research and Development (R&D) method. Researchers use the Agile Development software development method by applying the OOAD method in the analysis and design stages, with the ISO 25010 standard as a component of the feasibility test. Agile Development is an information systems development model concerned with streamlining system development procedures by reducing extensive documentation and modeling efforts and using time more effectively. On the other hand, this project emphasizes simplicity. Agile Development Methodologies follow a simple cycle through the traditional phases of the systems development process, and almost all agile methodologies are used in conjunction with object-oriented technologies (Tegarden et al., 2015). Look at Figure 1. to see the Agile Development Methodology.
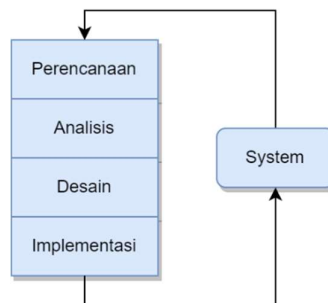
Figure 1. Agile Development Methodology

(Tegarden et al., 2015) The planning phase is fundamental to capturing why we are building an information system. Observation techniques, interviews, and questionnaires were carried out in the data collection (Nur et al., 2015).

The analysis and design stage provides answers regarding who the system users are, what systems can be used, when and where the system is used (Tegarden et al., 2015). The needs analysis and system design process uses UML (Unified Modeling Language) modeling tools. OOAD (Object Oriented Analysis and Design) is used in this stage as a method of analysis and design. The OOAD method is carried out by identifying objects, identifying relationships between objects, and determining the attributes and behavior of objects. OOA (Object Oriented Analysis) and OOD (Object Oriented Design) are stages of OOAD. Commonly used in OOA modeling is the Use Case Diagram. Activity Diagrams and Class Diagrams are used in OOD modeling (Pane & Sarno, 2015). OOA with OOD keeps a vague boundary, so it is usually called directly as OOAD (A. S & Shalahudin, 2018).

At the Implementation stage, the agreed design is translated from the previous step into a programming code that is by the needs that will be recommended (Saputra et al., 2019). Implementation was carried out by creating a web-based assignment information system using the PHP language and the Laravel Framework.

System testing is carried out in this phase, from the results of the coding that has been done on the local system using the ISO 25010 standard with the characteristics of performance efficiency, usability, portability, and functional suitability, then uploaded to the VPS whether it is running well or not online.

The research subjects on functional suitability characteristics were two respondents who were software development experts. The research subject on usability characteristics used ten respondents consisting of system users at each user level, namely one admin, three teachers, and six students. Researchers used ten respondents who took reference in (Jacob, 2012) to get a statistically significant number. Meanwhile, performance efficiency and portability characteristics use a web-based assignment information system by applying leaderboard and quest gamification elements as research subjects.

The procedure for testing a web-based assignment information system by applying Leaderboard and Quest gamification elements is as follows: (1) Functional Suitability Trial, the researcher as a system developer carries out a black-box test containing system feature test-cases before giving it to experts ; (2) Portability, the information system is tested using various browsers on desktop and mobile devices; (3) Functional Suitability, experts in software development fill out a questionnaire containing a list of web-based assignment information system functionality by applying leaderboard and quest gamification elements; (4) Usability, system admin users, teachers, students fill out a questionnaire (USE Questionnaire) consisting of 30 questions; (5) Performance Efficiency, the information system is analyzed using Gtmetrix which will produce a performance score and a structure score. Then, analyze the average percentage score and determine the Gtmetrix Yslow grade.

Functional suitability testing is carried out by utilizing the agenda strategy in the experiment, which contains elements of the data framework. The motivation behind this testing is to ensure that there are no errors in the program being created, and if a mistake is found, it can be adjusted (Agarwal et al., 2010). The researcher conducted tests to improve the data frame application using the standard functional suitability characteristics of ISO 25010, which has

three sub-characteristics: functional completeness, functional correctness, and functional adequacy. Functional completeness has 60 statements, practical accuracy of 30 words, and functional adequacy of 10 comments with the Blackbox test method.

Portability testing tests information systems in browsers such as Chrome, Firefox, and Opera on desktops and smartphones. These tests are remembered for the Blackbox testing phase and performed at the framework testing stage in the framework progress.

Usability testing uses a Likert scale as a measurement scale for test equipment, with each response to equipment items having a gradation from very positive to very negative (Sugiyono, 2014). The Use Questionnaire Likert Scale instrument allows five scales to be used in the research. In this case, researchers use a scale of 5, as they do in technology and information research (Muderedzwa & Nyakwende, 2010).

Performance efficiency testing is carried out by load testing using GTmetrix software. Produce performance scores and structure scores. GTmetrix Performance is the result displayed using a website auditing tool called Lighthouse. Meanwhile, the GTmetrix Structure is a metric that assesses the performance of all website pages. The grade (weight) of the assessment is taken from the Performance and Structure scores' average. The Performance score is taken at 70%, and the Structure score and score at 30%. (*EVERYTHING YOU NEED TO KNOW ABOUT THE NEW GTMETRIX REPORT (POWERED BY LIGHTHOUSE)*, 2020) In 2020, Google introduced a set of web performance standards and user experience metrics called Web Vitals. Web Vitals consists of various metrics, but the metrics that GTmetrix takes into account are Largest Contentful Paint (LCP), Total Blocking Time (TBT), and Cumulative Layout Shift (CLS).

Functional suitability testing analysis applies the Guttman scale as the instrument measurement scale. Instrument responses using the Guttman scale must be fixed and consistent, such as yes or no (Guritno et al., 2011). The researcher will use yes/no answer options. The answer choice is worth 1, and no answer is worth 0. The functional suitability test results are calculated using the Feature Completeness matrix formula. (Acharya & Sinha, 2013). Matrix to find out if the feature design can be implemented. The following is the formula for calculating the feature completeness matrix. The following is the formula for calculating the feature completeness matrix.

$$X = \frac{I}{P}$$

Where:
P = Number of features designed
I = Number of features successfully implemented

The interpretation of the measurements used is derived from the functional completeness matrix. A value close to 1 indicates the number of successfully implemented features. When testing, the closer the X value is to 1, the functional suitability is said to be good.

Usability testing analysis uses a Likert scale with a scale of 5 with detailed answers: Strongly Agree (SA) is given a score of 5, Agree (A) is given a score of 4, Neutral (N) is given a score of 3, Disagree (D) is given a score of 2, Strongly Disagree (SD) is given a score of 1. Data is in the form of test results and percentages calculated using a formula. The usability assessment instrument consists of 4 assessment criteria, namely: (1) Usefulness; (2) Easy of Use; (3) Easy of Learning; (4) Satisfaction. Descriptive analysis is applied in data analysis by calculating:
Maximum total score per criterion = 5 x Number of questions per category.

$$Eligibility\ Percentage\,(\%) = \frac{Observed\ Score}{Expected\ Score}\,x\ 100\%$$

This percentage is then converted into a statement in Table 1. (Sudaryono et al., 2011).

Table 1. Interpretation of Eligibility Percentage

Eligibility Percentage	Criteria
0%-20%	Very Unfeasible
21%-40%	Unfeasible
41%-60%	Feasible Enough
61%-80%	Feasible
81%-100%	Very Feasible

Performance efficiency testing analysis was carried out by load testing using Gtmetrix. Produces variables Performance, Structure, LCP, TBT, and CLS, which are then averaged. The performance and structure results make Grade, determining Grade as in Table 2. The LCP results are stated in Table 3. TBT results are indicated in Table 4. The CLS results are indicated in Table 5.

Table 2. GTmetrix YSlow Grade Assessment Score

No.	Grade	Score Requirement
1.	A	$90 <= Skor <= 100$
2.	B	$80 <= Skor <= 90$
3.	C	$70 <= Skor <= 80$
4.	D	$60 <= Skor <= 70$
5.	E	$50 <= Skor <= 60$
6.	F	$0 <= Skor <= 50$

Table 3. LCP Threshold

Description	Time Limit
Good - nothing to do here	LCP 1200 milliseconds or less.
OK, but considering improvement	LCP between 1200 and 1666 milliseconds.
Longer than recommended	LCP between 1666 and 2400 milliseconds.
Much longer than recommended	LCP higher than 2400 milliseconds.

Tabel 4. TBT Threshold

Description	Time Limit
Good - nothing to do here	TBT 150 milliseconds or less.
OK, but considering improvement	TBT between 150 and 224 milliseconds.
Longer than recommended	TBT between 224 and 350 milliseconds.
Much longer than recommended	TBT higher than 350 milliseconds.

Tabel 5. CLS Threshold

Description	Time Limit
Good - nothing to do here	CLS 0,1 or less.
OK, but considering improvement	CLS between 0,1 and 0,15.
Longer than recommended	CLS between 0,15 and 0,25.
Much longer than recommended	CLS 0,25 or higher.

Gamification testing analysis is a test to get answers from users about the system used. This test is carried out by identifying users, selecting features, making test orders, determining time, measuring using questionnaires, and conducting analysis for future system improvements. The formula for determining the total value of opinions given by respondents is:

$$\bar{X} = \frac{\sum(f1 \times 1 + f2 \times 2 + f3 \times 3 + f4 \times 4 + f5 \times 5)}{n}$$

Where:
n = number of respondent
fx = frequency multiplied by each value on the Likert scale
X = average

Calculations are carried out by grouping values according to class intervals as follows:
a) Number of Classification (K) = 5 classes
b) Range (R):
    1. Highest score = 5
    2. Lowest score = 1
    3. Range (R) = 5-1 = 4
c) The length of the class interval © is calculated using the formula :

$$C = \frac{R}{K} = \frac{4}{5} = 0,8$$

Where:
R = Range

K = Number of classification
C = Class interval

Table 6. Class Interval

Description	Class Interval
Strongly Disagree	1.00 – 1.80
Disagree	1.81 – 2.60
Little Disagree	2.61 – 3.40
Agree	3.41 – 4.20
Strongly Agree	4.21 – 5.00

Selecting the "Agree" and "Strongly Agree" categories shows a positive assessment, while choosing the "Little Disagree", " Disagree " and "Strongly Disagree" categories shows a negative assessment (Pratama et al., n.d.).

3. RESULT AND ANALYSIS

Research on developing a web-based assignment information system by applying Leaderboard and Quest gamification elements at SMK Negeri 2 Surakarta TKJ expertise program was carried out from July 2021 – September 2022. Research location at SMK Negeri 2 Surakarta TKJ expertise Program.

3.1. RESULT

Based on interview data and filling out questionnaires with eight TKJ Skills Program teachers, it was found that 62.5% of teachers confirmed positively that students experienced boredom in doing assignments, and 75% of teachers confirmed positively that students were often late in submitting assignments. This happens because at SMK Negeri 2 Surakarta, the economic level of students is evenly distributed, so there are some who don't have laptops, or smartphones, another reason students experience boredom online because, for a year and a half students in classes X, XI have been doing online learning which is delivered only via WhatsApp, and E-Learning, this also causes students to prefer working rather than studying.

In the assignment of TKJ Expertise Program Teachers at SMK Negeri 2 Surakarta, it is known that 100% of teachers want a new atmosphere in giving assignments to students. This is because E-Learning is still in the development stage, several features are not complete, the display is still simple, and the collection of assignments utilizes two E-Learning, namely Vocational School E-Learning as the primary and google classroom, teams, and Edmodo as optional. In using the learning platform, it is known that 100% of teachers confirm that the TKJ Expertise Program does not yet have a unique assignment information system for majors that can increase student learning motivation.

The next stage is planning to identify goals, analyze and design using OOAD, implementation in the system testing stage.

Discussions and interviews have been conducted regarding these issues, and the results obtained are developing a web-based assignment information system by applying Leaderboard and Quest gamification elements at SMK Negeri 2 Surakarta TKJ Expertise Program. The advantage gained when using this assignment information system is implementing leaderboard and quest gamification elements, User Friendly.

Functional and non-functional requirements were obtained in the analysis of system requirements. Based on the results of the applicable requirements analysis, there are ten things that this system works on: Data Management (User, Student Quest, Jobclass, Skill, Quest, Reward, Student Reward, Article, Notification), Displays Leaderboard. The results of Non-Functional requirements used in the software implementation stage are reviewed from hardware and software. Laptop Hardware with IdeaPad 3 14IIL05, i5-1034G1 specifications, 8GB RAM, 512GB SSD and VPS Server with VPS specifications, two cores, 4 GB RAM, 60 GB Storage, OS: Ubuntu 20.04, NGINX, MySQL, Composer, JS, phpMyAdmin. Software Windows 10 Home (64bit) Visual Studio Code, Laravel 8 Framework, Node JS 16.13.1 LTS, PHP 8.0, Apache, MySQL, Web Browser (Chrome / Firefox), JS, Composer, phpMyAdmin.

The first stage in OOA activity is identifying objects and classes, which include people, places, entities, organizations, concepts, or specific events (Pane & Sarno, 2015). Modeling at this stage, namely, the design of use case diagram functions to describe the functions between actors in the system and the user level. Level levels consist of Admin, Teachers, and Students.

The next stage of OOD will be modeling using Activity Diagrams and Class Diagrams. Activity Diagrams show business processes in the system. Class diagrams display systems based on the classes that make up the system. In a class, there are attributes and methods. Classes have variables called attributes. Classes also have functions or methods.

Implementation is the coding of the results of planning and analysis; the implementation results are as follows.

Application of Gamification, in the application of gamification, the elements used are points/scores, avatars, levels, timers, quests/assignments, leaderboards, and rewards. The score functions as a reward exchange and competition value in the leaderboard. Avatar acts to display the user's photo. The results of applying Points / Scores and Avatars can be seen in Figure 2.
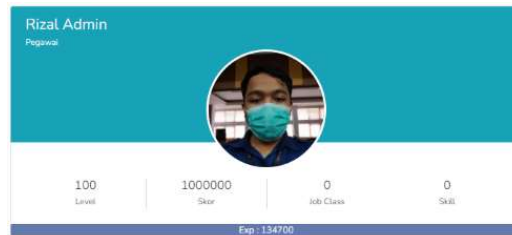

Figure 2. Application of Levels, Points/Scores, Avatars

Timer for completing quests. When completing an assignment, the user can monitor the time for completing the quest/assignment, which will later determine the limit for completing the quest. If missed, the search will be counted as having ended; the user cannot upload the assignment. The results of applying the Timer can be seen in Figure 3.

Figure 3. Application of Time

In implementing the leaderboard, it is calculated from the user's highest score, the higher the score, the higher the position, this is used as a ranking reference for who has the highest score to compete. The results of implementing the leaderboard can be seen in Figure 4.

Figure 4. Application of Leaderboard

The researcher created a leveling scheme with predetermined conditions, the levels available for this system are levels 1 - 100. In implementing the reward /Gift/Appreciation system, a system of exchanging objects/things that are useful in the real world is used in exchange for the results of the scores collected by the user. They are completing

quests in the system so users can benefit from the knowledge and goods/things they want. Determining rewards/prizes/appreciation depends on department/school policy. In the exchange process, students exchange in the system, then if the score is sufficient, they can print an invoice and come to a mutually agreed location in a particular school room. The results of applying rewards can be seen in Figure 5., and the effects of using invoice rewards can be seen in Figure 6.
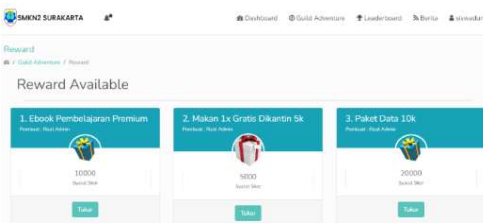

Figure 5. Application of Reward

Figure 6. Print of Invoice Rewards

Quests/Assignments are presented in the form of cards, in the form of story questions which contain the request of the question maker, namely the teacher/admin, lined up like sheets of paper stuck to the wall, including information on the title, level requirements, bonus exp, and score, level of difficulty, type of quest and limits quest time. The results of implementing the quest/assignment can be seen in Figure 7.
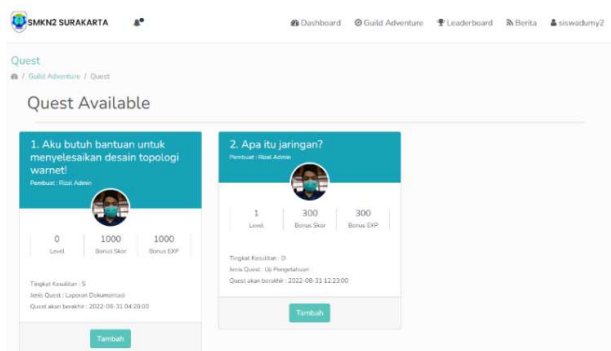

Figure 7. Application of Quest

The results of the functional Black-box test trials were carried out manually by researchers using the Black-box method. This test is carried out by testing every function contained in the information system being developed, there are 126 test cases. Based on the tests on the information system, it can be concluded that all functions in the assignment system are running well, and the system is ready to be tested by experts.

Two experts tested test results for ISO Standard 25010 functional suitability characteristics in web development. The first expert was Helmi Adi Prasetyo, Senior Backend Developer PT GITS Indonesia, and the second was Nurcahya Pradana Taufik Prakisya, S.Kom., M.Cs. Lecturer at Sebelas Maret University. The following are the results of functional completeness, functional correctness, and functional appropriateness tests.
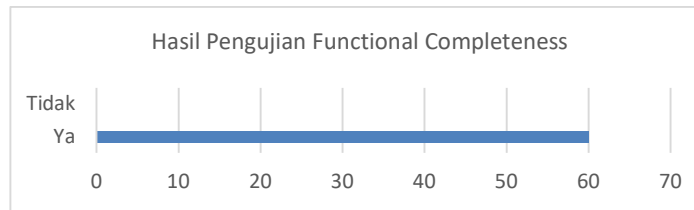
Figure 8. Functional Completeness Test Results

Then, the calculations from the test data result from Figure 8. P = 60 x number of examiners = 120, I = 60 x number of examiners = 120, So we get, X = 120 / 120 = 1.
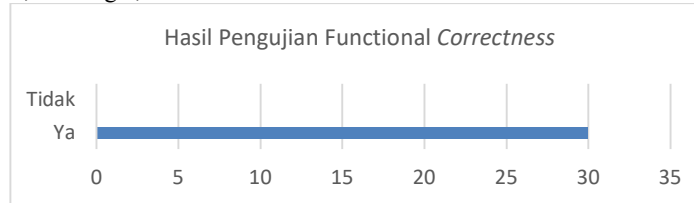

Figure 9. Functional Correctness Test Results

Next, carry out calculations from the test data results from Figure 9. P = 30 x number of testers = 60, I = 30 x number of testers = 60, So we get, X = 60 / 60 = 1
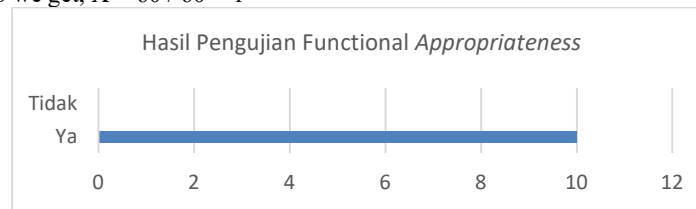
Figure 10. Functional Appropriateness Test Results

Next, carry out calculations from the test data results from Figure 10. P = 10 x number of examiners = 20, I = 10 x number of examiners = 20, So we get, X = 20 / 20 = 1.

Based on the calculation results of the three sub-characteristics of functional suitability, namely functional correctness, functional appropriateness, and functional completeness, it has the value of fulfilling the characteristic aspects of practical usefulness.

The results of this test on the assignment information system by applying the gamification element are carried out by load testing using the GTmetrix Software. Look at Figure 11 to find one example of the test.

Figure 11. Test Results Login Page

You can read further test results in attachment 10. The list of performance efficiency test data collection results is in Table 7. For calculation of test results, see Table 8.

Table 7. List of Performance Efficiency Test Results

No	Page	Test Result

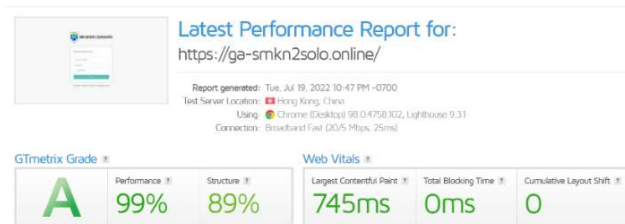|		Performance	Structure	LCP (s)	TBT (ms)	CLS
1	Login	99%	89%	0,754	0	0
2	Home	90%	83%	1,3	73	0
3	Notification	85%	82%	1,5	77	0
4	User Management	83%	73%	1,8	28	0,06
5	Add New User	89%	81%	1,4	76	0
6	Change User	91%	83%	1,1	62	0,01
7	Publised Jobclass Management	83%	79%	1,7	153	0,02
8	Trash Jobclass Management	90%	84%	1,2	35	0
9	See Jobclass	89%	82%	1,4	74	0,05
10	Published Skill Management	91%	84%	1,4	78	0,02
11	Trash Skill Management	86%	84%	1,5	23	0
12	See Skill	94%	82%	1,1	20	0,02
13	Quest All Management	91%	84%	1,2	49	0,11
14	Quest Publish Management	83%	81%	1,8	31	0,06
15	Quest Draft Management	92%	82%	1,2	26	0
16	Quest Trash Management	81%	83%	1,7	0	0
17	Add Quest	89%	82%	1,4	52	0,02
18	Change Quest	91%	82%	1,1	22	0,04
19	Student Quest Management	87%	77%	1,9	16	0,04
20	Edit Student Quest Status	87%	84%	1,6	30	0
21	Reward All Management	93%	82%	1,1	28	0,09
22	Reward Publish Management	94%	81%	1,1	40	0,07
23	Reward Draft Management	92%	82%	1,4	45	0
24	Reward Trash Management	90%	82%	1,4	38	0
25	Reward Student Management	93%	81%	1,2	24	0
26	Article All Management	79%	71%	1,8	215	0
27	Article Publish Management	91%	71%	1,5	68	0,01
28	Article Draft Management	91%	81%	1,5	84	0
29	Article Trash Management	92%	84%	1,2	40	0
30	Add Article	68%	78%	1,8	378	0,04
31	Change Article	80%	71%	1,2	312	0,06
32	Notification All Management	77%	83%	1,9	260	0,01
33	Notification Publish Management	92%	83%	1,3	37	0,01
34	Notification Draft Management	91%	82%	1,2	38	0
35	Notification Trash Management	89%	82%	1,4	57	0
36	Guild Adventure Guide Book	93%	84%	1,1	23	0
37	Guild Adventure Member	59%	71%	2	569	0
38	Guild Adventure Teaching Member	60%	72%	1,9	526	0
39	Guild Adventure Student Member	55%	73%	2,2	549	0
40	Guild Adventure Jobclass	90%	81%	1,5	60	0,03
41	Guild Adventure Skill	95%	82%	1,1	27	0,04
42	Guild Adventure Quest	96%	81%	0,989	33	0,01
43	Guild Adventure Reward	92%	84%	1,2	77	0,01
44	Leaderboard	91%	80%	1,3	130	0
45	News/Article	88%	72%	1,8	58	0,04
46	See News/Article	88%	81%	1,3	53	0,19
47	Profile	89%	81%	1,4	42	0,02
48	Change Password	85%	80%	1,5	65	0
49	My Quest	89%	81%	1,3	39	0,07
50	My Reward	90%	79%	1,5	51	0
	Average	**87%**	**80%**	**1,423**	**97,82**	**0,023**

Table 8. GTmetrix Grade Calculation

70% from *Performance* Average	30% from *Structure* Average	Total
61%	24%	85%

From the results of the performance efficiency test above, the average result is GTMatrix 70% performance plus 30% structure produces Grade 85% (Grade B), average Largest Contentful Paint 1.423s (OK, but consider improvements), average Total Blocking Time 97.82ms (Good - nothing to do here), Average Cumulative Layout Shift 0.023 (Longer than recommended).

The usability test results used a questionnaire based on the Arnold M. Lind User Questionnaire, which consisted of 4 evaluation criteria. The four criteria include Easy of Use, Satisfaction, Easy of Learning, and Usefulness.

This instrument includes eight evaluation indicators. Each indicator has five evaluation criteria, including 5 points, each scale has a score of 1 to 5. See Table 9. to find out the results.

Table 9. Usefulness Instrument Testing Results

No.	Instrument of *Usefulness*	Score
1.	This application helps me to be more effective	88%
2.	This application helps me be more productive	82%
3.	This application is useful	88%
4.	This app has given me a huge impact on the tasks I do in my life	86%
5.	This app makes it easy for me to get things done that I need	88%
6.	This app saves time when I use it	76%
7.	This app fits my needs	76%
8.	This application works as I expected	84%
	Average	**84%**

Based on the results of testing the assignment information system by applying leaderboard gamification elements and user quests in the Usefulness criteria, Table 9. shows that the bottom received an average score of 84%. Based on the eligibility description of the product (Sudaryono et al., 2011). With an achievement percentage of 84%, the information system is Very Feasible.

This instrument includes 11 evaluation indicators. Each indicator has five evaluation criteria including 5 points, each scale has a score of 1 to 5. Look at Table 10. to find out the results.

Table 10. Easy of Use Instrument Testing Result

No.	Instrument of *Easy of Use*	Score
9.	This application is not difficult to use	80%
10.	This application is functional to use	88%
11.	This application is very easy	88%
12.	This appication requires functional steps to achieve what I'm doing	82%
13.	This application can be customized according to my needs	84%
14.	There is no difficulty using this application	82%
15	I can use without the guidelines compiled	64%
16.	I didn't notice anything wrong when I used it	76%
17.	Users who use it occasionally or regularly will love this system	86%
18.	I can return from errors quickly and without problems	72%
19.	I can use this system effectively	86%
	Average	**81%**

Based on the results of testing the assignment information system by applying leaderboard and quest gamification elements by users in the Easy of Use criteria, Table 10 shows that it gets an average value of 81%. Based on the eligibility description of the product (Sudaryono et al., 2011), with an achievement percentage of 81%, the information system is Very Feasible.

This instrument includes four evaluation indicators. Each indicator has five evaluation criteria including 5 points, each scale has a score of 1 to 5. See Table 11. to find out the results.

Table 11. Easy of Learning Instrument Testing Result

No.	Instrument of *Easy of Learning*	Score
20.	I learned to use this application quickly	90%
21	I can easily remember how to use this application	84%
22.	This application is not difficult to know how to use it	88%
23.	I immediately became skilled with this application	80%
	Average	**86%**

Based on the results of testing the assignment information system by applying leaderboard and quest gamification elements by users in the Easy of Learning criteria, Table 11. shows that it gets an average score of 86%. Based on the description of product feasibility (Sudaryono et al., 2011), with an achievement percentage of 81%, the information system is very feasible.

This instrument includes seven evaluation indicators. Each indicator has five evaluation criteria including 5 points, each scale has a score of 1 to 5. See Table 12. to find out the results.

Tabel 12. Satisfaction Instrument Testing Result

No.	Instrument of *Satisfaction*	Score
24.	I'm happy with this application	86%
25.	I would recommend this system to friends	88%
26.	This application is fun to use	88%
27.	This application works exactly what I need	80%
28.	This application is generally very good	90%
29.	I believe I should have this system	80%
30.	This application is very helpful and comfortable to use	86%
	Average	**85%**

Based on the results of testing the assignment information system by applying leaderboard gamification elements and user quests in the Satisfaction criteria, Table 12. shows that the bottom received an average score of 85%. Based on the product feasibility classification (Sudaryono et al., 2011), with an achievement percentage of 85%, the information system is Very Feasible.

Portability Testing Results were carried out manually by researchers using different browsers on desktops and mobile devices. The purpose of this test is to find out whether the information system is functioning correctly. Researchers used browser software for tests such as Google Chrome, Mozilla Firefox, and Opera on desktop and mobile devices (Poco F3, Nokia 5.1 Plus, Honor 10 Lite). The test results show that the information system works well on different devices and software without errors. So that it can be concluded that the system is suitable for use directly by users and continued at the following testing stage.

Table 13. Gamification Instrument Testing Result

No.	Instrument of *Gamification*	Score
1.	The leaderboard motivates me to increase my score in competing with my friends.	4,1
2.	I am motivated to do assignments because the assignments are in the form of interesting quests.	4,5
3.	The avatar, level, exp, point/score features in the Assignment Information System provide a new atmosphere like playing a game.	4,8
4.	The variations in quest difficulty available in the Assignment Information System give an idea of my level of understanding in mastering the material.	4,5
5.	The use of the new terms jobclass, skill, quest, in the Assignment Information System attracts me when working on assignments/quests.	4,2
6.	I was helped by the timer feature when working on quests.	4,2
7.	I am motivated to complete many quests to get scores that can be exchanged for rewards.	4,8
	Average	**4,4**

Based on the gamification test results in Table 13. the average survey score was 4.44. Based on the total score, users are categorized as strongly agreeing with the existence of gamification in the system.

3.2. ANALYSIS

a. Assignment Information System Development

After obtaining the data required at the research stages, an analysis is then carried out to get information in the discussion so that it can answer the formulation of the problem referred to in this study.

The development of a web-based Assignment Information System by applying leaderboard and quest gamification elements in this study uses the agile development method consisting of 5 stages: Planning, Analysis, Design, Implementation, and System.

In the Planning Stage, the goal is to develop a Web-Based Assignment Information System by Applying Leaderboard and Quest Gamification Elements, which can provide new things to attract students and teachers toto process assignments online. The advantage gained when using this assignment information system is that it applies leaderboard and quest gamification elements, which User Friendly. In addition, there are functional and non-functional requirements. Applicable Requirements: Data Management (User, Student Quest, Jobclass, Skill, Quest, Reward, Student Reward, Article, Notification), Displays Leaderboard. Non-Functional Requirements: Software and hardware requirements, namely a Laptop with Windows 10 Home OS along with programming applications, and a VPS Server with two core processor specifications, four gb ram, 60 GB storage with Ubuntu 20.04 its Operating System.

Applying the Object Oriented Analysis and Design (OOAD) method in the Analysis and Design Stage. In the OOA (Object Oriented Analysis) stage, one use case diagram is obtained with three admin, teacher, and student user roles. In the OOAD stage, 10 Activity Diagrams are obtained, which describe business processes according to use cases and 1 Class Diagram. Then, in implementing gamification, several elements are applied, including points/score, level, timer for completing quests, quests/assignments, leaderboard, and rewards.

In the Implementation and System Phase, namely the translation of the agreed design from the previous phase into programming code using the PHP programming language version 8.15 (Laravel Framework version

9), MySql Database 8.0.29. Then, it is tested using the ISO 25010 standard with functional suitability, performance efficiency, portability, and usability, and then uploaded to the VPS whether it runs well or not online. The results of the ISO 25010 standard test phase are in the discussion of Information System Feasibility.

b. Assignment Information System Testing

Below, we will discuss the results of testing the assignment information system by applying leaderboard and quest gamification elements using the ISO 25010 Standard, which includes Functional Suitability, Performance Efficiency, Portability and Usability.

Functional Suitability. Based on the test results of the assignment information system by applying leaderboard and quest gamification elements to the functional suitability characteristics, a success rate of 100% was obtained. In the functional completeness sub-characteristics, the test results obtained a value of $X = 1$, and the functional correctness of the test results received a value of X value $= 1$. From this, it can be concluded that the information system meets the characteristics of practical suitability.

Performance Efficiency. Based on the results of testing the assignment information system by applying leaderboard and quest gamification elements to performance efficiency characteristics, the average GTMatrix Grade is 85% (Grade B), the Largest Contentful Paint average is 1,423s (OK, but consider improvements), average Total Blocking Time 97.82ms (Good - nothing to do here), average Cumulative Layout Shift 0.023 (Longer than recommended). From this, it can be concluded that the information system meets the characteristics of Performance Efficiency.

Portability. Based on the test results, the information system can run error-free on various devices and with different software. So, it can be concluded that the system is feasible to be used directly by the user.

Usability. Respondents for this test were ten system users at each user level, namely one admin, three teachers, and six students. The test scenario between users is almost the same, namely, trying use cases according to the user's role. It is done simultaneously in the office for admins and teachers, with the flow of trying out all the features. Meanwhile, for students, the scenario is done in class. After testing the application, testing was carried out by distributing questionnaires based on Arnold M. Lind's User Questionnaire, which consists of 4 evaluation criteria.

The usefulness test results are 84%. However, there are two indicators, namely number 6. This application saves time when I use it, and 7. This application suits my needs. Both hands have a reasonably low value, namely 76%. The question from indicator 6 is that I want to know whether This application saves the user's time during use, and the questions of the seven indicators of this application are according to the user's needs. In addition, there was input from respondents who said that the application needed to be developed more comprehensively, which consisted of many departments. Therefore, from a Usefulness point of view, researchers can conclude that it meets the category of very suitable for use with an average score of 84%. However, two indicators have the lowest value regarding the expectations of users of this system, which has a broader scope.

The Easy of Use test result is 81%. However, there are three indicators, namely number 7, which I can use without the guidelines prepared with an indicator value of 64%, 8 I don't see any irregularities when I use it with an indicator value of 76% and 10, I can return from errors quickly and without problems with an indicator value of 72%, questions from indicator 7 Users can use without prepared guidelines, questions from indicator 8 Users do not notice any irregularities when I use it, and questions from indicator 10 Users can return from errors quickly and without a problem. Apart from that, there were comments from respondents who said that the interface should be made more user-friendly, and they were confused about how to use the application because there are many steps in running it; apart from that, there were positive responses, including that while using this application there were no difficulties, it was fun, and it had a good appearance. Therefore, from an Easy Use point of view, researchers can conclude that it meets the category of being very suitable for use with an average score of 81%, even though three indicators have the lowest scores regarding users' expectations of this system being more user-friendly.

Easy of Learning test results 86%, there is input from users, this website is excellent and fun to use, not too monotonous, but you have to read the guide first before using it, this website will be fun to use for school. Therefore, from the Easy of Learning point of view, researchers can conclude that it meets the category of very suitable for use with an average score of 86%.

The results of the Satisfaction test are 85%. In addition, there are web comments, which is very cool and makes students feel more comfortable, good, very easy & practical, and helps us to be more active in learning, users like this application because it is easy to use and has a positive effect on students like me. Therefore, from the point of view of Ease of Learning, researchers can conclude that it meets the very feasible category for use with an average score of 85%.

The results of testing four usability items using a user questionnaire show that the average value for each item is 84%, 81%, 86%, and 85%. These results show that the average for all is 84%. Therefore, the researcher concluded that the information system implementing leaderboard and quest gamification elements was very feasible to use with some input notes from the user.

The results of the gamification test are in Table 13. For the Gamification Instrument, the average score obtained from the survey was 4.44. Based on the total score, users are categorized as strongly agreeing with the existence of gamification in the system.

4. CONCLUSION

This research produced a web-based assignment information system by applying Leaderboard and Quest gamification elements at SMK Negeri 2 Surakarta TKJ Expertise Program. Information system development using the Laravel web application framework using the Agile Development software development model which consists of 5 stages, namely (1) Planning, (2) Analysis, (3) Design, (4) Implementation, (5) System. The research applies the Object Oriented Analysis and Design (OOAD) method in the analysis and design process. This information system has three levels of users, namely admin, teachers and students. The web-based assignment information system by implementing the Leaderboard and Quest gamification elements at SMK Negeri 2 Surakarta TKJ Expertise Program was tested using the ISO 25010 standard. For three sub-characteristics of functional suitability, namely functional completeness, it has an average value of 1 (Good). Functional correctness has an average value of 1 (Good). Functional appropriateness has an average value of 1 (Good). Performance efficiency characteristics obtained an average GTMatrix Grade result of 85% (grade B). The largest contentful paint average is 1.423s (OK, but consider improvements). Average total blocking time 97.82ms (Good - nothing to do here). Average cumulative layout shift 0.023 (longer than recommended). Portability characteristics have excellent results in that the system can run on desktop or mobile devices. Usability characteristics of 85% (Very Decent). From the results of these tests it can be concluded that the web-based assignment information system by applying Leaderboard and Quest gamification elements at SMK Negeri 2 Surakarta TKJ Expertise Program, has met ISO 25010 quality standards.

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