# QoE and QoS Evaluation for Academic Portal in Private Higher Education Institution

**5 authors**, including:

**Edy Budiman**
Universitas Mulawarman
**57** PUBLICATIONS   **203** CITATIONS

SEE PROFILE

**Masna Wati**
Universitas Mulawarman
**31** PUBLICATIONS   **42** CITATIONS

SEE PROFILE

**Dolly Indra**
Universitas Muslim Indonesia
**15** PUBLICATIONS   **5** CITATIONS

SEE PROFILE

**Muh Jamil**
Universitas Mulawarman
**4** PUBLICATIONS   **17** CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:

Biodiversity View project

prediction View project

# QoE and QoS Evaluation for Academic Portal in Private Higher Education Institution

Edy Budiman
*dept. of informatics engineering*
*universitas mulawarman*
Samarinda, Indonesia
edy.budiman@ieee.org

Dikwan Moeis
*dept. of information system*
*stmik professional makassar*
Makassar, Indonesia
dikwan.moeis@gmail.com

Masna Wati
*dept. of informatics engineering*
*universitas mulawarman*
Samarinda, Indonesia
masnawati.ssi@gmail.com

Muh Jamil
*dept. of informatics engineering*
*universitas mulawarman*
Samarinda, Indonesia
jamil.unmul@gmail.com

Dolly Indra
*dept. of informatics engineering*
*universitas muslim indonesia*
Makassar, Indonesia
dolly.indra@umi.ac.id

*Abstract*— **ISO 9126 standard provides very important key indicators as a basis for improving the quality of academic portals. The demands of users' needs for providing good quality academic portal services for students, and the time problems available in system maintenance motivate us to evaluate the main indicators of web performance that affect the performance of academic portals. This study aims to evaluate the performance of academic portals to determine the factors that influence service quality using the ISO 9126 quality model from the characteristics of reliability, efficiency, and usability academic portals in one of the Private Higher Education. Based on the measurement results of page loading time on the academic portal, it's stated that the quality of reliability characteristics is recommended to reduce page load time, which should not exceed 3 seconds. Results of quality measurement based on recommendations from Google's Page Speed obtained values with Grade D (66%) and recommendations from Page YS-Low with Grade D (67%). The results of the quality evaluation for usability characteristics recommend 4 items that fall into the category of small problems with a low priority level of improvement, and improvements needed.**

*Keywords—ISO 9126, academic portal, student, usability, reliability, efficiency*

## I. INTRODUCTION

The measurement of system quality as the resulting software is an important factor in the system implementation process [1]. The aim is to ensure that the system used meets the existing quality measurement software standards so that the resulting system is quality and can meet user needs. An effective software process is implemented by creating useful products that provide measurable value to those who produce it and those who use it [2]. Every software produced must be able to provide quality assurance to developers and users, so it is necessary to measure using the specified standards [3]. To determine the suitability between user needs and the process of running the system, it is necessary to measure quality on the characteristics of the information system. One of the standard standards used in the software quality measurement process is ISO 9126 [4]. ISO 9126 standard provides very important key indicators as a basis for improving and identifying information system quality attributes. The ISO 9126 standard identifies six information system quality attributes, i.e.: Functionality, Reliability, Usability, Efficiency, Maintainability, and Portability [5].

One of the information systems evaluated in this study is the academic portal in one of the private higher education institution in Eastern Indonesia. Academic portal as a guide for students serves to assist in carrying out activities and/or transactions related to academic problems such as accessing courses offered, student study plans per semester, access to class schedules, semester achievement grade (GPA), and academic transaction management other students.

The research on evaluating the quality of academic portal systems has been carried out by [6-10], discussing quality characteristic identification of software on academic application in higher education institutions (HEI), [11-12] research on the performance efficiency assessment for software systems. Academic and research libraries' portals [13]. Applying the ISO/IEC 25010 quality models to software product [14-15], etc.

Performance evaluation academic portals are very important, because in their processes and services they are required to be able to work optimally every day in serving the many users of the campus academic community. This problem is certainly a challenge and more attention for the manager of the portal system in an effort to maintain quality of service. The demands of users' needs for the provision of good quality student academic portal services, and the problem of time available in system maintenance motivated us to evaluate the quality of the attributes that affect the performance of student academic portals.

The study aims to evaluate the performance of academic portals to determine the factors that influence service quality using the ISO/IEC 9126 quality model approach from the point of view quality of experience (QOE) and quality of service (QOS). The characteristics of the ISO/IE 9126 i.e. reliability, efficiency, and usability towards student academic portals in one of the private higher education institutions. This evaluation is very important, considering the number of users of this system is very large and continues to grow, one of the efforts to improve and optimize the performance of academic management. Evaluation of students' academic portals analyzed based on QOE from user perceptions and QOS for academic portal.

## II. MATERIALS AND METHODS

### A. Data Collection Methods

Data collection methods using:

*1) Questionnaire technique,* by giving a series of questions or written statements to respondents. Respondents are students with total is 120 students as samples who will provide a scaled assessment of the academic portal. The results of the questionnaire are an assessment for evaluation.

*2) Observation technique,* conducts a series of tests using a website or web-server performance measurement tool to determine the behavior of academic portals. The tool used is GT-Metrix [16-17] to test the efficiency of quality and the Stress Web Server tool to measure the quality of reliability on the Academic Portal.

### B. ISO 9126 Quality Model

There are various software quality models available as a guide to be followed [6] in evaluating the quality of academic portals. This study uses the ISO 9126 Quality Model with an approach to the characteristics of reliability and efficiency to measure QOS, and usability characteristics to measure the QOE. The following in "Fig. 1" is an architectural quality evaluation model on an academic portal.
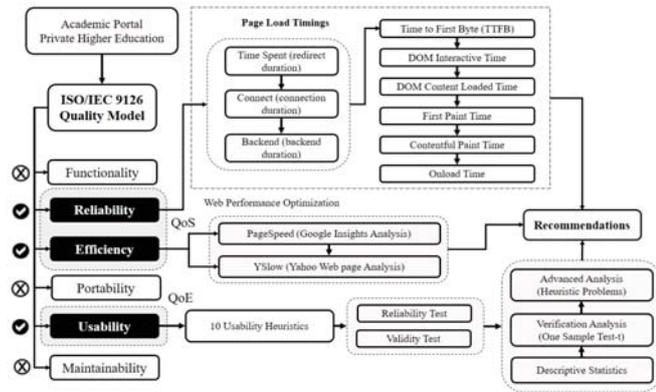


Fig. 1. An architectural quality evaluation model on an academic portal

- Variables evaluation method for reliability analysis

Analysis of reliability characteristics by measuring or testing page loading timing on academic portals. The variables for reliability analysis presented in "Table I".

TABLE I.    RELIABILITY ANALYSIS VARIABLES

| Variable | Description |
|---|---|
| Redirect durationis | is the time spent redirecting URLs before the final HTML page is loaded |
| Connection duration | is the time spent connecting to the server to make the request to the page. |
| Backend duration | Is the time it takes to generate the response |
| Time to First Byte (TTFB) | It is the sum of "Redirect duration" + "Connection duration" + "Backend duration" |
| DOM interactive time | is the point at which the browser has finished loading and parsing HTML. |
| DOM content loaded time | is the point at which the DOM is ready and there are no stylesheets blocking JavaScript execution |
| First paint time | is the first point at which the browser does any sort of rendering on the page |
| First Contentful Paint | is triggered when any content is painted (text, an image or canvas render) |
| Onload time | occurs when the processing of the page is complete and all the resources on the page (images, CSS, etc.) have finished downloading |

Calculations for reliability values refer to [18-24], and then compare according to TELCORDIA standards [19-27], the reliability of software reliability is 95% or 0.95.

- Variables evaluation method for efficiency analysis

This test uses the GT-Metrix [16-17] measuring tool developed by GT.net. This tool uses a combination of Google Page Speed Insights and YS-low to generate value and recommendations. Recommendations for Page Speed and YS-low Parameters presented in "Table II".

TABLE II.    PAGESPEED AND YSLOW RECOMMENDATIONS [16]

| Recommendation Page Speed | Recommendation YS-low |
|---|---|
| Enable GZIP compression | Add Expires headers |
| Leverage browser caching | Compress components with GZIP |
| Minify CSS | Use a Content Delivery Network |
| Optimize images | Use cookie-free domains |
| Avoid bad requests | Make fewer HTTP requests |
| Avoid CSS @import | Avoid HTTP 404 (Not Found) error |
| Minify HTML | Minify JavaScript and CSS |
| Minify JavaScript | Avoid URL redirects |
| Specify image dimensions | Make AJAX cacheable |
| Specify a Vary: Accept-Encoding | Remove duplicate JScript and CSS |
| Avoid landing page redirects | Avoid Alpha Image Loader filter |
| Defer parsing of JavaScript | Reduce the number of DOM |
| Enable Keep-Alive | Use GET for AJAX requests |
| Inline small CSS | Avoid CSS expressions |
| Inline small JavaScript | Reduce DNS lookups |
| Minimize redirects | Reduce cookie size |
| Minimize request size | Make favicon small and cacheable |
| Optimize the order of styles and scripts | Configure entity tags (E-Tags) |
| Put CSS in the document head | Make JavaScript and CSS external |
| Serve resources from a consistent URL | |
| Serve scaled images | |
| Specify a cache validator | |
| Combine images using CSS sprites | |
| Prefer asynchronous resources | |
| Specify a character set early | |
| Avoid a character set in the meta tag | |
| Remove query strings from static resources | |

- Variables evaluation method for usability analysis

Usability characteristic evaluation uses 10 general principles of J. Nielsen for interaction design (10 Usability Heuristics) [28]. The variables used are described in "Table III" based on 10 Heuristic methods.

TABLE III.    DESCRIPTION of 10 Heuristic Methods

| | Variables | Indicators |
|---|---|---|
| 1 | Status visibility on the system (Feedback) | Informative and communicative information and feedback |
| 2 | Match between system and real world (Metaphor) | a. The system uses human language b. All components (icons, menus, buttons, forms) are logical according to the symbol of the real world |
| 3 | User freedom and control of the system (Navigation) | a. There is navigation to control the interface b. Easy to change operations |
| 4 | Consistency and standards (consistency) | a. Language structure, navigation, color and font are consistent b. Suitability of menus with tasks |

| | Variables | Indicators |
|---|---|---|
| 5 | Helps users to recognize, diagnose, and recover from errors (Recovery) | Informative and problem-solving error messages |
| 6 | Error prevention and recognition (Prevention) | There is a confirmation option for each operation |
| 7 | Easy to recognize rather than remember | Objects and layout are clear |
| 8 | Flexible and efficient in use (Efficient) | Informative commands for beginners and experts |
| 9 | Clear and simple instructions (Design) | a. Dialogue and information displayed communicatively b. Layout and color alignment |
| 10 | Help and documentation | There is a help menu for the user |

- Instrument Testing

The distribution of questionnaires was carried out through two stages to find out whether the questionnaire was made valid and reliable, the first thing to do was test the validity and reliability. Data validity testing uses Pearson product moment correlation and reliability analysis of respondents' ratings was done with the Alpha model (Cronbach's Alpha). The resulting consistency value is compared to the consistency value table [29].

After t-test one sample, further analysis of the advanced problem Heuristics is done by using interval class. This analysis aims to provide the scoring of each item. Scale as the description of academic portal usability level on respondents' answers through questionnaires. This study uses a five-point Likert scale as described in "Table IV".

TABLE IV.    Weighting Scale for Respondent Questionnaire

| Respondent's Answer | Value |
|---|---|
| There is no problem at all | 0 |
| A little problem that doesn't need to be fixed | 1 |
| Small problems whose improvements are the low priority | 2 |
| Problems that must be fixed and become a high priority | 3 |
| Very Important To Repair | 4 |

## III. Results and Discussion

### A.  Results of Measurement of Reliability Characteristics

The results of measuring the characteristics of the reliability of academic portals using the GT-Metrix tool. The values and scores of the page loading timings variable shown in "Fig. 2" and "Fig. 3" for waterfall chart.
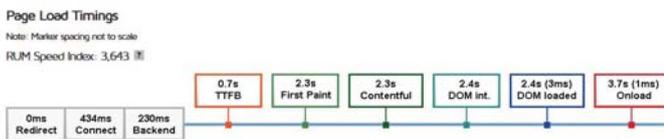


Fig. 2.   Performance report of academic portal

Redirect duration is the time spent redirecting URLs before the final HTML page is loaded. This timing is the total of all this time that's spent redirecting, from the measurement results obtained 0ms, meaning no redirects occurred. Once any redirects have completed, Connection duration is measured. The time spent connecting to the server to make the request to the page is 434ms. During this time, the browser screen is still blank! Various causes could contribute to this, including a slow/problematic connection between the test server and site or slow response times from

the site. Once the connection is complete and the request is made, the server needs to generate a response for the page. The time it takes to generate the response is 230ms (known as the Backend duration).

The total amount of time spent to receive the first byte of the response once it has been requested (Time to First Byte - TTFB) is 0.7s. It is the sum of "Redirect duration" + "Connection duration" + "Backend duration". The First paint time is the first point at which the browser does any sort of rendering on the page. Measurement results The First paint time is 2.3s this first paint could just be displaying the background color (including white), or it could be a majority of the page being rendered.
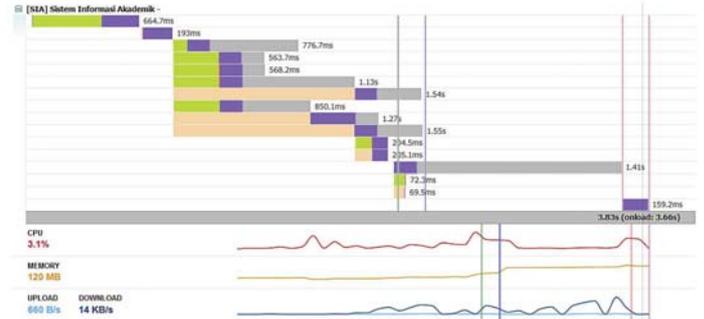


Fig. 3.   Waterfall Chart: request-by-request visualization of the page load

Measurement results for First Contentful Paint is 2,3s, triggered when any content is painted. This could be text, an image or canvas render. This timing aims to be more representative of the user's experience, as it flags when actual content has been loaded in the page. DOM interactive time is 2,4s, the point at which the browser has finished loading and parsing HTML. The DOM (Document Object Model) has been built. The DOM is how the browser internally structures the HTML so that it can render it. DOM content loading time is the point at which the DOM is ready. It's the time is 2.4s and there are no stylesheets blocking JavaScript execution (this the same as DOM interactive time). The On-load time is 3,7s, occurs when the processing of the page is complete and all the resources on the page (images, CSS, etc.) have finished downloading. This is also the same time that DOM complete occurs and the JavaScript window.onload event fires.

According to Brian Shumway [30] cites statistics from research conducted by Gomez and Akamai, that:

47% of consumers expect a web page to load in 2 seconds or less. 40% abandon a website that takes more than 3 seconds to load. 79% of shoppers who are unhappy with website performance are less likely to buy again. Conversions are reduced by 7% for every 1 second delay in page response. Reducing load time from 8 seconds to 2 results in a 74% increase in conversions. Based on these [30] and if compared to the results of measuring the page loading time on the academic portal and by referring to [18], stated that the quality of the reliability characteristics of the academic portal is recommended to reduce the load time which should not exceed 3 seconds. Optimization recommendations for influential variables on the server side.

## B. Results of Measurement of Efficiency Characteristics

The results of quality measurements on the efficiency characteristics in "Table V" and "Table VI".

- Recommendation of Page Speed

TABLE V.  PERFORMANCE SCORE OF PAGESPEED RECOMMENDATIONS

| Recommendation | Grade | Type | Priority |
|---|---|---|---|
| Enable GZIP compression | F (0) | Server | High |
| Leverage browser caching | D (63) | Server | High |
| Minify CSS | D (66) | CSS | High |
| Optimize images | C (77) | Images | High |
| Avoid bad requests | A (92) | Content | High |
| Avoid CSS @import | A (92) | CSS | Medium |
| Minify HTML | A (99) | Content | Low |
| Minify JavaScript | A (99) | JS | High |
| Specify image dimensions | A (99) | Images | Medium |
| Specify a Vary: Accept-Encoding | A (93) | Server | Low |
| Avoid landing page redirects | A (100) | Server | High |
| Defer parsing of JavaScript | A (100) | JS | High |
| Enable Keep-Alive | A (100) | Server | High |
| Inline small CSS | A (100) | CSS | High |
| Inline small JavaScript | A (100) | JS | High |
| Minimize redirects | A (100) | Content | High |
| Minimize request size | A (100) | Content | High |
| Optimize order of styles and scripts | A (100) | CSS/JS | High |
| Put CSS in the document head | A (100) | CSS | High |
| Serve resources from consistent URL | A (100) | Content | High |
| Serve scaled images | A (100) | Images | High |
| Specify a cache validator | A (100) | Server | High |
| Combine images using CSS sprites | A (100) | Images | High |
| Prefer asynchronous resources | A (100) | JS | Medium |
| Specify a character set early | A (100) | Content | Medium |
| Avoid a character set in the meta tag | A (100) | Content | Low |
| Remove query strings from static resources | A (100) | Content | Low |

Based on the results of quality measurements on the characteristics of efficiency, there is one recommendation that obtains Grade (score) F(0), is *Enable GZIP Compression* recommendations. There are two (2) recommendations that are of Grade D value, is *Leverage Browser Caching* with score D (63) and a *Minify CSS* recommendation D (66). For *Optimize Images* recommendations get a score of C (77). As for other recommendations, in general, get Grade A with a score range of 92-100. From the results of quality measurements based on recommendations from Page Speed Google, the percentage of portal performance with Grade (score) is D (66%).

- Recommendation of YS-low

Based on the results in "Table VI", the quality measurements on efficiency characteristics based on YS-low recommendations, there are three (3) recommendations that obtained Grade F, i.e. the recommendations of *Add Expires headers* F (0), *Compress components with GZIP* is F(12), and *Use a Content Delivery Network (CDN)* is F(10). Recommendation *Use cookie-free domains* are Grade E(55). For recommendation *Make fewer HTTP requests* get B score (84). While for others recommendation generally get Grade A with a score range of 95-100.

TABLE VI.  PERFORMANCE SCORE OF YSLOW RECOMMENDATIONS

| Recommendation | Grade | Type | Priority |
|---|---|---|---|
| Add Expires headers | F (0) | Server | High |
| Compress components with GZIP | F (12) | Server | High |
| Use a Content Delivery Network (CDN) | F (10) | Server | Medium |
| Use cookie-free domains | E (55) | Cookie | Low |
| Make fewer HTTP requests | B (84) | Content | High |
| Avoid HTTP 404 (Not Found) error | A (95) | Content | Medium |
| Minify JavaScript and CSS | A (100) | CSS/JS | Medium |
| Avoid URL redirects | A (100) | Content | Medium |
| Make AJAX cacheable | A (100) | JS | Medium |
| Remove duplicate JavaScript and CSS | A (100) | CSS/JS | Medium |
| Avoid Alpha Image Loader filter | A (100) | CSS | Medium |
| Reduce the number of DOM elements | A (100) | Content | Low |
| Use GET for AJAX requests | A (100) | JS | Low |
| Avoid CSS expressions | A (100) | CSS | Low |
| Reduce DNS lookups | A (100) | Content | Low |
| Reduce cookie size | A (100) | Cookie | Low |
| Make favicon small and cacheable | A (100) | Images | Low |
| Configure entity tags (E-Tags) | A (100) | Server | Low |
| Make JavaScript and CSS external | (n/a) | CSS/JS | Medium |

From the results of quality measurements based on recommendations from Page YS-Low, the percentage of portal performance with Grade (score) is D (67%).

## C. Results of Measurement of Usability Characteristics

Usability is one of the evaluation characteristics of ISO 9126, which describes how effective users are in interacting with a product or system. Usability is also a measure of how easily a product can be learned quickly and how easily a product can be used. Usability can be used as a measure of the quality of user experience when interacting with an interface.

- Validity test

Validity is done to test valid or not on each item statement/question in measuring the variable, with the aim of calculating the correlation between each question (item) and the total score. Based on the validity test data, the data is compared with a significant level of critical r = 0.30. If the measuring instrument is < 0.30 then the data is stated invalid and if the measuring instrument > 0.3 then the data is declared valid. Validity test on all items available in "Fig. 4" shows the results of the validity test analysis using SPSS IBM Version 24.0 for windows.
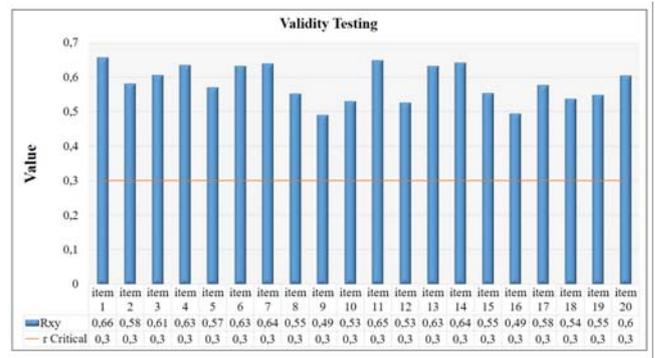


Fig. 4.  Results of the validity test analysis

The data in "Fig. 3" shows that no questionnaire items have a validity coefficient smaller than the critical r of 0.3. So that, it can be concluded that all of 20 instrument items are declared valid, which means the items used in the questionnaire to measure these indicators can represent the theory and be able to measure what should be measured.

- Reliability Test Results

In this study used the Cronbach alpha reliability measurement method, with the criteria of the minimum reliability coefficient must be met by a measuring instrument is greater than 0.7 (Cronbach alpha ≥ 0.7) which means that

the overall measuring instrument has consistency. Based on the results of the reliability test, it is known that in the usability variable reusability variable, all items in the questionnaire indicator are reliable because the reliability coefficient value is greater than 0.70, which is 0.752 ($0.752 \geq 0.7$).

- Descriptive Analysis of Variables

Research conducted on 120 samples of student respondents as users of academic portal by providing a questionnaire consisting of 20 questions on the usability variable heuristic approach with 10 indicators to be evaluated, of which each question has 5 alternative answers that are rated. Based on the results of processing data from the questionnaire, a descriptive analysis can be carried out regarding the average of each per-item indicator can be explained in "Table VII".

TABLE VII.    VARIABLE DESCRIPTIVE ANALYSIS

| | Variables | Item | Average |
|---|---|---|---|
| 1 | Status visibility on the system (Feedback) | highest: 2. There is feedback from the academic portal when a button is pressed by the user | 1.375 |
| | | lowest: 1. Each academic portal page provides clear information to users | 1.208333 |
| 2 | Match between system and real world (Metaphor) | highest: 4. Questions in the academic portal are stated clearly and delivered simply | 1.141667 |
| | | lowest: 3. The colors used in academic portals are in accordance with the institution's color rules | 0.975 |
| 3 | User freedom and control of the system (Navigation) | highest: 5. Users can cancel operations or processes that are running on the academic portal | 1.708333 |
| | | lowest: 6. Academic portal uses many menu buttons. | 1.583333 |
| 4 | Consistency and standards (consistency) | highest: 9. The information column label appears on the left side of the portal screen | 1.216667 |
| | | lowest: 7. The format of letters and punctuation on academic portals adjusts to the standard of written spelling | 1.033333 |
| 5 | Helps users to recognize, diagnose, and recover from errors (Recovery) | highest: 11. The instructions on the academic portal are short and unambiguous | 1.241667 |
| | | lowest: 10. Error messages are used grammatically correctly and do not use harsh words | 0.925 |
| 6 | Error prevention and recognition (Prevention) | highest: 13. Academic portal system prevents users from making mistakes and will warn them | 1.666667 |
| | | lowest: 12. Menu options available on the academic portal | 0.975 |
| 7 | Easy to recognize rather than remember | highest: 14. Instructions, signs, and messages are placed where the user's eyes often look towards the layer | 1.2667 |
| 8 | Flexible and efficient in use (Efficient) | highest: 15. If the menu item is short, the user can choose an item by moving the cursor | 1.233333 |
| | | lowest: 16. The academic portal system automatically directs to the main page | 0.966667 |
| 9 | Clear and simple instructions (Design) | highest: 18. All icons on the academic portal are conceptually and visually different | 1.6333 |
| | | lowest: 17. Column label on short academic portal, no stranger and descriptive | 0.983333 |

| | Variables | Item | Average |
|---|---|---|---|
| 10 | Help and documentation | highest: 20. There are help reminders for orders, through online references on academic portals or others | 1.833333 |
| | | lowest: 19. Navigation: Information on academic portals is easy to find and information is interconnected | 1.191667 |

- Verification Analysis with One Sample Student Test-T test Statistics

In evaluating heuristic evaluations, evaluators will assess each item of question for each usability indicator in the questionnaire, by testing the hypothesis. Based on the results of the calculation, after testing 20 items using the t test. Of the 20 items that existed t count <t table, Ho was rejected which meant explaining that there were no problems in the academic portal.

- Advanced analysis of problem categories

The next step is to rank the problem of heuristic evaluation for items in each of these indicators that fall into the category of problem level that must be corrected. Based on the calculation, heuristic evaluation problem level category is obtained with a length of interval of each category as many as 96. Out of ten (10) average indicators of usability problems of academic portals have information (few problems that do not need to be fixed). Whereas the usability of the academic portal is actually not much of a problem that needs to be changed until the system is changed. However, there are 4 items that have small problems that the improvement is a low priority so that there is a need for improvement recommendations despite having low priority.

- Recommendation

Based on the findings of the problem, recommendations for improvement were made on the academic portal. "Table VIII" presents recommendations that can be used as a reference.

TABLE VIII.    RECOMMENDATIONS FOR IMPROVEMENT OF PORTALS

| Item | Recommendation |
|---|---|
| 20. There is a reminder aid for commands, through online references on student academic portals or others | There is a need for guidance on the use of student academic portal system to facilitate students in using portal both in terms of function and need of usage. |
| 5. Users may cancel operations or processes that are running on the student academic portal | Require optimization in the warning or option if the user wants to cancel the operation or running processes like back or Exit button. |
| 13. The student academic portal prevents users from making mistakes and will remind them if they make serious mistakes | There is a need for a notice on the system, if students access the portal system, a warning when doing something on the system. |
| 18. All the icons on the student academic portal are different conceptually and visually | The use of Icons in the academic portal becomes one of the recommendations for student academic portal can be more easily understood and also not too monotonous. |

Based on "Table VIII", from 20 items, around 16 items are in the category of a few problems that do not need to be fixed. That means only problems that are errors in the use of words or display that is less attractive. But there are 4 items that are in the least category of problems whose priority level of repair is low. So it needs improvement.

## IV. CONCLUSION

Based on the analysis presented it was found that the QOS academic portal in the ISO 9126 quality model with reliability and efficiency characteristics provides recommendations for improvement in reducing page loading timings and code optimization the resources of web portal builder content. QOE from the results of the measurement of usability characteristics gives recommendations in the category of small problems that the priority level of improvement is low. Academic portals at every private higher education institution are data and information management systems that continue to operate with high performance and are required to be optimal in their services. The problem of user satisfaction in service is very important in an effort to improve organizational management performance. Optimizing the performance of large-scale information systems is our challenge now and in the future.

## ACKNOWLEDGMENT

## REFERENCES

[1] M. A. Akbar *et al.*, "Improving the Quality of Software Development Process by Introducing a New Methodology–AZ-Model," in *IEEE Access*, vol. 6, pp. 4811-4823, 2018.

[2] Pressman, R. S. (2010). Software Engineering A Practitioner's Approach. Seventh Edition. Boston: McGraw-Hill

[3] J. Singh and N. B. Kassie, "User's Perspective of Software Quality," 2018 Second International Conference on Electronics, Communication and Aerospace Technology (ICECA), COIMBATORE, India, 2018, pp. 1958-1963.

[4] ISO, I. IEC 9126, Software Product Evaluation–Quality Characteristics and Guidelines for their Use. 2001.

[5] Padayachee, I., Kotze, P. and van Der Merwe, A., ISO 9126 external systems quality characteristics, sub-characteristics and domain specific criteria for evaluating e-Learning systems, 2010.

[6] Suradi N.R, Kahar S, Jamaluddin N.A, "Identification of Software Quality Characteristics on Academic Application In Higher Education Institution (HEI)", Journal of Telecommunication, Electronic and Computer Engineering (JTEC). vol. 10(2-7), pp.133-6, July 2018.

[7] Rosa, M.J., Sarrico, C.S. and Amaral, A., 2012. Implementing quality management systems in higher education institutions. In Quality assurance and management. InTech, 2012.

[8] E. Budiman, S. N. Alam and M. A. Akbar, "Mobile Learning: Utilization of Media to Increase Student Learning Outcomes," 2018 5th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI), Malang, 2018, pp. 138-143.

[9] Nur Razia Mohd Suradi, Saliyah Kahar, and N. A. A. Jamaludin, "A Review On Software Quality Attributes For Web-," in International Conference on Engineering and Applied Science Purwokerto , Indonesia, 2016, vol. 1, pp. 181–191.

[10] E. Budiman, Haeruddin and A. Tejawati, "Efficiency and Reliability Performance's of the Bioinformatics Resource Portal," 2018 5th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI), Malang, 2018, pp. 493-498.

[11] Kaur. A, P. S. Grover, and A. Dixit. "Performance Efficiency Assessment for Software Systems." In Software Engineering, pp. 83-92. Springer, Singapore, 2019.

[12] E. Budiman, Haeruddin and A. Tejawati, "Efficiency and Reliability Performance's of the Bioinformatics Resource Portal," 2018 5th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI), Malang, 2018, pp. 493-498.

[13] B. Blummer, and J. M. Kenton. "Academic and Research Libraries' Portals: A Literature Review from 2003 to the Present." In Digitizing the Modern Library and the Transition from Print to Electronic, pp. 29-63. IGI Global, 2018.

[14] J. Estdale, and E. Georgiadou. "Applying the ISO/IEC 25010 Quality Models to Software Product." In European Conference on Software Process Improvement, pp. 492-503. Springer, Cham, 2018.

[15] E. Budiman, M. Wati, J. A. Widians, N. Puspitasari, M. B. Firdaus and F. Alameka, "ISO/IEC 9126 Quality Model for Evaluation of Student Academic Portal," 2018 5th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI), Malang, 2018, pp. 499-504.

[16] https://gtmetrix.com/

[17] http://yslow.org/ruleset-matrix/

[18] Nielsen, J., "Website Response Times", Nielsen Norman Group, 2014. [Online]. Tersedia: http://www.nngroup.com/articles/website-response-times/

[19] E. Budiman, N. Puspitasari, S. N. Alam, M. A. Akbar, Haeruddin, F. Alameka, "Performance Analysis of the Resource Loading Time for Borneo Biodiversity Information System," 2018 The Third International Conference on Informatics and Computing (ICIC), Palembang, pp. 1-6.

[20] E. Budiman, D. Moeis and R. Soekarta, "Broadband quality of service experience measuring mobile networks from consumer perceived," *2017 3rd International Conference on Science in Information Technology (ICSITech)*, Bandung, 2017, pp. 423-428. doi: 10.1109/ICSITech.2017.8257150.

[21] Budiman, E., Haeruddin, H., Hairah, U. and Alameka, F., Mobile Learning: Visualizing Contents Media of Data Structures Course in Mobile Networks. Journal of Telecommunication, Electronic and Computer Engineering (JTEC), 10(1-9), 2018, pp.81-86.

[22] E. Budiman, U. Haryaka, J. R. Watulingas and F. Alameka, "Performance rate for implementation of mobile learning in network," *2017 4th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI)*, Yogyarta, 2017, pp. 1-6. doi: 10.1109/EECSI.2017.8239187

[23] E. Budiman and S. N. Alam, "User perceptions of mobile internet services performance in borneo," *2017 Second International Conference on Informatics and Computing (ICIC)*, Jayapura, 2017, pp. 1-6. doi: 10.1109/IAC.2017.8280643

[24] E. Budiman and N. Puspitasari, "Evaluation of Borneo's Biodiversity Information System," 2018 9th Electrical Power, Electronics, Communications, Controls, and Informatics Seminar (EECCIS), Malang, 2018, pp. \

[25] Budiman, E., Haeruddin, H., Hairah, U. and Saudek, A., Mobile networks for mobile learning tools. Journal of Telecommunication, Electronic and Computer Engineering, 10 (1-4), 2018, pp. 47-52

[26] E. Budiman and O. Wicaksono, "Measuring quality of service for mobile internet services," *2016 2nd International Conference on Science in Information Technology (ICSITech)*, Balikpapan, 2016, pp. 300-305.
doi: 10.1109/ICSITech.2016.7852652

[27] M. Taruk, E. Budiman, Haviluddin and H. J. Setyadi, "Comparison of TCP variants in Long Term Evolution (LTE)," *2017 5th International Conference on Electrical, Electronics and Information Engineering (ICEEIE)*, Malang, 2017, pp. 131-134.
doi: 10.1109/ICEEIE.2017.8328776

[28] J. Nielsen, 10 Usability Heuristics for User Interface Design, Accessed: October 20, 2018, Homepage: https://www.nngroup.com/articles/ten-usability-heuristics/

[29] J. A. Gliem and R. R. Gliem, Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education, 2003.

[30] B. Shumway, Site Speed, Mobile Usability, and SEO, Retrieved from homepage:https://www.linkedin.com/pulse/20141119181300-142790335-site-speed-mobile-usability-and-seo/