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

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***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.

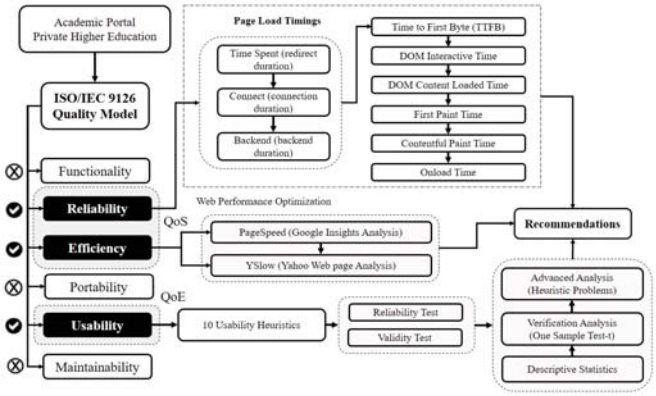

Fig. 1. An architectural quality evaluation model on an academic portal

- 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.

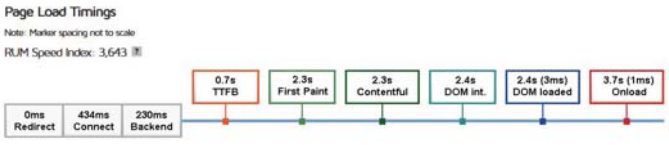

Fig. 2. Performance report of academic portal

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.

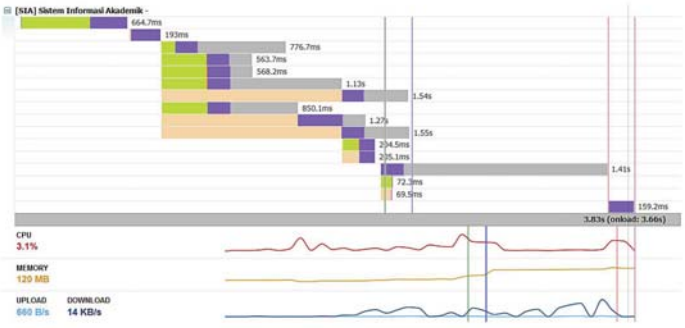

Fig. 3. Waterfall Chart: request-by-request visualization of the page load

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.

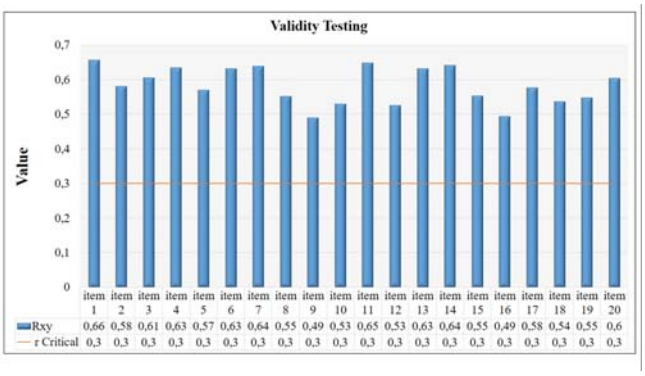

Fig. 4. Results of the validity test analysis

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
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.

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