

ISO/IEC 9126 Quality Model for Evaluation of Student Academic Portal

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Abstract—The papers discuss and evaluate the quality of student academic portal using ISO / IEC 9126 quality modeling approach. Quality factors are tested and analyzed are characteristics of Usability, Reliability, Efficiency, and Portability, this evaluation is very important, considering the number of users of the portal system so much and growing. One of the efforts to improve and optimize the performance of the academic Information System Management team. Evaluate the quality of the user perception approach 10 principles of usability heuristics and internal site performance testing or web server. The results of analysis and testing of 4 quality characteristics have issued several recommendations for improvement and optimization of the performance of student academic portals.

Keywords—ISO/IEC 9126, performance, heuristics, website.

I. INTRODUCTION

Software quality can be assessed through certain measures and methods, as well as through software tests. The various definitions of software quality depend on which user's point of view defines and views according to their individual needs. According to Crosby [1] defines quality or quality as "conformance to requirements". As long as one can argue about the difference between needs, wants and desires, the definition of quality must take into account the perspective of the user.

The key question for a quality definition is who the wearer is, what matters to them and how does his priority about what method is built, wrapped to support a product. To answer that question, we must recognize the hierarchy of software quality. First, a software product must provide the same function and type of time when the user needs it. Second, the product must be running. If the product has a defect then the product is, of course, no consistency of eligibility. The users will not use it by ignoring the attributes that accompany it. This does not mean that disability is always the main priority in rejecting a product but it will be very important in seeing whether or not it is appropriate.

If the minimum defect rate has not been reached, then there is nothing to consider. Beyond the threshold of quality, however, something related to the consideration and assessment of the defects of a software product as well as its usefulness, suitability, ability, and others depends on the user

looking at and evaluating it including its application and the accompanying software environment [2].

One of the software quality benchmarks is ISO 9126, created by the International Organization for Standardization (ISO) and the International Electro-technical Commission (IEC) [3], [4]. ISO 9126 defines the quality of software products, models, quality characteristics, and related metrics used to evaluate and determine the quality of a software product [3], [4]. The ISO 9126 standard has been developed in an effort to identify key attributes of quality for computer software. Quality factors according to ISO 9126 include six quality characteristics, i.e. Functionality, Reliability, Usability, Efficiency, Maintenance, and Portability.

Comparison of the quality models of McCall, Boehm, Dromey, FURPS, BBN, Star, and ISO 9126 according to [5], the results show that the ISO / IEC 9126 quality model is stated to be more complete and useful. Two main reasons are found in the literature. First, Behkamal [5] states the ISO 9126 model looks more complete than other models and free of other shortcomings. Secondly, Al-Qutaish [6] states that the ISO 9126 quality model is built on international approval.

Website utilization as an online data and information management software has been generated different points of view from the user group (user). To optimize the quality of the website, it is necessary to evaluate the needs of software quality. Website quality evaluation is important to ascertain whether the website has met the needs, expectations and end-user goals.

This paper will discuss and evaluate the quality of one of the student academic portals using the ISO 9126 quality model approach, Quality factors according to ISO 9126 to be discussed and analyzed are quality characteristics, i.e. Usability, Reliability, Efficiency, and Portability, this evaluation is very important, considering the number of users of the system is so many and growing, one of the efforts to improve and optimize the performance of academic management. Evaluation of student academic portals will be analyzed with approaches from user perceptions and portal system applications.

II. RESEARCH METHODOLOGY

A. Data Collection Methods

Data collection methods in this paper using:

- Questionnaires, provides a set of questions or written statement to the respondent to be answered. Respondents are students, as many as 120 students as samples will provide a scaled assessment of the student academic portal. The result of the questionnaire will be an assessment for evaluation.
- Observation, conduct testing using a website or web server performance measurement tool to determine the behavior of student academic portals. The tool used is GT-Metrix to test the quality of efficiency and Web Server Stress tools to measure the quality of reliability.

B. Variables

The variables that will be used in this paper are independent variables. These variables are explained based on the characteristics of the ISO 9126 model with the 10 Heuristic method approach, shown in TABLE I. Variables for testing portal applications using recommendation parameters from Google Page-Speed and YS-low Yahoo.

TABLE I. 10 USABILITY HEURISTICS VARIABLE

Usability Heuristics Variable	Criteria Indicators	Question Number
Visibility of system status	Consistency of view and content	1
	Information Clarity and Status	1
	Feedback System	2
Match between the system and the real world	User Habits Using the System	3
	Color Selection	3
	Use of Words and Languages	4
User control and freedom	Ease of Use	6
	Usage Controls	6
	Operation Cancellation	5
Consistency and standards	Standard Format Design	7
	Standard Formats of Numbers and Alphabets	7
	Color Usage Standards	7
	Consistency of Content and Navigation	9
	Navigation Format Standards	8
Error prevention	Avoiding Error Messages	13
	Use of Keys and Navigation	12
	System Response to Users	12
Help users recognize, diagnose, and recover from errors	Error Information	
	Use of Instructions	11
Recognition rather than recall	Object Clarity and Layout	14
	Ease In Getting Directions	14
	Application of Color In System	14
Flexibility and efficiency of use	Error Message Display	10
	Freedom of Action User Against the System	15
	Availability of Functions	16
Aesthetic and minimalist design	Display Information is Simple and Easy to Understand	18
	Use of Objects and Icons	17
	Menu Order Specifications	18
Help and documentation	Use of instructions on the system	20
	System Navigation Support	19
	Ease of Getting Information	20

C. Instrument Testing

Testing instruments in the questionnaire uses validity and reliability tests. Testing the validity of data using Pearson product moment correlation coefficient [7], [8]. According to [9] a question is said to be valid and can measure the research variables in question if the validity coefficient is more than or equal to 0.3 to simplify the process of calculating the correlation coefficient, then, Reliability test, this research using Alpha reliability coefficient [10].

Internal reliability testing using to test the consistency of an answer. SPSS provides facility facilities to measure reliability with Cronbach's alpha test statistics. It's suggested that reliability estimates in the range 0.7-0.8 are good enough in basic research. After testing the validity and reliability, the t test item questionnaire will be examined, this test is done to see how big influence between each item refer to [11].

D. Measurement Scale

Assessment criteria for instruments use a Likert scale [10] giving 5 answer choices. Likert-rating criteria can be seen in Table II.

TABLE II. THE WEIGHT ANSWER QUESTIONNAIRE RESPONDENTS

Answer	Value
Problems at all	0
a little problem that doesn't need to be fixed	1
Small problems whose improvements are low priority	2
Problems that must be fixed and become a high priority	3
Very Important To Fix	4

E. Testing for Characteristic Efficiency

This test uses the GT-Metrix [12], measuring tool developed by GT.net, this tool uses a combination of Google Page-Speed Insights and YS-low to generate value and recommendations.

The basic parameter used is the document size, http request, so as to obtain a predetermined Grade from the measuring instrument. After getting score from test result then calculated percentage with formula of percentage and interpretation according to recommendation of Yahoo Developer Network [13] shown in TABLE III.

TABLE III. DATA ANALYSIS OF GRADE EFFICIENCY TESTING

Score	Grade
A	90 <= S <= 100
B	80 <= S < 90
C	70 <= S < 80
D	60 <= S < 70
E	50 <= S < 60
F	0 <= S < 50

F. Testing for Characteristic Reliability

This test uses the Webserver Stress Tool developed by PAESSLER AG [14]. The tool simulates the HTTP requests generated by hundreds or even thousands of simultaneous users, we can test web server performance under normal and excessive loads to ensure that critical information and

services are available at speeds end-users expect [14].

The parameters used are failed session, failed pages, and failed hits. The “equation (1)” for calculating the reliability values according to the Nelson model [15]. Reliability aspects are tested using the help of the Webserver Stress Tool. Based on the results of the test, you will get successful access data and failed access. The data is then converted into a percentage form. The percentage results are then compared to the TELCORDIA standard. According to TELCORDIA standards, 95% or more of the tests planned for the system must be successful [16].

III. TESTING AND ANALYSIS RESULTS

A. Analysis of Usability Test

Based on the validity and reliability test of the questionnaire that has been disseminated on 120 respondents, The results of the data show that from 20 questionnaire items have a validity coefficient greater than the critical r that is 0.3, so it can be concluded that 20 other instrument items stated otherwise valid, which means the items used in the questionnaire to measure the indicator can represent the theory and able measure what should be measured, so that it can be included in the next analysis.

The results of reliability test presented on TABLE IV, it is known that the variable usability heuristic approach, all items in the questionnaire indicator is reliable because the value of reliability coefficient greater than 0.70 that is 0.928 which means usability variable heuristic or reliable approach.

TABLE IV. RELIABILITY STATISTICS

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.893	.898	20

According to [11], for hypothesis testing the average of one party either the right or left-handed test, if the value of σ 2 is unknown then use the student t-test statistic, with the result for each item of each usability indicator.

The result of calculation with alpha (α) = 0.05 and degrees of freedom (DB) $n-1 = 120-1 = 119$ obtained the table of 1.65776 with the acceptance test criteria H_0 if $t\text{-count} \leq -t\text{-table} (5\%, 119)$, reject H_0 in terms of other. If the value of $t\text{-count} < -t\text{-table} (5\%, 119) = -1.65776$, then H_0 is rejected means there is no problem on the Student Portal Student item, whereas if $t\text{-count} > -t\text{-Table} (5\%, 16) = 1.65776$, then H_0 accepted which means there are problem on student academic portal item. After 20 items were tested using t-test, out of 20 items, there was no problem in student academic portal.

Once known items that have problems then stage next is to determine the level problems. To determine level of the problem, carried out the assessment level of evaluation problem heuristics based on scores maximum of each answer weight. The division of the category level interval the problems are presented in TABLE V.

TABLE V. INTERVAL CATEGORY LEVEL HEURISTIC EVALUATION PROBLEMS

Interval Category		Level of Problems
lower limit	upper limit	
	96	Problems at all
97	192	a little problem that doesn't need to be fixed
193	288	Small problems whose improvements are low priority
289	384	Problems that must be fixed and become a high priority
385	480	Very important to fix

Based on TABLE V, it can provide an assessment of the category of heuristic evaluation problem level on the results of hypothesis research through one sample t-student test, obtained some items on each reusability that there are problems that need to follow-up improvements in the Student Academic Portal. Each item that problem is calculated the value of the score per item then score value compared to TABLE V, then obtained the assessment of heuristic problems based on the scores of each indicator.

TABLE VI. ASSESSMENT OF LEVELS OF HEURISTIC EVALUATION PROBLEMS

Item	Score	Category
20. There is a reminder aid for commands, through online references on student academic portals or others	220	Small Problems that fixes are low priority
5. Users may cancel operations or processes that are running on the student academic portal	205	Small Problems that fixes are low priority
13. The student academic portal system prevents users from making mistakes and will remind them if they make a serious mistake	200	Small Problems that fixes are low priority
18. All the icons on the student academic portal are different conceptually and visually	196	Small Problems that fixes are low priority

Based on TABLE VI, the reusability of the student academic portal is actually not much of a problem that needs to be upgraded. However, there are 4 items that have minor problems that the improvement is a low priority so there is a need for improvement recommendations although having low priority.

TABLE VII. REKOMENDASI SISTEM

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 the findings of the problems in TABLE VI, the recommendation of improvement of academic portal system of students on TABLE VII, presents recommendations that can be used as future reference for the category of problems that the improvement is low.

B. Analysis of Reliability Test Results

The result of reliability test using Webserver Stress Tool with simulation:

Test Type: CLICKS (run test until 10 clicks per user), User Simulation: 500 simultaneous users - 10 seconds between clicks (Random). The Webpage measurement results (per URL) can be seen on TABLE VIII.

TABLE VIII. RESULTS PER URL

Name URL	Clicks	Errors	Errors [%]	Time Spent [ms]	Avg. Click Time [ms]
Index	140	0	0	520.259	3.716
KHS	155	0	0	547.101	3.530
KRS	137	0	0	415.952	3.036
Curriculum	179	0	0	461.560	2.579
Lecturer Evaluation	136	0	0	363.822	2.675
Sum	747			461.739	3.107

TABLE VIII presents the data of simulation result of web page performance with predefined user number, obtained by measurement value of 747 successful clicks with 0 errors, Avg. click times with value 3.107ms and Time spent with value 461.739ms. Calculation of reliability value according to equation [15]. The result shows that the value of $R = 1$ or the percentage of reliability value is 100% and $r = 0.0$ or the error rate is 0%.

According to TELCORDIA standard that has been discussed by A Asthana and Jack O [16], software reliability success is 95% or 0.95, so based on the benchmark, and from the value of R obtained then testing Reliability of Student Academic Portal can be stated "accepted" according to TELCORDIA standards.

Furthermore, the graph of open requests Transferred data and system memory, CPU load can be seen in "Fig. 1".

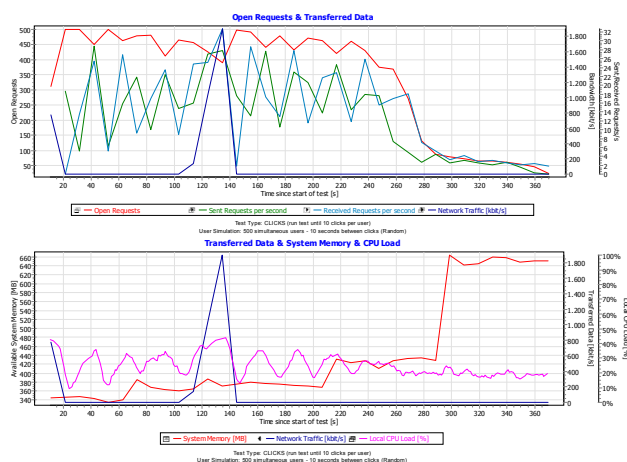


Fig. 1. Requests, Transferred data and system memory, CPU load

Additional testing is done to determine the level of ability and threshold of the user on the system, conducted simulation testing by raising the value on the number of users. and the threshold test results are found when the number of users is 1000. Reliability value calculation results for 1000 users, the percentage of error rate of 99.218%. Avg. click time of 3.624ms

C. Analysis of Efficiency Test Results

Based on the analysis and calculation of efficiency testing of portal: sia-dev.unmul.ac.id using GT-Metrix tool. The grade and score as shown in "Fig. 2" for the performance of Page-Speed score D (66%) and YS-slow score D(67%).

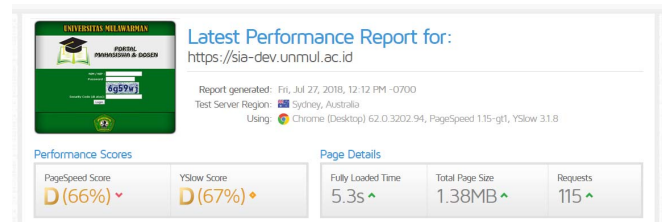


Fig. 2. Performance report of academic student portal

In detail, the performance of the Page-Speed test results is presented in "Fig. 3", and for the details of the YS-low test results are presented in "Fig. 4".

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 header	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 the order of styles and scripts	A (100)	CSS/JS	HIGH
Put CSS in the document head	A (100)	CSS	HIGH
Serve resources from a 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

Fig. 3. Recommendation and grade of pagespeed results

The performance of the Page-Speed test results on "Fig. 3", there are recommendations of Enable GZIP compression in grade F (0), Leverage browser caching grade D (63), Minify CSS grade D (66), and Optimize images with grade C (77).

PageSpeed	YSlow	Waterfall	Timings	Video	History
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 (64)	CONTENT	HIGH	
▼ Avoid HTTP 404 (Not Found) error		A (65)	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 AlphaImageLoader 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 (ETags)		A (100)	SERVER	LOW	
▼ Make JavaScript and CSS external		(99)	CSS/JS	MEDIUM	

Fig. 4. Recommendation and grade of yslow results

The performance of YS-low test results based on Figure 4, is generally in grade A category, and there is recommendation of Add Expires headers that are still in F grade (0), Compress components with GZIP with grade F (12), Use a Content Delivery Network (CDN) F (10), and Use cookie-free domains grade E (55).

From the score obtained, the software quality developed from the efficiency measurement side (Page-Speed and YS-low) generally get "Grade A", it is stated that the performance analysis of Academic Student Portal in efficiency characteristics has passed the testing.

The Response-time limits to keep the user's attention can wait for the load of the web page is 10s [15]. Whereas according to [17-23] the best load time a website page is less than 3s, for an acceptable load time of less than 10s.

The graph of the response-time measurement shown in "Fig. 5", obtained the average time load of about 5.29s (on-load: 5.09s) with the number of requests of 155 and with the data of 1.4 MB. Based on the data, the time load can be said to be "accepted" by referring to recommendations J Nielsen [15] for an acceptable time load of fewer than 10s.

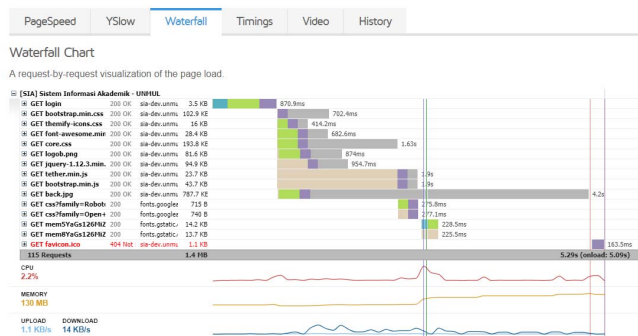


Fig. 5. Response-time load requests webpage of academic student portal

D. Portability Testing

Portability test is done by running the application on the browser directly and using the browser tester online at www.browserstack.com. Testing is done on Google Chrome browser, Mozilla Firefox, Internet Explorer, Safari, Opera and on smartphone devices, tablets, and other mobile-based devices. Student portal test results can run without an error. So the quality of portability characteristics is good and fulfilling because the application can run on different browsers without encountered an error.

IV. DISCUSSION AND CONCLUSION

Quality factors according to ISO 9126 are discussed and analyzed are quality characteristics of Usability, Reliability, Efficiency, and Portability. Based on the results of analysis and testing that have been done, it can be concluded that:

- Usability Characteristic, recommendations based on Heuristic 10 analysis in the Small Problems category that fixes are low priority.
- Reliability Characteristic, the value of R 100% (accepted), with simulated 500 users. the user's capability and threshold level occurs when simulating 1000 users with a percentage error rate 99.218%.
- Efficiency Characteristic, performance of Page-Speed recommendation score Grade D (66%), and recommendation YS-low score grade D (67%). The response-time obtained the average time load of about 5.29s (on-load: 5.09s) with the number of requests of 155 and with the data of 1.4 MB
- Portability Characteristic, the academic student portal test results can access without an error, the application can run on different browsers without encountered an error.

Knowing the quality of the software can help the Academic Information Systems Division (ICT Team) in assessing the system and improving, planning the determination of future application development cost budgets.

Furthermore, solutions that can be done to optimize performance and improvements on efficiency characteristics that still grade score D, are:

- Enable GZIP compression, Reduce the size of files sent from your server to increase the speed to which they are transferred to the browser, Increase page speed, Cost-benefit ratio: high, Access needed to the .HTACCESS files or server administration files.
- Leverage browser caching, Page load times can be significantly improved by asking visitors to save and reuse the files included in portal.
- Minify CSS, Compacting CSS code can save many bytes of data and speed up downloading, parsing, and execution time.
- Optimize images, Reduce the load times of pages by loading appropriately sized images. Reduce file sizes based on where images will be displayed, resize image files themselves instead of via CSS, save files in appropriate format depending on usage.

- Add Expires headers, expires headers let the browser know whether to serve a cached version of the page, Reduce server load, and decrease page load time.
- Use a Content Delivery Network (CDN), CDNs can give an equally fast web experience to users across the globe.
- Use cookie-free domains, serve static content from a different domain to avoid unnecessary cookie traffic.

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