Efficiency and Reliability Performances of the Bioinformatics Resource Portal

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Efficiency and Reliability Performance's of the Bioinformatics Resource Portal

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***Abstract*—The paper discusses the resource portal of the Borneo's Biodiversity Information System (BBIS) from the point of view of the characteristics of efficiency and reliability performance. Data collection methods and tools use the observation approach that simulates 100 simultaneous users, logging every 10 seconds between random clicks on the URL site. Efficiency testing results based on 27 recommendations from Page-Speed instruments and 19 recommendation parameters from YS-low, obtained average scores on grade A. However, there were still 6 parameters related to system resource issues with score is grade F. Reliability test results referring to Jacob Nelson's equation approaches and Standard TELCORDIA reference. The result shows that the value of R = 0.988967 or the percentage of the reliability value is 98.89% and r = 0.011 or the error rate is 1.1%. The user threshold test results are found when the number increases to 500 users. The success of efficiency testing parameters significantly affects the percentage of performance reliability.**

Keywords—biodiversity, performance, efficiency, reliability.

I. INTRODUCTION

Biological diversity (biodiversity) can be translated as all living things on earth, including all plant species, animals and microbes. The species within biodiversity relate to each other and need other to grow or bloom form a living system [1].

Indonesia as an archipelagic country has 13,466 islands, scattered along the tropical equatorial line [2]. One of the largest islands is Borneo known as Kalimantan for the Indonesian territory with high rainfall and humidity, geological events, and geography, Indonesia has many rare plants and species and endemic species that can live and maturate.

The greatest challenge in biodiversity management is to maintain a balance between sustainability (ecological) and sustainable benefits (economic). This challenge is not easy to deal with. This is because most of the biodiversity is a cross-border administrative resource and is managed by various parties/sectors. There is considerable pressure from utilization forest and forest products beyond their carrying capacity. Biodiversity is now diminishing on an alarming scale. Species by species disappear faster than the discovery of new species, and also the potential value of the creature for the future just disappears [3],[4], [5].

Regard this, it requires follow-up in the form of data handling and monitoring activities so that the sustainability of the biodiversity of the plant can be maintained for its sustainability, then developed a biodiversity information system of plants in the rain forest of Kalimantan-Borneo in an effort to integrate the data that has been collected from various sources.

The Borneo Biodiversity Information System (BBIS) that has been built [5], [6], is an open source information system of Borneo island information management systems. The modules developed in BBIS have been able to accommodate all data management and information on biodiversity of plants in the rain forest of Kalimantan, from front desk process to back office (transaction & interaction enabler).

According to Riaz Ahamed's research [7]," Software testing is a critical element of software quality assurance and represents the ultimate review of specification, design and coding. Software testing is the process of testing the functionality and correctness of software by running it. Software testing is usually performed for one of two reasons: defect detection, and reliability estimation" [7].

Further explains that, the problem of applying software testing to defect detection is that software can only suggest the presence of flaws, not their absence (unless the testing is exhaustive) [7]. The problem of applying software testing to reliability estimation is that the input distribution used for selecting test cases may be flawed. The key to software testing is trying to find the modes of failure - something that requires exhaustively testing the code on all possible inputs [7].

One of the software quality benchmarks is ISO 9126 [8], created by the International Organization for Standardization (ISO) [9] and International Electro-technical Commission (IEC). ISO 9126 defines the quality of software products, models, quality characteristics, and related metrics used to evaluate and define the quality of a software product. The ISO 9126 standard has been developed in an attempt to identify key quality attributes for computer software. Quality factors according to ISO 9126 include Six Quality Characteristics, the model itself is characteristics functionality, reliability, usability, efficiency, maintainability, and portability [10], [11], [12].

This paper will discuss the performance evaluation of a BBIS that focuses on the efficiency and reliability characteristics in software capabilities to maintain certain performance levels, when used under certain conditions, and the efficiency in software capabilities to deliver performance as appropriate and relative to the amount of resources used at the time conditions.

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II. Background and Related Work

A. Borneo Biodiversity Information System

The development of plant biodiversity information systems in the Borneo island rainforest has been discussed and developed by various approaches and methods, research that has been discussed about; development of plant database management system that discusses plant name taxonomy referring to International Code of Botanical Nomenclature (ICBN) [13], Ethnobotany database: Exploring diversity medicinal plants of Dayak tribe Borneo [14]. Biodiversity information system: Tropical rainforest Borneo and traditional knowledge ethnic of Dayak [15]. Borneo biodiversity in [5], the paper about is Exploring endemic tree species and wood characteristics. The author has also discussed in [6] about the implementation of the six concepts of association owned by Eloquent ORM (i.e. One to One, One to Many, Many to Many, Many Through Many, Polymorphic Relation, and Many to Many Polymorphic Relation) [6].

B. Network Performance Testing

According to [16], performance tests are used to test each part of the webserver or the web application to discover how best to optimize them for increased web traffic, this is done by testing various implementations of single web pages to check what version of the code is the fastest. This type of test is run without requesting page images in order to concentrate the testing on the code-script and itself [16].

The server performance issues and availability of existing networks in the Borneo area, we have also analyzed and discussed them in previous research, among others; the paper [17], the study was conducted using a mobile device and implemented in seven districts and four points in every district in the city of SAMARINDA, East Borneo. Measurements using the standard quality of TIPHON with some parameters such as end-to-end delay, jitter, packet loss probability and throughput [17]. The paper [18] about the broadband quality of service experience measuring mobile networks from consumer perceived, this paper provides an overview of the quality of service experience from the viewpoint of the customer's perceived of mobile broadband services.

The user perceptions of mobile internet services performance in Borneo on the [19], the study tries to assess the Quality of Service (QOS) for mobile internet services in the ways assessment involves identifying user perception to assess consumer experience of the mobile internet services. The information from the survey pertains to the awareness levels among consumers regarding their data plans overall satisfaction, Indonesia Telecommunication Regulatory Authority (BRTI) and its regulations on QOS [19]. The network performance measurement related to the content of the application has been discussed in the paper [20], this paper discussion of performance rate for implementation of mobile learning in network. And the paper [21] about Mobile learning: Visualizing contents media of data structures course in mobile networks [21].

III. Methodology

A. Data Collection Methods and Tools

The data collection method used is the observation technique, which performs the measurement and direct test of the field using a measuring instrument to test the performance capabilities of BBIS applications that have been developed. The performance characteristic and data collection tool used as follows:

B. Testing for Characteristic Efficiency

This test uses the GT-Metrix [22], measuring tool developed by GT.net, a Canadian company, which aims to help customer hosting to see website performance, is one tool to check website speed. 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 [23] shown in TABLE I.

TABLE I. Data Analysis of Grade Efficiency Testing [23]

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

[23]source: http://yslow.org/ruleset-matrix/

C. Testing *for Characteristic Reliability*

This test uses the Webserver Stress Tool developed by Paessler AG [24]. Webserver Stress 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 [24], [25].

The parameters used are failed session, failed pages, and failed hits. The “equation (1)” for calculating the reliability values according to the Nelson [23] model is as follows:

$$R = \frac{n}{n-f} = 1 - \frac{f}{n} = 1 - r \qquad (1)$$

Where: R = Reliability
n = Number of workload units
f = Total number of failures
r = The failure rate

IV. Testing and Analysis

Borneo's Biodiversity Information System (BBIS) was developed using the PHP Framework LARAVEL, which has a Model View Controller design pattern, and Eloquent Object Relational Mapping that can store biodiversity data of plants with the application of six relationship concepts. Implementation of development result Borneo’s Biodiversity information system online can be accessed site

URL: http://borneodiversity.org/, the BBIS main menu view can be seen in "Fig. 1".

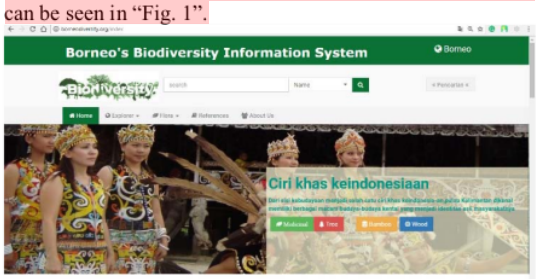

Fig. 1. Webpage of borneodiversity.org

To date, BBIS has stored 233 records of Medicinal Plants, 1482 records of Tree species, 86 records of Wood species and characteristics, 80 records of Bamboo species.

A. Analysis of Efficiency Testing

Based on the analysis and calculation of efficiency testing of website:borneodiversity.org using GT-Metrix tool, then the Grade and score as shown in TABLE II for recommendation of Page-Speed and TABLE III for recommendation of YS-low.

TABLE II. PERFORMANCE SCORE OF PAGESPEED PARAMETERS [22]

Recommendation	Grade/Score	Type
Serve scaled images	F (0)	images
Optimize images	F (0)	images
Leverage browser caching	F (0)	server
Minify JavaScript	E (52)	JS
Avoid bad requests	A (92)	content
Defer parsing of JavaScript	A (94)	JS
Minify CSS	A (98)	CSS
Minify HTML	A (98)	content
Specify a character set early	A (99)	content
Specify image dimensions	A (99)	images
Specify a Vary: Accept-Encoding header	B (88)	server
Avoid landing page redirects	A (100)	server
Enable GZIP compression	A (100)	server
Enable Keep-Alive	A (100)	server
Inline small CSS	A (100)	CSS
Inline small JavaScript	A (100)	JS
Minimize redirects	A (100)	content
Minimize request size	A (100)	content
Optimize the order of styles and scripts	A (100)	CSS/JS
Put CSS in the document head	A (100)	CSS
Serve resources from a consistent URL	A (100)	content
Specify a cache validator	A (100)	server
Combine images using CSS sprites	A (100)	images
Avoid CSS @import	A (100)	CSS
Prefer asynchronous resources	A (100)	JS
Avoid a character set in the meta tag	A (100)	content
Remove query strings from static resources	A (100)	content

Based on the analysis and performance test results for Page-Speed presented in TABLE II, the average percentage range of 92-100% (grade A) is available, there are 3 recommendation metrics that are still 0 with grade F (*Serve scaled images, optimize images,* and *Leverage browser caching*), and for *Minify JavaScript* metrics obtained 52% value (grade E). So it can be said that the software has a very high efficiency value, from the score obtained then the quality of the software developed from the side of the measurement Page-Speed efficiency mostly get "grade A" if adjusted to the rules recommended [23].

TABLE III. PERFORMANCE SCORE OF YSLOW PARAMETERS [23]

Recommendation	Grade/Score	Type
Add Expires headers	F (0)	server
Use a Content Delivery Network (CDN)	F (0)	server
Make fewer HTTP requests	D (60)	content
Use cookie-free domains	F (0)	cookie
Minify JavaScript and CSS	C (70)	CSS/JS
Avoid HTTP 404 (Not Found) error	A (95)	content
Reduce DNS lookups	A (95)	content
Compress components with GZIP	A (100)	server
Avoid URL redirects	A (100)	content
Make AJAX cacheable	A (100)	JS
Remove duplicate JavaScript and CSS	A (100)	CSS/JS
Avoid Alpha-Image-Loader filter	A (100)	CSS
Reduce the number of DOM elements	A (100)	content
Use GET for AJAX requests	A (100)	JS
Avoid CSS expressions	A (100)	CSS
Reduce cookie size	A (100)	cookie
Make favicon small and cacheable	A (100)	images
Configure entity tags (ETAGS)	A (100)	Server
Make JavaScript and CSS external	(n/a)	CSS/JS

Based on the analysis performance results for YSlow presented in TABLE III generally obtained average percentage range 95-100% (grade A). There are 3 recommendations that are still worth 0 with grade F that is add expires headers, use a CDN and use cookie-free domains, and minify JAVASCRIPT and CSS are 70% (grade C) and Make fewer HTTP requests are 60% (grade D). So it can be said that the software has an average value for testing High category YSlow.

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 Borneo Biodiversity information system inefficiency characteristics has passed the testing.

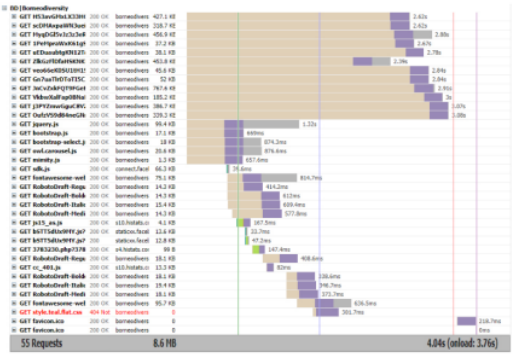

Fig. 2. Response-time load webpage of borneodiversity.org

The Response-time limits to keep the user's attention can wait for the load of the web page is 10s [26]. Whereas according to [27] the best load time a website page is less than 3 second, for an acceptable load time of less than 10s.

The Graph of the response-time measurement shown in "Fig. 2", obtained the average time load of about 4.04s (on-load: 3.76s) with the number of requests of 55 and with the data of 8.6 MB. Based on the data, the time load can be stated to be "accepted" by referring to recommendations J Nielsen [26] for an acceptable time load of fewer than 10s.

B. *Analysis of Reliability Testing*

Reliability testing is done using Webserver Stress Tool version 8.0.0.1010 Enterprise Edition (Freeware), with test scenario following [16], as:

- Test Type: CLICKS (run test until 10 clicks per user), the test is finished when each user has initiated the given number of clicks. Clicks tests to test specific URL sequences, on this test URL: http://borneodiversity.org/
- User Simulation: 100 simultaneous users – 10s between clicks (Random)
- Logging Period: Log every 10s
- URL Sequencing: Users select URL for each click randomly
- Browser Simulation: HTTP Request Timeout: 120s
- System: Windows 8/2012 V6.2 (Build 9200), CPU Proc. Lev. 686 (Rev. 19971) at 2400 MHz,
- Memory: 445 MB available RAM of 4182 MB total physical RAM, 2852 MB available *Page-file*.

Based on testing the performance of the URL that has been done. The graphs of click time and errors per (URL) in "Fig. 3", and click time, Hits/s, users / s (all URLs) are shown in "Fig. 4".

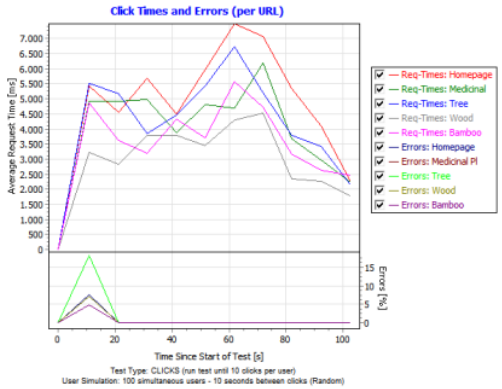

Fig. 3. Click time and errors per (URL)

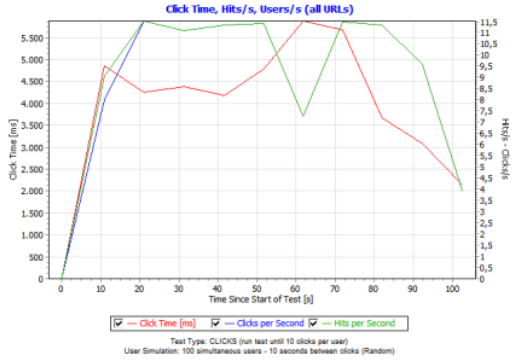

Fig. 4. Click time, hts/s, users/s (all URLs)

Furthermore, the resulting measurement value as presented in TABLE IV.

TABLE IV. WEBPAGE PERFORMANCE RESULTS PER URL WITH 100 SIMULTANEOUS USERS

Page (URL)	Clicks	Errors	Errors (%)	Time Spent (ms)	Avg. Click Time (ms)
Homepage	196	1	0,51	1.067.967	5.477
Medicinal	220	4	1,82	980.660	4.540
Tree	200	4	2,00	923.998	4.714
Wood	204	1	0,49	665.737	3.279
Bamboo	177	1	0,56	689.501	3.918
Sum	997	11	1,1	865.572	4.385

TABLE IV presents the data of simulation result of web page performance with predefined user number, obtained by measurement value of 997 successful clicks with 11 errors, Avg. click times with value between 3.279ms – 5.477ms and Time spent with value between 665.737ms – 1.067.967ms, mean value from Avg. click times is 4,385ms and the mean value of Time spent is 865,572ms.

Calculation of reliability value can be obtained by "equation (1)", as follows:

$$R = 1 - \frac{f}{n} = 1 - \frac{11}{997} = 1 - 0{,}011 = 0{,}988967$$

The result shows that the value of R = 0.988967 or the percentage of reliability value is 98.89% and r = 0.011 or the error rate is 1.1%.

According to TELCORDIA standard that has been discussed by A Asthana and Jack O [28], software reliability success is 95% or 0.95, so based on the benchmark, and from the value of R obtained then testing Reliability of Borneo's Biodiversity Information System can be stated "accepted" according to TELCORDIA standards.

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 500. The test results are presented in TABLE V.

TABLE V. WEBPAGE PERFORMANCE RESULTS PER URL WITH 500 SIMULTANEOUS USERS

Page (URL)	Clicks	Errors	Errors (%)	Time Spent (ms)	Avg. Click Time (ms)
Homepage	958	955	99,69	8.841	2.947
Medicinal	968	965	99,69	9.724	3.241
Tree	1.018	1.014	99,61	15.602	3.901
Wood	1.026	1.020	99,42	18.589	3.098
Bamboo	1.026	1.023	99,71	9.996	3.332
Sum	4996	4977	99,624	12.550	3.303

Reliability value calculation results for 500 users, in TABLE V, the percentage of error rate of 99.624%. Avg. click time of 3.303ms.

C. *Evaluation of Efficiency & Reliability Testing*

Borneo's Biodiversity Information System performance analysis from testing of efficiency characteristics (recommendation of Page-Speed and YSlow) which relate to the ability of the software to provide appropriate performance to the number of resources used in certain circumstances still need to be repaired. Such as serve scaled and optimize images, make fewer HTTP requests and use

cookie-domain, minify JavaScript/CSS, use a content delivery network (CDN), and leverage browser caching.

Aspects of reliability characteristics, software capability of the BBIS to maintain its performance when used under certain conditions, by simulating testing on the number of users and click on webpage - URLs randomly. Reliability analysis results show that the software capability of BBIS with 100 user simulation is the highest limit of system capability to the number of user resources, it is highly influenced by the aspect of efficiency characteristics with very low parameter scores, for example on Serve scaled images and optimize images that require high time on-load

V. Conclusion

Borneo's Biodiversity information systems are one of the enterprise-scale systems that represent open-source plant-based taxonomy data, developed by the research team in a follow-up effort to manage the digital inventory of biodiversity data contained in the Rainforest of Borneo Island in terms of its monitoring can be preserved sustainability. The system has a large data content, with diverse types and characteristics of plants, of course, will affect system performance functionality in terms of data accessibility, use of resources, level of efficiency and reliability issues.

The amount of data capacity, writing long and repeatable script code, will have a direct impact on the request, Add Expires headers, and Use cookie-free domains will create long system load time and limited number of users in accessible data. The efficiency aspect must be properly addressed. Inefficient resource use can cause software performance to be sluggish.

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