

Quantitative analysis in a heuristic evaluation of web-based encyclopedia for children

Gita Indah Marthasari, Nur Hayatin

Universitas Muhammadiyah Malang, Malang, Indonesia

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ABSTRACT

Anapedia is a web-based encyclopedia designed specifically for children. The web was built because there are still very few Indonesian-language encyclopedias for children. This paper presents an evaluation of the usability of the Anapedia website developed for children in Indonesia to retrieve information available in a wide range of areas. In the context of usability evaluation of children encyclopedia, this is the first study to analyze usability problems identified by experts during the heuristic inspection on their overall evaluation score. This evaluation, performed by seven usability experts, involved the identification and analysis of usability problems in the selected website. The assessment process was mainly based on the Sirius framework evaluation mechanism. The web considered as having high usability level, but they identified many usability problems for further improvement of the site. The most violated heuristic item was found to be "help" whereas the least violated heuristic item was "labelling" aspect.

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Corresponding Author:

Gita Indah Marthasari

Universitas Muhammadiyah Malang

Bendungan Sutami St. No.188, Sumbersari, Lowokwaru, Malang, East Java 65145, Indonesia

Email: gita@umm.ac.id

1. INTRODUCTION

Usability is one of the key success factors of a website that determines the ease or difficulty of users operating a website [1]-[3]. Besides the performance and reliability factors, usability is included as an important attribute of software quality [2]. According to International Organization for Standardization (ISO) 9241-11, usability is defined as "the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" [4], [5]. Usability is related to user experience when interacting with the system including the aspect of learnability, understandability, and operability [6], [7]. The usability level of the software can be measured using an automated or manual approach using tools or evaluations from end users or experts. These approaches can identify usability issues in terms of efficiency, effectiveness, and user satisfaction. The choice of evaluation method greatly influences the accuracy of the results which will inform the quality of the measured software. Usability evaluation is not only needed as a reference for the quality of the website (the lower value will affect the efficiency of use and user satisfaction), but also contribute for decreasing the risk of the result [8].

The application's interface is usually designed based on the perspective of the developer, so it is often not according to user needs [9]. Therefore, an evaluation of the user interface needs to be done to ensure that the interface is in accordance with user requirements. Based on the assessment mechanism, there are three categories of usability evaluation, namely: 1) User-based method, where the system user is involved

in the process of identifying usability issues. The purpose of this method is to measure the user performance or satisfaction when interacting with the system [10]; 2) Evaluator based method, where usability issues are identified by a group of evaluators. One is a heuristic evaluation that involves a group of experts to assess the user interface; and 3) Device-based method, where identification of problems related to the user interface is done using software [6]. The way this device works is to ensure that the system meets the specified usability standards.

Heuristic evaluation is the most popular method used in software usability measurement because it is fast and inexpensive. The method proposed by Nielsen and Molich involves a group of evaluators (generally numbering 3 to 5 people) who understand some of the principles of usability (known as 'heuristics') or who are usability experts [11]. These ten principles are still relevant and are widely used in evaluating software interfaces. Heuristic evaluation gives effective results when applied to software development iteratively even though it does not involve many evaluators, it is able to detect problems related to usability at the software interface [11], [12]. Heuristic evaluation methods can be applied to web-based software [13], [14] and mobile [15] both applying qualitative and quantitative approaches. Website evaluation using heuristic evaluation has been carried out by Rangraz, *et al.* [16] where heuristic evaluation is applied to evaluate the national health information system with the number of evaluators as many as five experts who judge based on the ten principles of Nielsen's usability; Inal [14] used a heuristic method to inspect the national library website where the evaluators involved were 57 students then combined with the System Usability Scale (SUS) and Net Promoter Score (NPS) methods. The heuristic evaluation used is able to detect most of the crucial usability issues in the system. However, there are not many studies that discuss the application of heuristic evaluation on children's encyclopedia web.

One of the heuristic evaluation methods that is comprehensive, empirical, and can be applied to websites with various types is the Sirius framework [17]. This framework covers ten aspects of assessment which includes general aspects, website identity and information, accomplishment of user interface, and search features. Furthermore, all aspects are then break down into 83 criteria [13], [17]. Compared with other quantitative heuristic evaluation methods [18]-[20], this framework can be used in evaluating several types of websites including educational websites, e-commerce, e-learning, institutions, government, and social media. In addition, the criteria are more comprehensive (representing all the principles of Nielsen's heuristic evaluation) and the results of the evaluation are quantitative values that state the level of website usability. Several studies have used this framework for evaluating usability including Aparna and Baseer [7] and Rodríguez *et al.* [21].

Anapedia is a web encyclopedia designed specifically for children [22]. The app was built because there are still very few Indonesian-language encyclopedias for children. Given the large number of school-age children in Indonesia, this website will be able to support the learning process of children. Anapedia Web has been tested using black-box testing to measure the performance aspects of the application. Based on the previous research, users still do not feel comfortable when adopting Anapedia because of the user interface. Even though, usability aspects have a strong connection with user readiness [23]. Therefore, in this study, we analyze the user interface of Anapedia from a perspective of an education website using the Sirius framework. The research questions in this study are: 1) What is the usability level of Anapedia's website according to Sirius framework evaluation; and 2) What are the usability problems of Anapedia.

2. RESEARCH METHOD

This section explains research methodology to answer research questions. The overall process is shown in Figure 1. The methodology is divided into three phases. First stage, a literature review process was carried out to obtain an overview of usability evaluation both manually and automatically in the usability evaluation of the children's encyclopedia website. Sirius has 10 assessment aspects (as shown in Table 1) and each aspect has sub-criteria so that the total criteria are 83 items [13]. Framework on Figure 2 is able to produce global usability values based on expert judgment while providing information about usability errors from websites based on their type. This information is useful for the website developer to improve the interface.

The evaluators provide an assessment of all criteria covering 10 aspects as shown in Table 1. There are 2 rating scales, i.e: 1) using the numbers 0 to 10 where a value of 10 is given if the criterion is fully achieved and a value of 0 if it is not met or a value between 0 and 10 according to the level of achievement of the website; 2) using labelling as shown in Table 2, where the value of YES if a criterion is achieved by the web or not conform in the whole site (NWS) if the web does not meet the criteria or values other than both, namely not conform in the main links (NML), not sustained in the home page (NHP), and not conform in one or more subpages (NSP). Not applicable criteria (NA) if the evaluator decides that an assessment criteria cannot be applied to the web. Each criterion is given a weight (critical/major/moderate/minor) where the

weight of each criterion is determined by the type of website to be evaluated. Based on the value given by the evaluator, global usability can be calculated using (1), where PU : usability percentage (%), nec : number of criteria evaluated (maximum number is 83, but not all of them are used depending on the type of website), sv : Sirius value (value of evaluator), wc : weighting coefficient (weighting for criteria calculated using (2)). For (2), rv is the weight value of each criterion. If the evaluator is more than one person, then the global usability value is obtained from the average calculation.

$$PU = \frac{\sum_{i=1, nec}(wc_i * sv_i)}{\sum_{i=1, nec}(wc_i * 10)} \times 100 \quad (1)$$

$$wc_i = \frac{rv_i}{\sum_{i=1, nec}(rv_j)} \quad (2)$$

In the second stage, the usability evaluation process uses two approaches that begin with developing an evaluation scenario. For automatic assessment, it is done by entering the Anapedia web URL (<http://anapedia.org>) into the Google PageSpeed web [24]. The manual assessment begins by determining the evaluator who will provide an assessment based on the criteria in the Sirius framework. Based on research from [11], [13], the number of expert evaluators involved in heuristic assessment is as many as five people. However, the evaluation in this study will be carried out by seven experts as evaluators. Furthermore, the manual evaluation uses the following scenario [12]:

- Review: Evaluators are given time to use the Anapedia website at <http://anapedia.org/>. For the search feature, the evaluator includes several keywords namely "photosynthesis", "plants", "snake", "sun", and "rainbow" in the text field provided.
- Evaluation: Evaluator observes search results. The evaluator evaluates the overall website interface based on 10 aspects in the Sirius framework.
- Rate severity: Evaluators give ratings for each criterion using a rating scale of 0 ... 10 or NWS ... YES.

The Anapedia web page is shown in Figure 3. The evaluator will enter the requested keyword in the column provided and press the "Search on Anapedia" button. The evaluator repeats the search process on Anapedia with different keywords. The evaluator then provides an assessment based on his experience interacting with the Anapedia website for a number of 83 Sirius framework criteria.

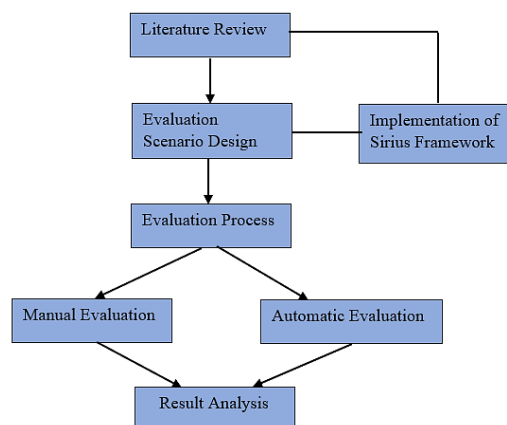


Figure 1. The Measurement model for evaluating Anapedia website

Table 1. Aspects used in the Sirius framework evaluation

Aspect	Description
General Aspects (GA)	Components related to the site target, look & feel, coherence, and intensity of content revising.
Identity dan Information (II)	Components related to the sufficiency of the information architecture and site navigation.
Structure dan Navigation (SN)	Components related to the site navigation and sufficiency of the information architecture
Labelling (LB)	Components related to the acquaintance of content labelling, importance and accuracy
Layout of the Page (LY)	Components related to the view and location of navigation and information components in the interface.
Comprehensibility dan Ease of Interaction (CI)	Components related to the quality and adequacy of icons, controls, and text contents of the interface.
Control dan Feedback (CF)	Components related to the navigation freedom, and information presented to the user in the interaction mechanism with the site.
Multimedia Elements (ME)	Components related to the multimedia contents to the site.
Search (SE)	Components related to the search facility applied in the site.
Help (HE)	Components related to the help feature prepared to the user while using the site.

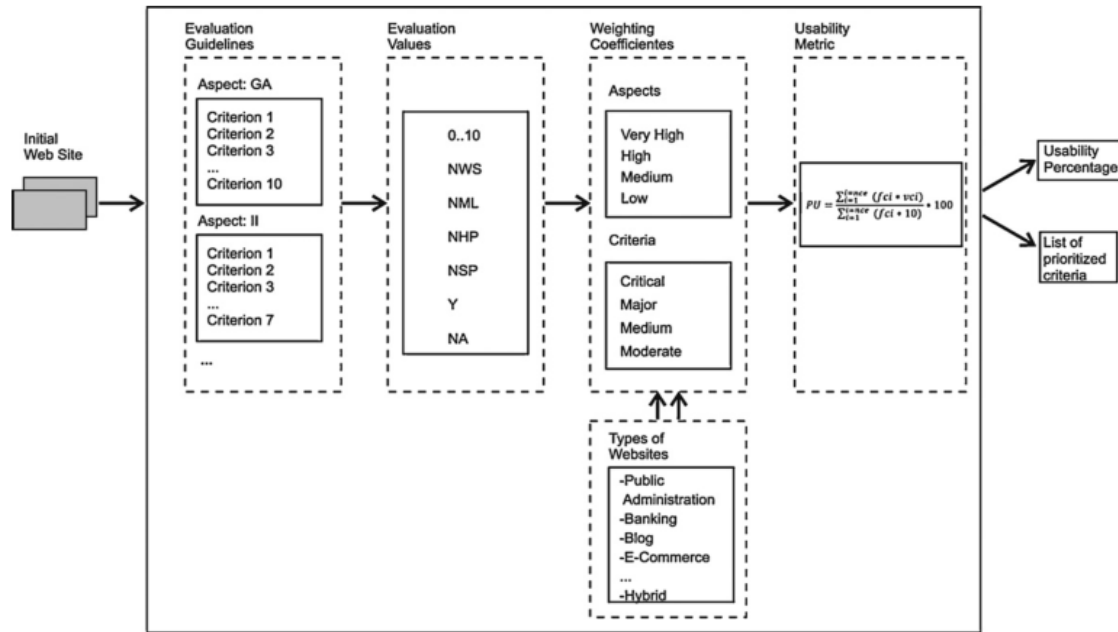


Figure 2. Usability level measurement process using Sirius framework [13]

Table 2. Assessment value of web usability

Value	Definition	Numeric Value
0..10	0: not conform at all, 10 : fully conform	0, 1, 2, ..., 9, 10
NWS	Not conform in the whole site	0
NML	Not conform in the main links	2.5
NHP	Not sustained in the home page	5
NSP	Not conform in one or more subpages	7.5
YES	Fully conform	10
NA	Not applicable criteria	-



Figure 3. Anapedia homepage

3. RESULTS AND ANALYSIS

3.1. Calculating global usability

In the third phase, a calculation is performed to determine the global usability value of the Anapedia web. Based on the content and objectives, the Anapedia website is included in the education web. Examples of global usability calculations from one evaluator for GA and II aspects can be seen in Table 3 (see in Appendix). The *ev* is the evaluation value given by the evaluators, *sv* is the conversion of the evaluator value, *rv* is the relevant criterion value for the educational web type, and *wc* is the weight coefficient of each

criterion. Then the final value for each criterion is calculated, these values are then added to the *fav* value. Based on the table, the global usability value of evaluator one is 94.66% (shown in Table 3 in the % usability column). The same steps are applied for the other six evaluators. Based on the results of the evaluations of all evaluators, an average global usability value of 81.4% was obtained which means that the usability of Anapedia's website is included in the high category [21]. Automatic evaluations for the Anapedia web are conducted using Google PageSpeed. Google PageSpeed can be used to measure the performance and loading pace of the web [17], [25]. Based on an analysis using Google PageSpeed, Anapedia's web loading speed is 80% which is included in the HIGH category [26].

3.2. Analysis

A comparison of the usability level of all aspects is shown in Figure 4. The results show that the best usability component on the Anapedia website is the labelling (LB) aspect of 84% where all the criteria in this aspect are considered GOOD. Labelling aspects include evaluating labels on the web, page title, and page uniform resource locator (URL). Conversely, the help (HE) aspect perform poorly with a value of 17%. This result is related to the absence of the Help feature on the Anapedia web. In addition to the two components, the usability criteria that has not been met by the Anapedia website and their weights are shown in Table 4. Table 5 presents a comparison of aspects of the Sirius framework with several quantitative evaluation methods.

Table 4. Comparison of Sirius framework to existing methods

Aspect	Criteria	Priority
General Aspects	AG1: Site goals are concrete and well defined	MAJOR
	AG2: Offered content and services are precise and complete	CRITICAL
	AG3: General site structure is user-oriented	MAJOR
	AG4: General Look & Feel matches the site goals, characteristics, content and services	MODERATE
	AG5: Recognizable site visual design	MODERATE
	AG6: Site's general design is coherent	MAJOR
	AG8: Other languages are supported	MODERATE
	AG9: Site's translation corrects and complete	MODERATE
	Identity and Information	II1: Identity or logotype is significant, identifiable and sufficiently visible
II5: Means of contact available		MODERATE
II6: Data Protection information is available for both personal information and site content copyright		MODERATE
Structure and Navigation	SN3: Element organization is consistent with industry standards.	MODERATE
	SN11: On image-based links, there is indication of the content to be accessed.	MODERATE
	SN13: Elements that inform the user of where they are and how to navigate back are present (e.g breadcrumbs)	MAJOR
Page and Layout	PL5: Visual space on the page is used correctly.	MODERATE
Multimedia Element	ME6: Some added value is provided by using sound.	MINOR
Search	SE6: Advanced search is provided.	MODERATE
Help	HE1: Help link is located in a visible and expected location.	MODERATE
	HE2: Easy access to and return from the help system.	MODERATE
	HE3: Contextual help is offered for complex tasks.	MODERATE
	HE4: FAQ contain correct and relevant questions.	MODERATE
	HE5: FAQ contain correct and relevant answers.	MODERATE
General Aspects	AG1: Site goals are concrete and well defined	MAJOR

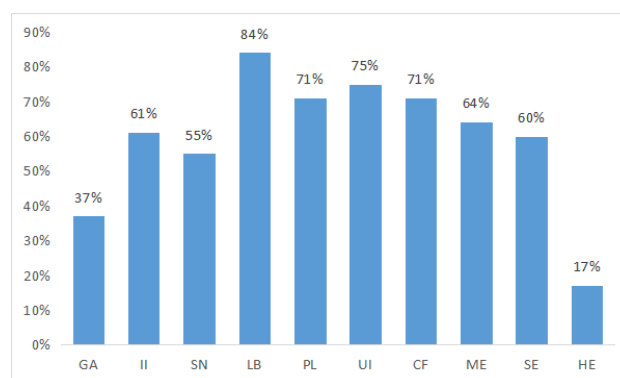


Figure 4. Achievement level of Anapedia's usability aspect

Table 5. Identified usability problems

Elemen Evaluasi Heuristik	Hasan <i>et al.</i> [20]	Omar <i>et al.</i> [27]	Nazir <i>et al.</i> [18]	Torrente <i>et al.</i> [13]
Number of aspect/category	5	5	3	10
Number of criteria/metric	25	37	10	83
Criteria weighting	yes	yes	no	yes
Aspect/category weighting	yes	yes	yes	yes
Evaluated web type	specific	specific	any	any
Global usability calculation	yes	yes	yes	yes
Used by expert	no	yes	no	yes
Quantify non-compliance kriteria	no	no	yes	yes
Quantify severity level	yes	yes	no	no
Validation of the method	no	no	no	yes

4. CONCLUSION

This research provides information to the developer team regarding web quality in the context of usability for the improvement of design both in terms of interface and content. Evaluation by experts is one way to measure website usability. In this study we evaluated Anapedia Web, the first open web-based encyclopedia for children built in Bahasa, that is still considered low in terms of comfort. This aspect is related to the usability of the website. The automated and manual tools were conducted to measure the usability aspect of the app. Google PageSpeed app were used for the automatic evaluation and heuristic (with the involvement of a group of evaluators) for measuring the usability level manually. Based on the evaluations of all evaluators, the average value of global usability is considered high. To find out which aspects have the highest and lowest values, measurements are made based on evaluator evaluations and the best and worst aspects of the results are related to labeling and assistance. To be more thorough, it is necessary to do an assessment by the user using existing methods.

APPENDIX

Table 3. Calculating the GA dan II aspects of Anapedia for one evaluator

Aspect	Criteria	Evaluation Value (ev)	Sirius Value (sv)	Relevance Value (rv)	Weighting Coefficient (wc)	Final Criteria Value (sv x wc)	Final Aspect (fav)	% Usability (Σ fav x 10)
General aspect	Site goals are concrete and well defined	8	8	4	0.019417476	0.155339806	1,485	94.66
	Offered content and services are precise and complete	9	9	8	0.038834951	0.349514563		
	General site structure is user-oriented	8	8	4	0.019417476	0.155339806		
	General Look & Feel matches the site goals, characteristics, content and services	9	9	2	0.009708738	0.087378641		
	Recognizable site visual design	8	8	2	0.009708738	0.077669903		
	Site's general design is coherent	9	9	4	0.019417476	0.174757282		
	User language is used throughout	S	10	4	0.019417476	0.194174757		
	Other languages are supported	S	10	2	0.009708738	0.097087379		
	Site's translation correct and complete	S	10	2	0.009708738	0.097087379		
	Regularly updated site	S	10	2	0.009708738	0.097087379		

Table 3. Calculating the GA dan II aspects of Anapedia for one evaluator (continue)

Aspect	Criteria	Evaluation Value (ev)	Sirius Value (sv)	Relevance Value (rv)	Weighting Coefficient (wc)	Final Criteria Value (sv x wc)	Final Aspect (fav)	% Usability ($\Sigma \text{ fav} \times 10$)
Identity and Information	Identity or logotype is significant, identifiable and sufficiently visible	10	10	1	0.004854369	0.048543689	0.72815534	
	Site identity on all pages	S	10	2	0.009708738	0.097087379		
	Slogan or tagline is appropriate for the site goals.	10	10	2	0.009708738	0.097087379		
	Information about the site and company is available	S	10	2	0.009708738	0.097087379		
	Means of contact available	S	10	2	0.009708738	0.097087379		
	Data Protection information is available for both personal information and site content	S	10	2	0.009708738	0.097087379		
	copyright							
	Information available about the author, sources, and content publishing and update dates.	S	10	4	0.019417476	0.194174757		

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