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Modification of The Online Gunning Fog Index for Readability Analysis of Indonesian Texts : A Prototype Development

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Abstract: This study aims to develop a statistical formula for the readability of Indonesian texts by modifying the Gunning Fog Index (GFI) formula. GFI is one of the objective readability statistics with a syntactic approach. The GFI formula is used to measure the readability of text based on the calculation of the number of words, sentences and complex words. The underlying theory is that a good text is a text that is appropriate or easily understood by its target readers. The level of text readability is influenced by the syntactic complexity in the text. The research method used is R&D (Research and Development). The formula is made online using Google Sheets so that the link can be accessed by the public. The developed formula uses complex word count criteria that have been adapted from the Gunning Fog Index formula. The basis of this modification is that the original GFI criteria is based on English text which is different from Indonesian text. This formula was tested using the same text sample as the text sample used by previous researchers. Data dianalisis dengan perhitungan GFI untuk jumlah kata kompleks dalam kalima. The results of this study show a more detailed difference in the Gunning Fox index. In addition, this formula provides more detailed and informative calculations that make it easier for users to analyze the readability of Indonesian texts. This study's findings provide an improved tool for evaluating the readability of Indonesian texts, offering educators, writers, and literacy enthusiast a more accurate and accessible method to assess and enhance text comprehension for Indonesian readers.

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Introduction

Text readability is one of the important factors in ensuring that the message conveyed through the text can be well understood by the reader. Readability analysis helps align the complexity of the text with the reader's comprehension ability, thereby enhancing comprehension and engagement. This is especially important in various contexts, especially education where clarity of communication is important. By assessing readability, writers and educators can tailor content to meet the needs of the audience, ensuring that the information is accessible and useful. In an educational setting, readability analysis is essential for aligning textbooks and learning materials with students' comprehension level (Az-Zahra & Romadhony, 2023; Choi et al., 2024). For example, a study of school textbooks in Indonesia highlighted the need for readability tools (Febriana et al., 2022; Prastyo & Inayati, 2022) to ensure that textbooks meet quality standards and are age-appropriate for the intended audience.

Analysing the readability of texts is critical to improving literacy skills as it directly affects reading comprehension and fluency. Recent research highlights the importance of

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adjusting text complexity to match children's cognitive and linguistic abilities, thereby facilitating a more effective learning experience. By understanding and applying readability measures, educators can select and adapt challenging and accessible reading materials, ultimately supporting literacy development. Research shows the use of readable English for example (Coggins, 2023; Elbro et al., 2021), a method that simplifies text presentation, has been shown to significantly improve reading fluency and comprehension among primary school students. This approach helps students read faster and more accurately, closing the reading gap and improving overall literacy skills. (Coggins, 2023). By analysing the readability of the text, educators can ensure that the text is appropriate for the cognitive level, thus facilitating better comprehension and retention of information (Dewi & Adijaya, 2022). Advanced readability models that consider factors such as word length and sentence structure can provide insight into text difficulty, helping educators design materials that maintain student interest and motivation in literacy programs (*Research on Text Readability Based on Computer Multi-Level Comprehensive Evaluation Model and Algorithm Optimization*, 2022). Analysing the readability of texts plays an important role in supporting effective literacy by ensuring that texts are appropriate for readers' cognitive and linguistic levels.

From the vocabulary aspect, the relationship between vocabulary and also the discourse context are important factors in the readability of a text (Pitler & Nenkova, 2008). Discourse context viewing skills, such as text structure knowledge and topic knowledge, contribute significantly to reading comprehension. These skills help readers understand the organization and main ideas of a text, thus facilitating better comprehension. (Ho et al., 2019). One method used to measure the readability of texts is readability statistics, which are based on syntactic complexity, such as the number of words, number of sentences, and word length in the text (O'Sullivan et al., 2020; *Research on Text Readability Based on Computer Multi-Level Comprehensive Evaluation Model and Algorithm Optimization*, 2022). The number of words and sentences in a text is a basic metric for assessing the syntactic complexity of a text (Jagaiah et al., 2020). Word length, while not a direct measure of syntactic complexity, contributes to the overall complexity of the text. Longer words often correlate with more complex syntactic structures, as they are usually associated with a larger vocabulary (Zhiqin, 2024).

In the Indonesian context, there are still few readability methods specifically adapted for Indonesian language structures (Cahyawijaya et al., 2021) thus posing a challenge in readability research. Various readability formulas, such as Flesch Reading Ease and Flesch-Kincaid Grade Level, which are commonly used in English, are not fully relevant for Indonesian texts due to differences in linguistic structure. Flesch-Kincaid Grade Level, for example, although it is often used to measure the readability of Indonesian texts, it is not capable enough to capture the nuances in the structure of Indonesian language. (Biddinika et al., 2016). The Flesch-Kincaid formula, developed for English texts, cannot account for the unique syntactic and lexical characteristics of Indonesian. Research shows that syntactic complexity plays an important role in reading comprehension, which Flesch-Kincaid may not be able to adequately measure (Sahiruddin, 2022).

The readability or difficulty of a text is often measured objectively using readability statistics. There are three variables used in the calculation of text readability statistics, namely:

1) Word length. Words that consist of many letters or syllables are considered easier to understand than words that are long (Gerth & Festman, 2021; Kuperman et al., 2024; Zang et al., 2018).

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2) Number of words in the sentence. Short or simple sentences are easier to understand than long or complex sentences (Kadayat & Eika, 2020; Spencer et al., 2019; Wilkinson & Patty, 1993)
3) Word frequency. A frequently used word will be better known to people than a word that is rarely used (Brysbaert et al., 2018; Rastle, 2018)

The calculation of word length and number of words is called syntactic calculation. While calculations based on word frequency are called semantic calculations. Most readability statistics formulas use the syntactic approach. The syntactic approach is relatively easier to make compared to semantic calculations.

There are several statistical formulas for syntactic readability that can be used, such as Flesh Reading Ease and Flesch-Kincaid Grade Level. Both formulas are used by the Microsoft Word program. The calculations in both formulas are only based on the average number of syllables in a word and the number of words in a sentence. Unfortunately, both formulas are based on English syllable counts. This calculation cannot be used for text in Indonesian language (Tirza & Hananto, 2024)

Besides the Flesch Reading Ease and Flesch-Kincaid Grade Level formulas, the Gunning Fog Index (GFI) formula is also quite popular. In previous research conducted by Saptono and his colleagues (Saptono et al., 2013), they had developed a prototype of readability test in Indonesian scientific discourse using the GFI formula. Unfortunately, the prototype they developed cannot be used by the public. In addition, there are several things that can be done to improve the prototype. For example, there is some irrelevant information that does not need to be displayed. Another improvement is to modify the operational definition of "complex words" that they used. Saptono and his colleagues followed the original definition, which is a word consisting of 3 or more syllables. At the end of their conclusion, they finally realized that the definition was not appropriate when applied to Indonesian texts. This can be seen in the resulting GFI. The trial of three texts produced GFIs that were too high: 29.93, 29.10, and 29.93.

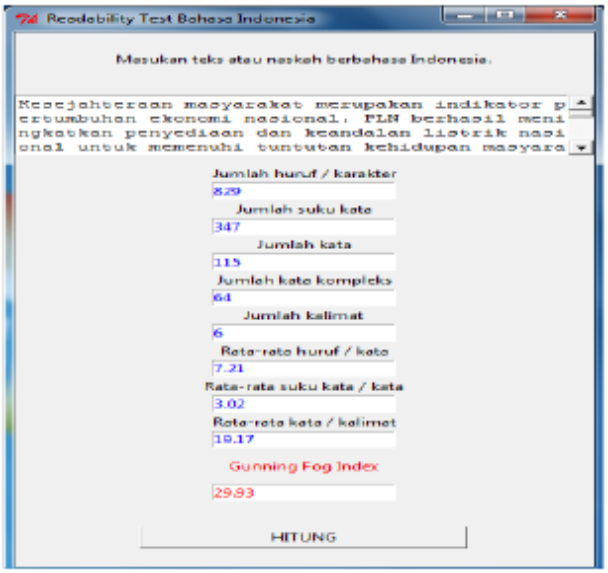

Figure 1. Test results of sample 1 (Saptono et al., 2013)

These results are not in accordance with the Gunning Fog Index interpretation table. The resulting index number indicates the level of education required to understand the text. The higher the index, the more complex the text is and therefore the more difficult it is to

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understand. For example, a text with a Gunning Fog Index of 12 could be understood by a grade 12 student. Figure 2 provides an interpretation of the Gunning Fog Index.

Fog Index	Reading level by grade
17	College graduate
16	College senior
15	College junior
14	College sophomore
13	College freshman
12	High school senior
11	High school junior
10	High school sophomore
9	High school freshman
8	Eighth grade
7	Seventh grade
6	Sixth grade

Figure 2. GFI interpretation table.

Source: https://alan.co.id/apa-itu-gunning-fog-index-metode-pengukuran-readability-teks/

Therefore, this study aims to develop a statistical formula for the readability of Indonesian texts by modifying the GFI and comparing the final findings with the development carried out by Saptono (Saptono et al., 2013). Improvements made in this study include: (1) the formula is made online so that it can be accessed by the wider community, (2) changing the definition of complex words from a minimum of 3 to 4 syllables or more, (3) displaying relevant information, (4) adding other information that makes it easier for people to verify the resulting calculations. The expectation of this study is to provide a more accessible, accurate, and user-friendly readability formula for Indonesian texts, which improves upon previous methods by incorporating enhanced criteria for complex words (modifying the GFI formula), and ensuring greater public accessibility through an online platform.

Research Method

The research applies a research and development method. The formula is developed and then implemented in Google Sheets, allowing public access through a provided link. The formula is based on the Gunning Fog Index created by Robert Gunning and modified to fit the structure of the Indonesian language. GFI is particularly useful for assessing the complexity of English texts by considering sentence length and the proportion of complex words. The index is widely used in various fields to ensure that written content is accessible to the intended audience (Lines, 2022), the formula is:

$$0.4\left[\left(\frac{\text{words}}{\text{sentences}}\right)+100\left(\frac{\text{complex words}}{\text{words}}\right)\right]$$

Words = number of words. A word is defined as a space-separated unit of language.

Sentences = number of sentences. A sentence is defined as a unit of language that ends with a full stop, question mark or exclamation mark.

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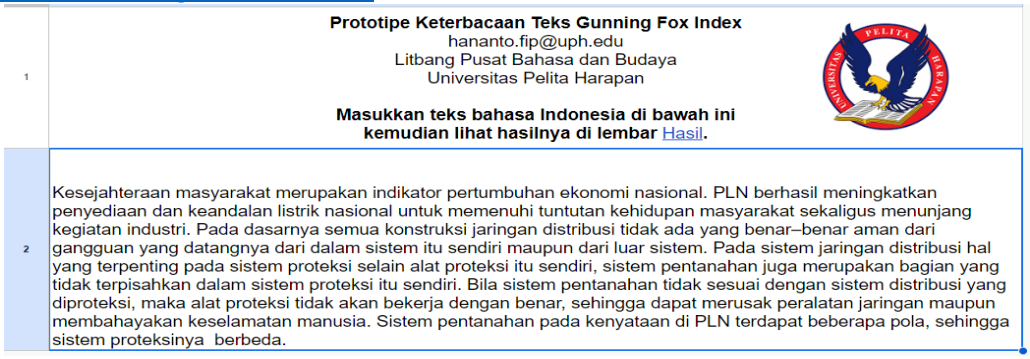
Complex words = complex words are defined as words consisting of four or more syllables. This is different from the original syllable count which is only three or more. The steps in this study are as follows:

- copying the first sample text used by Saptono's research (Saptono et al., 2013) in the designated place (see Figure 3, line 2).
- break the text into words organized in a column. Each word is on a line. All words are converted to all lowercase letters.
- count how often a word appears (frequency) in the text in the next column.
- counts the number of syllables for each word in the next column. A syllable can consist of a vowel (V), vowel-consonant (V-C), or C-V-C (Divo Pratama Pasaribu et al., 2024).
- determines whether a word is a complex word or not. If the number of syllables is four or more then it is counted as a complex word.
- count the number of complex words based on their frequency.
- count the number of sentences based on period, question mark and exclamation mark punctuation.
- calculate the average number of words per sentence.
- calculate the percentage of complex words by dividing the number of complex words by the total number of words.
- calculating the readability index of the text by using the Gunning Fog formula.
- comparing the results with the results obtained in Saptono's research (Saptono et al., 2013).

Data analysis is conducted by utilizing Excel formulas to identify and classify words as complex based on their syllable count, while also calculating the frequency of complex words. Subsequently, the total number of words and sentences is determined, followed by the calculation of the average number of words per sentence. The readability index is then computed using the modified Gunning Fog Index formula, and the results are compared with previous research (Saptono et al., 2013) to evaluate the accuracy of the modifications. Ideally, the GFI should fall within the range of 1 to 17 (Rahman & Kartika, 2021); thus, if the data analysis reveals a GFI score exceeding 17, the text is considered highly complex.

Results and Discussion

The sample text used can be seen in Figure 3 (second line). The first line contains information on the developer of this formula. The developed formula prototype can be accessed by the public at the link: https://docs.google.com/spreadsheets/d/1vtkxAAP9ZHakWVK4ZRduPqpKk1Mwb32KaquL9zhrfzo/edit?gid=1077427607#gid=1077427607



1	**Prototipe Keterbacaan Teks Gunning Fox Index** hananto.fip@uph.edu Litbang Pusat Bahasa dan Budaya Universitas Pelita Harapan **Masukkan teks bahasa Indonesia di bawah ini kemudian lihat hasilnya di lembar** Hasil.
2	Kesejahteraan masyarakat merupakan indikator pertumbuhan ekonomi nasional. PLN berhasil meningkatkan penyediaan dan keandalan listrik nasional untuk memenuhi tuntutan kehidupan masyarakat sekaligus menunjang kegiatan industri. Pada dasarnya semua konstruksi jaringan distribusi tidak ada yang benar–benar aman dari gangguan yang datangnya dari dalam sistem itu sendiri maupun dari luar sistem. Pada sistem jaringan distribusi hal yang terpenting pada sistem proteksi selain alat proteksi itu sendiri, sistem pentanahan juga merupakan bagian yang tidak terpisahkan dalam sistem proteksi itu sendiri. Bila sistem pentanahan tidak sesuai dengan sistem distribusi yang diproteksi, maka alat proteksi tidak akan bekerja dengan benar, sehingga dapat merusak peralatan jaringan maupun membahayakan keselamatan manusia. Sistem pentanahan pada kenyataan di PLN terdapat beberapa pola, sehingga sistem proteksinya berbeda.

Figure 3. Data view of the first text sample (in Indonesian text)

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The results of the text readability statistics are displayed in tabular form. Figure 4 shows a partial result of the first sample text.

A	B	C	D	E	F	G	H
Kata Unik	**TOTAL Kata**	**TOTAL Suku Kata**	**Kata Kompleks**	**TOTAL Kalimat**	**Kata per Kalimat**	**Persentase Kata Kompleks**	**GFI**
73	**116**	**217**	**33**	**6**	**19.3**	**0.28**	**19.11**
kesejahteraan	1	6	1				
masyarakat	2	4	2				
merupakan	2	4	2				
indikator	1	4	1				
pertumbuhan	1	4	1				
ekonomi	1	4	1				
nasional	2	4	2				
pln	2	0					
berhasil	1	3					

Figure 4. Partial result view of the first sample text

The explanation for each column is as follows:

- Column A displays every unique word (a word that appears multiple times is only displayed once) in the text. The word order is based on the order of the words in the text from the beginning (i.e. ***kesejahteraan***) to the end. The number of unique words reported in the second line (i.e. 73)
- Column B counts the frequency of occurrence of each word, for example the word ***kesejahteraan*** (3rd line) there is only one time, while the word below it ***masyarakat*** there are two. The second line shows the total number of words in the text (116 words).
- Column C counts the number of syllables, for example ***kesejahteraan*** consists of 6 syllables and ***masyarakat*** consists of 4 syllables. The total number of syllables in the text is in the second line (217).
- Column D counts complex words. The criteria for counting complex words is based on the number of syllables. This research tries with 3 criteria: (1) 3 syllables or more, (2) 4 syllables or more, and (3) 5 syllables or more. If the number of syllables in colon C meets a certain criterion then, in the same row, the contents of column D will be the same as the contents of column B. If the content in the row of column C is less than the criteria then the content of column D will be blank, for example, the word ***pln*** and ***berhasil*** (at the last 2 line). Line 2 counts the total number of complex words (33).
- Column E line 2 reports the number of sentences in the text (6)
- Column F calculates the average number of words in a sentence, i.e. Total Words (column B) divided by Total Sentences (column E). In the sample text this is 116/6 = 19.3.
- Column G calculates the Complex Word Percentage by dividing the Number of Complex Words (column D) by the Total Words (column B), i.e. 33/116 = 0.28.
- Column H reports the calculation index based on the Gunning Fog formula (19.11).

The three variables used in the Gunning Fog formula are number of words, sentences, complex words. Table 1 shows the comparison of the three variables and the index produced in Saptono's study compared to this study.

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Table 1. Comparison of readability statistics results

Text	Saptono's Study	This Study		
Sentence	6	6		
Word	115	116		
Complex syllable count criteria	>= 3	>= 3	>= 4	>= 5
Complex word count	64	61	33	4
Gunning Fog Index	29.93	28.77	19.11	9.11

Both studies reported the same number of sentences (6 sentences), but there was a 1-word difference in the number of words (115 and 116). To find out which calculation is correct, the researcher performed a manual calculation. The manual calculation resulted in a word count of 116.

The complex word count calculation shows a considerable difference. With the same criteria (3 syllables or more) the results show a difference of 3 words (64 and 61). With criteria of 4 and 5 syllables or more, the number of complex words was 33 and 4.

The criterion for calculating complex words greatly determines the resulting index. With the same criteria (3 syllables or more), Saptono et al.'s research produced a different Gunning Fog Index (29.93 and 28.77). This is natural because Saptono's research produced a larger number of words. With a criterion of 4 syllables or more (Modified GFI developed), this study produced an index of 19.11. This is better because this index is close to the GFI interpretation (Larbi et al., 2023; Rahman & Kartika, 2021) table in Figure 2 above. Meanwhile, the criteria of 5 syllables or more (Saptono et al., 2013) resulted in an index of 9.11.

In this study, the Gunning Fog Index (GFI) formula has been modified by adjusting the criteria for complex words. The definition of complex words was expanded from three syllables to five syllables, which significantly affected the resulting readability index. The results of this study show a substantial difference in complex word counts depending on the syllable criteria, with the modified criteria yielding a GFI of 9.11, indicating that the text is at a lower readability level, which aligns with the ideal range of GFI between 1 and 17 (Rahman & Kartika, 2021). This finding is consistent with the GFI interpretation table (Larbi et al., 2023), which emphasizes that a lower GFI is more suitable for texts intended for a broader audience. The comparison with Saptono et al.'s (2013) research reveals that the modified GFI is more suitable for Indonesian texts, as it considers the linguistic structure of the language, offering a more accurate and accessible readability measure. Additionally, readability indices like GFI are essential for improving text accessibility and making texts more comprehensible to a wider range of readers (Gómez & Sánchez-Lafuente, 2019; Yaffe, 2022).

This study's results are interesting because it highlights the significant impact of adjusting the operational definition of complex words based on the linguistic structure of the Indonesian language can significantly impact readability assessments. By utilizing the new criteria of five syllables, the readability of Indonesian texts can be more accurately assessed, offering valuable insights for educators in developing materials that are better suited for their target audiences.

Conclusion

The results of this study indicate that modifying the operational definition of complex words, from three syllables to five syllables, has a substantial impact on the readability index of Indonesian texts. By using the new syllable criteria, the Gunning Fog Index (GFI) for the sample text was calculated to be 9.11, which suggests that the text is more accessible and

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suitable for a wider audience. This is a notable improvement, as the modified GFI falls within the ideal range of 1 to 17, indicating that it is easier to understand compared to earlier results from Saptono, where the GFI was higher (28.77 and 29.93). The results highlight that the threshold for counting complex words is crucial in determining the readability index, as it directly influences the calculated GFI. Furthermore, the findings demonstrate that adjusting the criteria for complex words based on the linguistic structure of the Indonesian language improves readability assessments, making the modified GFI formula more applicable and accurate for Indonesian texts. The study provides valuable insights for educators and content creators in designing materials that are more appropriate and accessible for their target audiences.

Recommendation

Educators should consider utilizing the modified Gunning Fog Index (GFI) formula, which uses five syllables as the threshold for complex words, to assess the readability of learning materials. This can help ensure that texts are appropriately tailored to the reading capabilities of students, especially in early education. By aligning materials with the GFI score that is more accessible (such as scores within the 1-17 range), educators can improve comprehension and engagement, particularly for students at different literacy levels. Additionally, educators should encourage students to read texts with varying GFI scores to foster their ability to understand texts of different complexity levels.

For Indonesian Language Book Compilers: Book compilers and publishers should adopt the modified GFI formula when selecting or designing educational materials. The adjustment of the complex word criteria to five syllables will better reflect the readability of Indonesian texts and provide more accurate measurements for audience comprehension. When compiling textbooks or supplementary materials, compilers should aim for an optimal GFI score that aligns with the grade level of students or the target audience, ensuring that materials are neither too complex nor too simplistic. For Future Researchers: Future research should explore the application of the modified GFI formula across different genres of Indonesian texts, such as literature, technical writing, and media. Comparing the readability of texts from different domains using this formula will provide insights into how language complexity varies across contexts.

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