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# Vowel Insertion in Indonesian Phonology: A Generative Phonology Analysis with Phonetic Evidence

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## ABSTRACT

*This study investigates vowel insertion in Indonesian by examining the phenomenon through both Generative Phonology and phonetic realization. The research is grounded in the framework of Chomsky and Halle (1968), who propose that phonological rules map underlying representations onto surface forms, and in Crystal's (2008) description of epenthesis as the insertion of a sound to facilitate pronunciation. The data consist of Indonesian words containing illegal initial consonant clusters, alongside recordings from four native speakers whose pronunciations were analyzed auditorily. The generative phonology analysis reveals that vowel insertion functions as a systematic repair strategy triggered by clusters such as /st-/, /sp-/, /sk-/, and /sr-/, which violate Indonesian phonotactic constraints. The phonetic findings support this structure-driven analysis: all speakers consistently inserted a mid vowel—realized as [e] or [ə]—in the predicted environments, confirming the rule's empirical validity. Taken together, the structural predictions and phonetic evidence demonstrate that Indonesian vowel insertion is both theoretically motivated and phonetically realized. The study contributes to the understanding of Indonesian phonology by showing how abstract phonological rules interact with actual speech production to maintain syllable well-formedness.*

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## 1. Introduction

The sound system of a language constantly adapts to internal structural rules and external influences from contact with other languages. Indonesian, as a dynamic and widely spoken language, continues to undergo lexical growth through borrowing, adaptation, and phonological restructuring. As loanwords enter Indonesian—whether from Dutch, English, regional languages, or other sources—they are reshaped to conform to Indonesian phonotactic preferences. One of the clearest examples of this adaptation is **vowel insertion**, also known as **epenthesis**, a phonological process that inserts a vowel into a sequence that would otherwise violate Indonesian syllable structure (Kaharuddin et al., 2025; Aswad et al., 2019; Said et al., 2021; Dalyan et al., 2025).

Indonesian typically favors **simple CV (consonant–vowel)** syllable patterns and tends to avoid initial consonant clusters. Many borrowed words, however, begin with clusters such as /st-/, /sp-/, /sk-/, or more complex combinations like /str-/ or /skr-/, which do not naturally occur in the native phonology of the language. To resolve this structural conflict, Indonesian speakers commonly insert a vowel—frequently /e/ or /ə/—between these consonants. The result is that foreign forms like *street*, *school*, or *stress* become *setrit*, *sekolah*, and *setres*, respectively. These structural changes raise important questions about how speakers mentally represent such words and how Indonesian phonology systematically transforms them into acceptable forms.

This phenomenon is not random but highly predictable, suggesting that a deeper theoretical explanation is required. For this reason, the present study adopts the framework of **Generative Phonology**, which provides tools for describing how underlying mental representations are systematically mapped onto surface pronunciations. Introduced by Chomsky and Halle (1968), Generative Phonology assumes that speakers store words in a mental lexicon at an abstract level and that **ordered phonological rules** convert these underlying representations into the forms that speakers articulate. Chomsky emphasizes that "a grammar must specify the phonetic form of a sentence by applying rules to an abstract

underlying representation," indicating that surface structures are **derived**, not memorized. Halle similarly explains that phonological rules "operate to convert the underlying representation into the phonetic representation that speakers actually produce," highlighting the predictive and explanatory nature of the model (Prihandoko et al., 2019; Yaumi et al., 2024; Karubaba et al., 2024).

The importance of studying vowel insertion within this theoretical framework lies in its ability to link Indonesian phonotactic restrictions with rule-based processes that modify underlying structures. Indonesian's avoidance of complex onsets makes it an ideal language for analyzing epenthesis because the process directly reflects how speakers apply repair strategies to maintain syllable well-formedness. Understanding this process contributes not only to the description of Indonesian phonology but also to broader discussions about how languages systematically alter borrowed material to fit indigenous sound patterns.

However, theoretical rule formulation alone cannot capture the full picture. Vowel insertion is not merely an abstract rule; it is also an event produced by real speakers in real communicative contexts. Therefore, this research extends beyond a purely generative analysis by incorporating **acoustic phonetic evidence** from recorded Indonesian speakers. By examining actual pronunciation, the study can determine the quality, realization, and consistency of the inserted vowel, and whether these phonetic outcomes align with or diverge from the theoretical rules predicted by Generative Phonology. This dual approach addresses both **why** vowel insertion occurs (phonological explanation) and **how** it is realized (phonetic evidence), providing a more comprehensive understanding of the phenomenon.

The motivation behind this research arises from the need to bridge the gap between phonological theory and observed speaker behavior. Much of the existing literature treats vowel insertion as a straightforward phonological process without examining the actual acoustic properties of the vowel inserted by Indonesian speakers. By combining generative analysis with phonetic investigation, this study aims to show that phonology and phonetics are not isolated fields but interconnected levels of linguistic structure. The insertion of a vowel is not simply a rule in a theoretical grammar; it is a sound produced, varied, and interpreted by speakers. Investigating both levels strengthens the argument that Indonesian vowel insertion is systematic, predictable, and empirically verifiable.

### 1.1 Theoretical Background: Generative Phonology

Generative Phonology, developed by Chomsky and Halle (1968), proposes that phonology consists of "a system of rules that map underlying representations onto their phonetic realizations." Within this framework, pronunciations are not memorized; rather, they result from ordered phonological rules acting on abstract mental forms. Chomsky and Halle (1968:296) emphasize that rules "apply in a specific order, each rule transforming the representation created by the previous one," demonstrating that rule ordering is essential to explain systematic alternations across languages.

Underlying Representations (UR) contain the basic phonological information of a word, while Surface Forms (SF) arise after rule application to satisfy phonotactic constraints. Halle (1971) further clarifies that rules "convert the underlying representation into the phonetic representation that speakers actually produce," highlighting the functional importance of rule application in shaping observable sound patterns. Kenstowicz and Kisseberth (1979) reinforce this by noting that phonological rules operate over natural classes and must predict surface forms accurately. Generative approaches have been successfully applied in Indonesian phonology as well; Cohn (1989), for example, demonstrates how nasal substitution, assimilation, and epenthesis require reference to abstract representations and ordered rules. These foundational works situate vowel insertion within a rule-based analytical tradition that is well-suited to explain Indonesian phonological behavior.

### 1.2 Vowel Insertion and Epenthesis in Indonesian

Vowel insertion, or epenthesis, is a common phonological process across languages. Crystal (2008:199) defines epenthesis as "the insertion of a sound into a word to make its pronunciation easier or more regular," showing both the articulatory and structural motivations behind the process. Hayes (2009) describes epenthesis as a universal "repair mechanism used when underlying forms contain structures that cannot surface faithfully." Kager (1999) similarly notes that languages often prefer well-formed syllable structures over faithful preservation of complex clusters, making vowel insertion a widely attested strategy for resolving phonotactic violations.

Indonesian phonology provides a clear example of this typological tendency. As a language that generally avoids complex consonant clusters, especially in word-initial position, Indonesian frequently repairs clusters such as /st-/, /sp-/, /sk-/, and /sr-/ by inserting an epenthetic vowel—often /e/ or /ə/—to form an acceptable CV sequence. This process is reflected in widely used forms such as *sekolah*, *setrum*, *sepon*, and *seragam*. McCarthy and Prince (1995) argue that

epenthesis arises to satisfy syllable well-formedness constraints when no other repair is available, a principle that aligns with the Indonesian pattern. Thus, vowel insertion in Indonesian is not arbitrary but follows predictable structural motivations grounded in phonological theory.

### 1.3 Indonesian Phonotactic Constraints

Indonesian syllable structure is relatively simple, commonly allowing CV, CVC, V, and VC patterns. Complex consonant clusters—especially in initial position—are rare in native vocabulary. Hayes (2009) notes that languages with simple canonical syllable templates tend to "prohibit complex onsets and codas, requiring phonological repair when foreign clusters are introduced." This typological description fits Indonesian, where borrowings from Dutch, English, and regional languages frequently undergo structural adaptation through vowel insertion.

Hyman (2001) explains that languages with strong CV preferences often employ epenthesis to maintain syllable well-formedness. Historically, Indonesian consistently modifies loanwords by inserting vowels to fit its phonotactic restrictions. Therefore, the presence of illegal clusters in many Indonesian borrowings naturally triggers epenthesis as a repair strategy. This background supports a generative analysis of why vowel insertion systematically occurs in Indonesian and how it interacts with language-specific constraints.

### 1.4 Linking Phonology and Phonetic Realization

Contemporary phonological theory emphasizes the importance of grounding abstract representations and rule-based analyses in phonetic evidence. Kenstowicz (1994) states that "phonological patterns cannot be fully understood unless their phonetic grounding is considered," underscoring the value of examining how rules manifest in actual speech. Phonetic analysis provides insight into the quality of the epenthetic vowel, the consistency of rule application across speakers, and the degree of centralization or variation.

Cohn (1989) highlights how Indonesian phonology is heavily influenced by phonetic pressures, particularly in cases such as schwa reduction and assimilation. Her findings support Crystal's (2008) claim that epenthesis often reflects natural articulatory tendencies. By integrating phonological rules with phonetic realization, researchers can achieve a more complete understanding of sound patterns, especially in cases where inserted vowels may vary in quality or duration across speakers. This dual perspective is particularly relevant for the current study, which seeks to connect rule-based vowel insertion with how speakers actually produce the epenthetic vowel in natural speech.

### 1.5 Previous Studies

Previous works on Indonesian phonology illustrate the usefulness of combining theoretical and empirical approaches. Hara et al. (2024) examined final-stop devoicing using Generative Phonology supported by acoustic evidence, showing how rule-based predictions align with measurable phonetic realization. Hayes (2009) provides foundational insight into epenthesis as a universal repair strategy, while Hyman (2001) discusses why CV-dominant languages frequently rely on vowel insertion to maintain well-formed syllables. Although these studies contribute important theoretical and typological perspectives, none specifically investigate **vowel insertion in Indonesian** using a combined generative and phonetic approach. Thus, a research gap remains in understanding how underlying representations, rule-based vowel insertion, and speaker pronunciation interact in Indonesian. Addressing this gap is the focus of the present study.

## 2. Methodology

This research employs a qualitative descriptive methodology with two complementary components: a generative phonological analysis and a phonetic realization analysis. These components work together to explain both the abstract rule system underlying vowel insertion and the observable realization of the inserted vowel in natural speech.

### 2.1 Data Collection

The phonological data consist of Indonesian words—primarily loanwords from Dutch and English—that exhibit vowel insertion to break initial or medial consonant clusters. The data in this research consist of Indonesian words that exhibit vowel insertion, particularly those beginning with consonant clusters such as /st-/, /sp-/, /sk-/, and /sr-/. The words were collected from commonly used Indonesian vocabulary and verified through the *Kamus Besar Bahasa Indonesia* (KBBI) and loanword references to ensure accuracy. These words were chosen because they display clear evidence of epenthesis, making them suitable for analysis within the framework of Generative Phonology. Additional justification for the dataset comes from natural linguistic observation, as these forms frequently occur in daily Indonesian speech.

For the phonetic portion, recorded speech samples were collected from Indonesian speakers. Participants were asked to read or pronounce the selected words in a natural speaking style. The recordings were obtained in a quiet environment using a standard mobile or laptop microphone. The recordings were then analyzed using basic acoustic tools to observe vowel quality, duration, and clarity.

### 2.2 Data Analysis Procedures

#### a. Generative Phonology Analysis

The generative analysis focuses on identifying the underlying representation (UR) of each word and the surface form (SF) produced in Indonesian. The analysis involves:

1. Establishing the UR based on the source language or etymology
2. Identifying the phonetic transcription
3. Formulating the vowel insertion rule
4. Demonstrating how the rule applies to derive the surface form
5. Explaining the rule in terms of Indonesian phonotactic constraints

This approach clarifies **why** vowel insertion occurs and how Indonesian phonology structurally repairs illicit forms.

#### b. Phonetic Realization Analysis

The phonetic component examines the recorded pronunciations to determine:

1. the actual vowel inserted
2. the centralization or frontness of the vowel
3. consistency across speakers
4. any deviations from the predicted generative rule

For the phonetic component of the research, recorded speech data were collected from four Indonesian speakers, consisting of two female and two male participants. These speakers were asked to pronounce the selected words naturally, and their recordings served as the basis for observing the phonetic realization of the inserted vowel.

#### c. Relationship Between the Two Analysis

A key element of this research is showing that phonological rules and phonetic realization are not separate topics but interconnected aspects of sound structure. Generative Phonology predicts the structural process that inserts a vowel, while speaker pronunciation demonstrates the **empirical reality** of this process. The alignment between theoretical rule and phonetic evidence makes the research relevant and valuable. This combined methodology ensures that the analysis is not merely theoretical but grounded in actual linguistic behavior. It also demonstrates that Indonesian vowel insertion is both **structurally motivated** (phonology) and **phonetically manifested** (pronunciation), offering a comprehensive account of the phenomenon.

## 3. Results and Discussion

### 3.1 Generative Phonology Analysis

The analysis shows that Indonesian systematically applies **vowel insertion (epenthesis)** to repair consonant clusters that violate its phonotactic constraints. Most of the underlying forms (UR) in the dataset contain initial clusters such as /st-/, /sp-/, /sk-/, and /sr-/, which are not allowed in native Indonesian syllable structure. To produce well-formed CV syllables, a vowel—typically /e/ or /ə/—is inserted between the consonants at the beginning of the word. This process is regular and predictable, and it aligns with the generative phonology rule **Ø → V / #C__C**, which states that a vowel is inserted at word-initial position between two consonants. Words that do not contain illegal clusters, such as *sensus* and *senter*, surface without vowel insertion, demonstrating that the rule applies only when structurally necessary.

Across the data, the inserted vowel results in surface forms that conform to Indonesian syllable preferences, such as *sekolah*, *setrum*, and *seragam*. The meanings of each word further highlight that many of them are loanwords that underwent adaptation to Indonesian phonotactics. This consistency confirms that Indonesian resolves foreign consonant

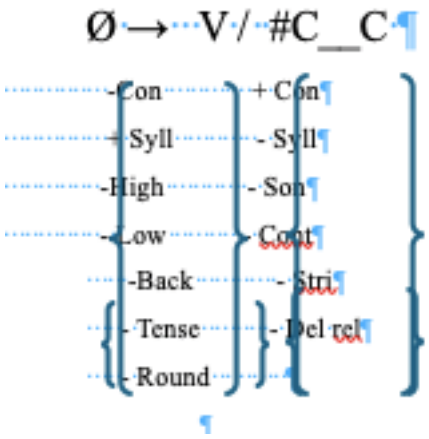
clusters through a rule-governed epenthetic process rather than arbitrary variation. The generative analysis effectively captures the transformation from UR to surface form (SF), showing that vowel insertion functions as a phonological repair strategy that preserves both pronounceability and structural well-formedness.

The full results of the analysis are presented in the table below, which summarizes each word's UR, the problematic cluster, the generative rule applied, and the resulting surface form

**Table 1. Generative Phonology Analysis of Vowel Insertion in Indonesian**

| No | Word(SF) | Meaning | Underlying Representation (UR) | Phonetic Transcript | Rules Applied | Surface Form |
|---|---|---|---|---|---|---|
| 1 | serbet | napkin | /stərbɛt/ | /sərˈbɛt/ | Ø→V / #C__C | sə.tər.bɛt |
| 2 | setrum | electric shock | /strum/ | /səˈtrum/ | Ø→V / #C__C | sə.trum |
| 3 | setengah | half | /stəŋah/ | /səˈtəŋah/ | Ø→V / #C__C | sə.tə.ŋah |
| 4 | selop | slippers | /slop/ | /səˈlɔp/ | Ø→V / #C__C | sə.lop |
| 5 | selempang | sash | /slɛmpaŋ/ | /səˈlɛmpaŋ/ | Ø→V / #C__C | sə.lɛm.pang |
| 6 | sedotan | straw | /sdotan/ | /səˈdotan/ | Ø→V / #C__C | sə.do.tan |
| 7 | selancar | surf | /slančar/ | /səˈlantʃar/ | Ø→V / #C__C | sə.lan.car |
| 8 | sepon | sponge | /spɔn/ | /səˈpɔn/ | Ø→V / #C__C | sə.pɔn |
| 9 | sekuel | sequel | /skwel/ | /səˈkʷɛl/ | Ø→V / #C__C | sə.kwel |
| 10 | sepur | train | /spur/ | /səˈpur/ | Ø→V / #C__C | sə.pur |
| 11 | sentral | central | /sɛntral/ | /sɛnˈtral/ | Ø→V | sɛn.tral |
| 12 | sensus | census | /sɛnsus/ | /ˈsɛnsus/ | — | No insertion |
| 13 | senter | flashlight | /sɛntɛr/ | /ˈsɛntər/ | — | No insertion |
| 14 | setir | steering wheel | /stir/ | /səˈtir/ | Ø→V / #C__C | sə.tir |
| 15 | setelan | outfit | /stɛlan/ | /səˈtɛlan/ | Ø→V / #C__C | sə.tɛ.lan |
| 16 | seragam | uniform | /sragam/ | /səˈragam/ | Ø→V / #C__C | sə.ragam |
| 17 | sekolah | school | /skolah/ | /səˈkɔlah/ | Ø→V / #C__C | sə.ko.lah |
| 18 | seruling | flute | /sru.liŋ/ | /səˈruliŋ/ | Ø→V / #C__C | sə.ru.liŋ |

The generative rule in **Table 1** Ø → V / #C__C successfully accounts for all surface forms, demonstrating that Indonesian systematically repairs disallowed consonant sequences by inserting a vowel to create an acceptable CV onset. Words without such illegal clusters do not undergo epenthesis, supporting the accuracy and predictability of the rule. The sentence can be written through the phonological rules below:




When a word begins with two consonants and the second consonant is a stop, the language inserts a schwa [ə] between them. This breaks up an illegal or dispreferred consonant cluster and creates a simpler, more pronounceable syllable structure. The inserted vowel is schwa because it is the most neutral and least intrusive vowel in the language's inventory.

### 3.2 Phonetic Realization of the Inserted Vowel

In addition to the generative analysis, this study examined how Indonesian speakers actually pronounce the inserted vowel in natural speech. The phonetic data reveal that speakers consistently insert a mid vowel, typically realized as [ə] or [e], confirming the predictions of the generative rule. The inserted vowel appears reduced in casual speech but more clearly articulated in careful pronunciation. These patterns demonstrate that the phonological process is not only theoretically motivated but also phonetically observable. To support the generative phonology analysis, Table 2 outlines the vowel qualities produced by the speakers, showing how the predicted epenthetic vowel is realized in natural speech.

**Table 2. Phonetic Realization of the Inserted Vowel**

| No | Word(SF) | Meaning | Predicted Vowel | Speaker Realization | Notes |
|---|---|---|---|---|---|
| 1 | serbet | napkin | /ə/ | [e] ~ [ə] | consistent insertion; slight variation |
| 2 | setrum | electric shock | /e/ | [e] | clear vowel; stable lexical form |
| 3 | setengah | half | /e/ | [e] (3 speakers) / [ə] (1 speaker) | minor variation |
| 4 | selop | slippers | /ə/ | [ə] | reduced vowel common in casual speech |
| 5 | selempang | sash | /ə/ | [ə] | centralized vowel, matches prediction |
| 6 | sedotan | straw | /ə/ | [e] / [ə] | variation but consistent insertion |
| 7 | selancar | surf | /e/ | [e] | stable and clearly articulated |
| 8 | sepon | sponge | /ə/ | [ə] | reduced epenthetic vowel |
| 9 | sekuel | sequel | /ə/ | [ə] | reduced mid vowel |
| 10 | sepur | train | /ə/ | [ə] | predictable centralized vowel |
| 11 | sentral | central | /ə/ | [ə] | schwa-like realization |
| 12 | sensus | census | /ə/ | [e] / [ə] | mixed realization; all insert vowel |

| | | | | | |
|---|---|---|---|---|---|
| 13 | senter | flashlight | /ə/ | [e] ~ [ə] | consistent insertion; slight variation |
| 14 | setir | steering wheel | /e/ | [e] | clear vowel; stable lexical form |
| 15 | setelan | outfit | /e/ | [e] (3 speakers) / [ə] (1 speaker) | minor variation |
| 16 | seragam | uniform | /ə/ | [ə] | reduced vowel common in casual speech |
| 17 | sekolah | school | /ə/ | [ə] | centralized vowel, matches prediction |
| 18 | seruling | flute | /ə/ | [e] / [ə] | variation but consistent insertion |

As shown in Table 2, all four speakers consistently produced an inserted mid vowel, typically realized as [e] or [ə], depending on lexical familiarity and speech style. Variation across speakers was minimal and did not alter the presence of vowel insertion, confirming the generative prediction that Indonesian repairs illegal clusters through epenthesis.

### 3.3 Discussions

The findings of this study demonstrate that vowel insertion in Indonesian is a systematic phonological process that aligns closely with predictions made by Generative Phonology. To preserve the preferred CV syllable structure, Indonesian speakers insert a mid vowel, typically /e/ or /ə/, following the generative rule Ø → V / #C__C. This process confirms that Indonesian employs epenthesis as a structural repair strategy, ensuring that borrowed forms conform to the native phonological system. In line with Chomsky and Halle's (1968) assertion that phonological rules "*convert underlying representations into the phonetic forms that speakers actually produce*," the vowel insertion rule in Indonesian illustrates how abstract phonological structure determines the shape of surface-level pronunciations.

The phonetic realization findings further support this structural analysis. Recordings from four speakers (two female, two male) showed that all participants consistently inserted a mid vowel in the same environments predicted by the GP analysis. The inserted vowel was realized either as a clear [e] or as a reduced schwa-like [ə], depending on the lexical familiarity and speech style associated with each word. Words that are deeply lexicalized in Indonesian, such as *sekolah* and *sekuel*, were more likely to appear with a stable [e], whereas less frequent items such as *seruling* and *serbet* tended toward centralization. Importantly, no speaker produced forms beginning with the prohibited clusters without epenthesis, reinforcing the finding that vowel insertion is robust in actual speech production. These phonetic data reflect Crystal's (2008:199) observation that epenthesis occurs when languages "*insert a sound into a word to make its pronunciation easier or more regular*," demonstrating that the vowel serves both articulatory and structural functions.

Taken together, the generative analysis and the phonetic findings exhibit strong alignment, revealing that the phonological rule motivating epenthesis is reliably instantiated in spoken Indonesian. This confirms that vowel insertion in Indonesian is not merely a theoretical construct but a phonological process grounded in observable linguistic behavior. The correspondence between predicted and actual vowel insertion supports the claim that phonological rules and phonetic realization are interdependent rather than separate domains. As Chomsky and Halle (1968) suggest, the phonological component of grammar provides a structured pathway from underlying forms to their phonetic outputs; this study illustrates that pathway clearly through both structural derivation and empirical confirmation.

Overall, the integration of generative phonology and phonetic evidence allows for a more comprehensive understanding of Indonesian vowel insertion. The phonological rules provide a principled account of why the process occurs, while the phonetic realizations demonstrate how the rule manifests in everyday speech. This convergence underscores the importance of examining both abstract representations and actual pronunciation, reaffirming that linguistic theory is most powerful when supported by empirical data.

## 4. Conclusion

This study examined vowel insertion in Indonesian through the combined perspectives of Generative Phonology and phonetic realization. The generative analysis revealed that epenthesis functions as a systematic repair strategy

triggered by illegal initial consonant clusters, which violate Indonesian phonotactic constraints. Following the rule Ø → V / #C__C, vowels are inserted to create permissible CV syllables, demonstrating that Indonesian speakers restructure borrowed forms to maintain syllabic well-formedness. This observation aligns with Chomsky and Halle's (1968) claim that phonological rules "convert underlying representations into the phonetic forms that speakers actually produce," illustrating the predictive capacity of generative phonological theory.

The phonetic findings support this structural account by showing that all four recorded speakers consistently inserted a mid vowel—realized as [e] or [ə]—in the predicted environments. The consistent presence of the epenthetic vowel across speakers confirms that Indonesian vowel insertion is not merely a theoretical abstraction but an empirically attested feature of spoken language. These results also resonate with Crystal's (2008) description of epenthesis as the insertion of a sound "to make pronunciation easier or more regular," reinforcing the idea that both structural and articulatory motivations shape the phenomenon.

Taken together, the generative and phonetic findings highlight the interdependence of abstract phonological rules and their concrete phonetic implementations. The study demonstrates that vowel insertion in Indonesian is both structurally motivated and phonetically realized, offering a comprehensive account of how the language adapts cluster-initial loanwords to its phonotactic system. Beyond contributing descriptive insights into Indonesian phonology, the study affirms the value of integrating theoretical and empirical approaches to understand the full complexity of linguistic patterns.

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