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Nasal Variability at the Contact Frontier: An Autosegmental-Moraic Analysis of Papuan Malay

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ABSTRACT

Researchers have recently started paying more attention to Papuan Malay (PM) because the language is widely used by people from different ethnic and linguistic backgrounds in Papua and beyond. Despite the growing number of studies on PM, in-depth phonological analyses remain limited. Previous studies have mainly discussed PM phonology descriptively, while analyses of nasal fluctuation from a moraic and autosegmental perspective remain limited. Using a qualitative contact-phonological approach, this study analyzes spontaneous PM speech collected through natural conversations, semi-structured interviews, and targeted elicitation from thirty-eight multilingual speakers in Manokwari, representing diverse first-language backgrounds across Papua. This article focuses on the conditioned fluctuation between the alveolar nasal [n] and the velar nasal [ŋ] in spoken discourse. The study analyzes this fluctuation using autosegmental moraic phonology to examine its underlying structure. The findings indicate that the alternation between [n] and [ŋ] is not arbitrary, but is mainly influenced by phonological assimilation. The analysis shows that sound changes occur more frequently in environments where nearby sounds influence one another. This study demonstrates that nasal fluctuation in PM is conditioned by prosodic and assimilatory environments rather than free variation alone. The findings suggest that variation in PM is not entirely unpredictable but follows systematic phonological patterns shaped by multilingual interaction and pronunciation habits. By integrating autosegmental, moraic, and contact phonological frameworks, this study advances a unified account of nasal variability in PM that treats phonetic variation not as noise, but as structured evidence of how multilingual systems negotiate phonological identity at the coda boundary.

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1. Introduction

Papua holds the highest linguistic diversity in Indonesia, accounting for approximately 280 out of the country's 703 living regional languages (Eberhard et al. 2025). These languages exhibit varying degrees of vitality, with several already identified as endangered. In many parts of Papua, people use more than one language in daily communication. Local vernaculars are commonly used in family and community settings, while Papua Malay (PM) and Standard Indonesian function as wider means of communication. Aikhenvald (2014) explains that Papua remains one of the world's most active multilingual contact zones because speakers regularly move between languages during everyday interaction. What makes this situation especially interesting for phonological study is not only the large number of languages, but also the clear effects of language contact. PM speakers may switch from Biak, Javanese, Hatam to PM and vice versa in just a few sentences, and each language can influence the pronunciation of the next.

Among the many languages spoken in the region, PM has become one of the most central vehicles of communication. The language is widely used in schools, markets, churches, workplaces, transportation, and social media communication. PM functions not only as a lingua franca but also as an important marker of urban Papuan identity. As a result, PM has developed several characteristics that distinguish it from Standard Indonesian, especially in pronunciation and sentence patterns. Arka (2013, p. 51) points out that eastern Indonesian Malay varieties often display strong phonological flexibility because speakers continuously move across multiple linguistic systems.

Although PM preserves much of the vocabulary and grammatical structure of Standard Indonesian, its phonology shows several distinctive features. One of the clearest patterns appears in the behavior of nasal consonants, especially the alveolar /n/, the velar /ŋ/, and the bilabial /m/. These sounds frequently undergo deletion, assimilation, and resyllabification, producing pronunciations that differ from Standard Indonesian forms. Hagedorn and Namasivayam (2024, p. 339) state that assimilation in multilingual communities usually follows regular articulatory tendencies. In slow and careful speech, the alveolar coda remains unchanged, but in fast everyday speech, it often shifts to match the velar onset that follows. This adjustment occurs automatically among most speakers, often without conscious awareness. Several indigenous Papuan languages do not strongly maintain contrasts involving the velar /ŋ/. Donohue (2021, p. 67) explains that phonological adaptation in Papua is strongly influenced by long-term contact between Papuan languages and Malay varieties. Because of these contact situations, speakers often simplify or modify nasal consonants based on surrounding phonetic context and speech rate.

Research on PM has increased significantly during the last two decades. Kluge (2017, p. 15) produced one of the most comprehensive descriptions of PM and discussed its phonology, morphology, syntax, and sociolinguistic functions. Her work demonstrates that PM is a systematic linguistic variety rather than "incorrect Indonesian." Recent studies have also examined language contact, multilingualism, and phonological variation in eastern Indonesia. Nevertheless, detailed studies focusing specifically on nasal fluctuation and assimilation in PM remain limited. Existing discussions often describe pronunciation differences without fully explaining the phonological mechanisms behind those variations. More recent studies argue that variation is usually influenced by systematic linguistic and social factors.

Meyerhoff (2018) explains that speakers in multilingual communities frequently adjust pronunciation according to interaction, identity, and communication habits. Similar observations are discussed by Meyerhoff et al. (2015), who argue that variation in contact languages is commonly shaped by both linguistic structure and social experience rather than random fluctuation alone. In phonological studies, scholars also debate whether assimilation should mainly be explained through abstract phonological rules or through articulatory processes occurring naturally during speech. Labov (2001, p. 156) suggests that fluctuation occurs in unstable linguistic situations where speakers variably choose between two forms. This variation may continue for long periods and can lead either to divergence between dialects or convergence through accommodation and continued language contact. These perspectives are important because nasal fluctuation in PM may appear unpredictable at first, but many patterns follow regular phonological tendencies influenced by multilingual interaction and everyday pronunciation habits.

This study therefore focuses on nasal variation in PM, particularly the fluctuation between alveolar and velar nasal sounds. The analysis examines how assimilation and fluctuation occur in different phonological environments and how these processes relate to multilingual interaction. This study contends that what appears as pronunciation instability in PM is, under formal analysis, a principled consequence of prosodic vulnerability at the coda boundary, a position where articulatory efficiency, multilingual transfer, and phonological under specification converge.

To explain these patterns, the data are analyzed through phonological and phonetic representations. Phonological representation focuses on the abstract organization of sounds within the linguistic system, while phonetic realization examines how those sounds are physically produced during actual speech. This perspective is important because sounds frequently overlap and influence one another across segment boundaries.

Within phonology, assimilation usually occurs because speakers naturally attempt to produce smoother pronunciation. Goldsmith (1999, p. 312) explains that articulatory efficiency is one of the strongest motivations behind assimilation processes in Indonesian speech varieties. In PM, assimilation frequently appears when the final consonant of one word interacts with the first sound of the following word. In many cases, the earlier sound changes while the following sound remains stable. These sound changes appear naturally because speakers tend to pronounce words more efficiently during rapid speech, as illustrated below.

(1) /kæ**n**/ + /**g**oʊ/ → [k^{h}æ**ŋ** goʊ]
[alveolar nasal] [velar voiced] → [velar nasal]

In that English phrase ‘can go’, the alveolar nasal /n/ at coda is followed by the voiced velar consonant /g/ at onset position, so that when pronounced together in natural speech, the alveolar [n] often takes the feature of velar sound, producing the velar nasal [ŋ]. This happens because speakers naturally adjust pronunciation to create smoother articulation.

Moreover, the study also considers the role of moraic structure in explaining fluctuation patterns. Moraic analysis helps explain why coda consonants are often more vulnerable to assimilation and resyllabification during rapid speech. In many PM utterances, the final consonant appears in weak syllable positions, making it more susceptible to articulatory adjustment. This relationship between moraic structure and consonant behavior helps explain why the alveolar nasal may fluctuate toward bilabial or velar realization without changing the overall syllable structure.

The present study aims to examine how nasal assimilation operates in PM and how multilingual interaction contributes to fluctuation between nasal forms. By integrating phonological representation, phonetic realization, moraic structure, and multilingual contact, this study explains how nasal fluctuation repeatedly appears in PM speech. The findings indicate that the alternation between alveolar and velar nasals is not random but strongly conditioned by phonological environment and multilingual interaction. Through this analysis, the study contributes to broader discussions in phonology, sociolinguistics, and contact linguistics by demonstrating how sound systems develop within multilingual communities. To the best of my knowledge, this is the first study to apply a combined autosegmental-moraic framework to the analysis of nasal fluctuation in Papuan Malay, and one of the few to situate phonological microvariation in eastern Indonesian contact speech within a formal non-linear account. The findings carry implications beyond PM: they speak to how phonological systems behave at the intersection of structural pressure and multilingual exposure. The following section reviews the relevant literature on PM phonology, nasal assimilation, moraic theory, and language contact.

2. Literature Review

PM is one of the most widely used contact languages in eastern Indonesia, especially in Papua and West Papua. The language developed through long interaction among Malay traders, missionaries, colonial administrators, migrants, and indigenous Papuan communities. Although PM belongs genetically to the Austronesian language family, its development has been strongly influenced by multilingual contact with local Papuan languages. Kluge (2017, p. 12) explains that PM gradually expanded from coastal trade communication into urban and interethnic domains where it later became a stable language used in everyday interaction. In several urban areas, younger speakers acquire PM as their first language, while local vernaculars and Standard Indonesian continue to coexist alongside it. Riesberg et al. (2020, p. 4) similarly note that PM has become increasingly dominant in multilingual urban communication.

The spread of Malay across the Indonesian archipelago also contributed to the historical development of PM. Long before Indonesian became the national language, Malay already functioned as a lingua franca across Southeast Asian trade networks. In

Papua, however, Malay underwent localization because speakers continuously interacted with languages possessing different phonological systems, consonant inventories, and syllable structures. Kaland et al. (2021, p. 145) further argue that PM demonstrates phonological characteristics that distinguish it from western Indonesian Malay varieties.

Papua contains hundreds of Austronesian and non-Austronesian languages spoken across highly diverse communities. In daily interaction, speakers regularly move between local languages, PM, and Standard Indonesian depending on social situation and communicative purpose. Aikhenvald (2014) describes New Guinea as one of the most linguistically complex regions in the world, where multilingual interaction continuously produces phonological and grammatical adaptation. This environment affects PM pronunciation because speakers frequently transfer phonological habits from one language into another. As a result, PM displays high levels of phonological flexibility. Similar multilingual adaptation processes have also been identified in eastern Indonesian speech communities (Yuwana, 2025, p. 218).

One of the most noticeable phonological characteristics of PM involves nasal consonants, particularly the alveolar /n/, the velar /ŋ/, and the bilabial /m/. These sounds frequently undergo deletion, assimilation, and resyllabification, depending on speech rate and phonological environment. Suhery et al. (2024, p. 2) explain that Indonesian speech varieties commonly display nasal assimilation across word boundaries because neighboring consonants naturally influence one another during rapid pronunciation. Brown and Meyer (2024, p. 1360) similarly explain that nasal place assimilation often emerges in environments involving coda-onset interaction.

Within phonology, assimilation refers to a process in which one sound becomes more similar to a neighboring sound. Goldsmith (1999, p. 82) explains that assimilation reflects the tendency of speech toward articulatory efficiency and perceptual clarity. Crystal (2008, p. 221) further explains that assimilation is among the most common processes found across world languages because speakers naturally simplify articulation during rapid communication. In place assimilation, a consonant changes its articulatory position to resemble a neighboring consonant. For example, the alveolar nasal /n/ may become bilabial [m] before /p/ or /b/, and /n/ may become the velar [ŋ] before /k/ or /g/ as previously discussed. Diani and Azwandi (2021, p. 135) argue that nasal assimilation reflects systematic phonological constraints rather than random variation because speakers naturally attempt to minimize articulatory movement between adjacent consonants (Shahid et al., 2023, p. 3027). Assimilation can generally be divided into regressive and progressive assimilation. Regressive assimilation occurs when a following sound influences a preceding sound, while progressive assimilation occurs when an earlier sound influences a later segment.

Another important distinction concerns phonological and phonetic representations. Phonological representation refers to the abstract mental structure of sounds, while phonetic realization concerns the physical production of sounds during actual speech. Goldsmith (1999, p. 25) explains that the principles of linearity and invariance do not always operate consistently because speech production frequently involves overlapping in articulation. Kaland et al. (2021, p. 151) similarly demonstrate that PM speech frequently displays phonetic overlap and prosodic adjustment during natural communication. Segmental phonology also provides an important framework for understanding nasal fluctuation because neighboring consonants often influence one another during coda-onset interaction. Brown and Meyer (2024, p. 1360) explain that nasal place assimilation is highly sensitive to phonological domains and syllable boundaries. Another process closely related to assimilation is resyllabification. Frost (2023, p. 25) defines resyllabification as a process related to prosody that helps maintain rhythmic efficiency and may affect pronunciation patterns such as aspiration. Additionally, resyllabification frequently creates environments that encourage assimilation and phonological reduction (Frost, 2023, p. 111). Similar processes are regularly observed in Indonesian and Malay varieties (Goldsmith, 1999, p. 329). Moraic theory also provides an important framework for understanding phonological variation in PM. Moraic theory examines syllable structure through units called morae, symbolized by the Greek letter μ. Gordon (2006, p. 5) explains that syllable weight is closely related to phonetic duration and perceptual prominence. Sounds located in weak moraic positions are often more vulnerable to deletion or assimilation. Hall (2006, p. 388) explains that coda consonants frequently display instability because weak moraic structure encourages phonological simplification. Salem and Alqahtani (2022, p. 102) similarly argue even that syllable weight and moraic structure strongly influence consonant reduction and phonological fluctuation in Malay varieties.

Language contact also plays a major role in shaping PM phonology. Donohue (2021, p. 69) explains that Papuan phonological systems frequently shape Malay pronunciation in eastern Indonesia, especially in consonant realization and syllable structure. Romaine (2023, p. 101) explains that multilingual communities generally display high levels of phonological flexibility because speakers constantly negotiate between different linguistic systems during communication. Syam et al. (2024, p. 173) explain that multilingual speakers frequently modify pronunciation patterns depending on audience, ethnicity, and communicative setting.

Previous studies on PM have contributed important discussions regarding grammar and pronunciation, particularly through the work of Kluge (2017). What is rarely discussed is the difference between description and mechanism. Earlier studies mention that [n] becomes [ŋ] before velars, but they rarely explain why the nasal changes place of articulation while the velar stop does not. Detailed studies focusing specifically on nasal fluctuation also remain limited. The field has described the surface pattern for decades; what has remained missing is an account of the mechanism. This study fills that gap by moving beyond descriptive inventory to show, through autosegmental and moraic representations, precisely how nasal alternation is structured, conditioned, and in certain environments, systematically ambiguous. Previous accounts have treated fluctuation between [n], [m], and [ŋ] as random or performance-based variation. This study argues otherwise: these alternations are systematic phonological processes conditioned by articulatory efficiency and neighboring sound environments. Within this framework, assimilation and fluctuation emerge from the regular interaction between phonology, speech production, and multilingual contact. The methodology used to obtain and analyze the data is described next.

3. Method

This study uses a qualitative research design to examine nasal assimilation and fluctuation in PM. A qualitative approach is suitable because the research focuses on sound variation in natural speech. The study combines phonology, phonetics, and contact linguistics to explain how assimilation and fluctuation occur in everyday pronunciation.

Creswell and Creswell (2023, p. 19) explain that qualitative research is useful for studying patterns and behavior in natural social settings. Since this research examines pronunciation in real communication, qualitative analysis helps keep the data close to actual language use. The primary data consist of spoken PM collected from natural communication settings. PM is widely used as a lingua franca in Papua and West Papua, especially among speakers from different language backgrounds. Kluge (2017, p. 18) explains that PM is commonly used in interethnic communication and shows variation depending on social and linguistic background. Previous studies discussing phonology, morphology, syntax, and sociolinguistic functions also show that PM has developed into a stable multilingual contact variety. This situation makes PM important for studying pronunciation and sound variation.

A total of 38 participants were involved in this study, ranging from approximately 12 to 70 years old. The fieldwork was conducted over four months in Manokwari and surrounding areas. The speakers represented diverse first-language (L1) backgrounds commonly found in Papua and West Papua, including Austronesian languages such as Biak, Sentani, Serui/Yapen, and Wondama, as well as Papuan languages such as Dani, Walak, Hatam, Sougb, and Meyah. Several participants from non-Papuan backgrounds, including Javanese, Makassarese, Butonese, Bataknese, Ambonese, Flores, and Timorese communities, were also included because PM is frequently used as a lingua franca across multilingual interactions. Some participants use PM as their first language, while others use it together with local Papuan languages, Indonesian, and other traditional languages. Romaine (2023, p. 101) explains that the linguistic diversity of this participant group is significant because, as documented in contact phonology literature, speakers who regularly navigate multiple phonological systems are more likely to display the kinds of assimilation and fluctuation patterns that this study aims to examine. Oral informed consent was obtained from all participants after explaining the purpose of the research, the recording procedures, and their right to withdraw at any time without consequence, and the participants' identities were anonymized during transcription and analysis.

Data collection was carried out through spontaneous conversation, semi-structured interviews, and targeted elicitation. Spontaneous speech was prioritized because natural conversation provides clearer examples of deletion, assimilation, and resyllabification than isolated pronunciation. During casual interaction, speakers are more likely to produce these patterns naturally. Recordings were collected in informal places such as traditional markets, homes, workplaces, small gatherings, and campus environments. Semi-structured interviews were also used to obtain examples involving the alveolar /n/, the velar /ŋ/, and the bilabial /m/. Targeted elicitation was then used to check whether certain assimilation patterns appeared consistently across different speakers and situations. Brown and Meyer (2024, p. 76) argue that assimilation in Indonesian varieties becomes more visible because neighboring consonants influence articulatory movement.

During fieldwork, observational notes and contextual information were written in a research notebook after each recording session. Since the data were recorded in noisy public spaces, audio quality was improved using ASR Voice Recorder on Android with a Boya BY-M1 external microphone and built-in filters. Recordings were made in WAV format at 44.1 kHz, 16-bit, mono settings, then transferred via USB cable to a laptop and processed in Audacity for noise reduction, normalization, trimming, and WAV export. All recordings were then stored in digital folders and labeled according to date, speaker background, and recording location. One recording session was excluded from the dataset due to excessive ambient noise that rendered coda consonants acoustically indiscernible, underscoring the practical challenges of naturalistic fieldwork in high-traffic urban environments. The recordings were reviewed several times before being transcribed in order to identify pronunciation details more accurately. Transcription was conducted manually using phonetic transcription adapted from the International Phonetic Alphabet (IPA). Microsoft Word and audio playback software were also used during transcription. Broad transcription was first used to identify general phonological patterns, while narrow transcription was used to capture more detailed pronunciation variation. Examples involving nasal fluctuation were grouped into bilabial, alveolar, and velar environments.

The analysis was conducted in several stages. The first stage involved identifying repeated pronunciation patterns involving nasal consonants. Special attention was given to environments in which assimilation and fluctuation occur. In many cases, the final consonant of one word interacted with the first consonant of the following word, causing changes in place of articulation. The second stage involved phonological analysis that examined whether these alternations reflected systematic phonological patterns rather than random variation.

The study also used phonetic and moraic analysis. Phonetic analysis examined how sounds were physically produced during actual pronunciation, while moraic theory was used to examine the relationship between syllable structure and nasal fluctuation. Gordon (2006, p. 5) explains that syllable weight may influence reduction and assimilation, especially in weak coda positions. In PM, coda nasals often showed instability during rapid speech. Finally, the findings were interpreted using a sociolinguistic perspective.

The results are presented through phonetic transcription, IPA notation, comparative pronunciation examples, phonological rules, and categorized assimilation patterns. Some data are organized in tables to show differences between underlying phonological forms and actual pronunciation forms used by speakers. To summarize, this study examines nasal variation from several perspectives, including phonology, pronunciation patterns, syllable structure, and multilingual language contact.

4. Results and Discussion

This section discusses the generalized rules and phonological alternations involved in nasal assimilation processes. The discussion focuses on two major patterns, namely velar nasal assimilation and alveolar nasal assimilation, as well as the conditioned fluctuation that appears in certain phonological environments. Furthermore, the analysis is interpreted within an Autosegmental-Moraic phonology framework to explain how these alternations can be represented through contemporary phonological approaches.

4.1 Distinctive Feature Analysis and Underlying Representations

The first area of investigation concerns assimilation between velar consonants and nasals, particularly the shift from the alveolar nasal [+anterior] to the velar nasal [-anterior]. This process exemplifies how assimilation operates across place of articulation, as the alveolar nasal adopts the features of a following velar consonant, resulting in a change from /n/ to [ŋ]. Such cases are highly relevant for understanding the mechanisms of sound variation in contact-induced varieties such as PM.

The second area involves assimilation between alveolar nasals and other alveolar sounds, such as liquids and stops. In these contexts, the interaction may produce subtle adjustments, but these alternations are significant for demonstrating the sensitivity of nasal consonants to surrounding phonetic environments. The analysis must therefore consider not only segmental identity but also specific features that govern assimilation.

To provide a more precise account, the evaluation can be framed within the principles of *Minimize Underlying Representations* (cf. Prince & Smolensky, 1993) and *distinctive feature matrix*. This allows for the identification of which features are necessary to capture the alternation patterns without introducing redundancy. One important feature to observe is [±voice], which can help determine whether assimilation involves adjustments in voicing in addition to place of articulation. By including [voice] alongside other relevant features, the analysis can yield a more systematic representation. Accordingly, the distinctive features of each relevant sound are presented in the following table for clarity and comparison.

Table 1. Distinctive Feature Matrix

Features		
Consonant		Place Features
k	[-son, -cont, -voice]	[-ant, -cor]
g	[-son, -cont, +voice]	[-ant, -cor]
t	[-son, -cont, -voice]	[+ant, +cor]
d	[-son, -cont, +voice]	[+ant, +cor]
s	[-son, +cont, -voice]	[+ant, +cor]
z	[-son, +cont, +voice]	[+ant, +cor]
r	[+son, +cont, +voice]	[+ant, +cor]
l	[+son, +cont, +voice]	[+ant, +cor]
n	[+son, -cont, +voice, +nasal]	[+ant, +cor]
m	[+son, -cont, +voice, +nasal]	[+ant, -cor]
ŋ	[+son, -cont, +voice, +nasal]	[-ant, -cor]

The Table 1 summarizes the distinctive phonological features relevant to nasal alternation in PM. These feature specifications help explain how assimilation occurs across different places of articulation. In this study, alternation refers to changes in sound realization that depend on the surrounding phonological environment. The data show that nasal consonants in PM undergo systematic alternation rather than random variation, providing the basis for the following phonological analysis.

4.2 Regressive Velar Place Assimilation

When the alveolar nasal /n/ appears before a velar sound such as /g/ or /k/, assimilation occurs. The alveolar nasal shifts to the velar nasal [ŋ], while the following velar consonant remains unchanged. As established in the literature review, regressive nasal place assimilation occurs when a nasal consonant adopts the place features of a following consonant. In PM, this process is most clearly observed when the alveolar nasal /n/ precedes a velar consonant such as /g/ or /k/, as illustrated in the data below.

Data 1: *ika**n*** + ***g**aram* → *ika**ŋ** garam* 'salt fish'

[n] [g] → [ŋ]

alveolar nasal + velar plosive → velar nasal

velar nasal

The analysis shows that the alveolar nasal /n/ assimilates to the place of articulation of the following velar plosive /g/, surfacing as the velar nasal [ŋ]. The nasal manner of articulation is preserved, while the place feature shifts from alveolar to velar through regressive assimilation. This alternation is conditioned by the phonetic environment, particularly the place of articulation of the following consonant, resulting in smoother articulation between adjacent sounds. The same assimilation pattern is observed in the following data. The analysis identifies the change in place feature underlying the nasal fluctuation in the sequence *ikan garam* → [ikaŋ garam].

Segment	Features
/n/	[+son, +nasal, +voice, +cor, +ant]
/g/	[-son, -cont, +voice, -cor, -ant]
[ŋ]	[+son, +nasal, +voice, -cor, -ant]

The table shows that /n/ and [ŋ] share similar nasal and voiced features but differ in place features. The alveolar nasal /n/ changes from [+cor, +ant] to [-cor, -ant] to become homorganic with the following velar consonant /g/. Phonologically, this process may be analyzed as regressive velar place assimilation, where the following velar stop influences the preceding nasal. As a result, the sequence [ŋg] becomes more economical and natural in connected speech.

Data 2: *cincin* + *kawin* → [cinciŋ kawin] 'wedding ring'

The Data show a fluctuation in which the alveolar nasal /n/ changes into the velar nasal [ŋ] before the velar consonant /k/ in *kawin*. Phonologically, this process may be analyzed as regressive velar place assimilation, where the following velar consonant influences the preceding nasal. As a result, the sequence [ŋk] becomes more natural and economical in connected speech. Based on the recurring pattern observed in the Data above, the following phonological rule can be formulated.
Rule: /n/ → [ŋ] / __ [k, g]

When the alveolar nasal /n/ occurs in coda position before the velar consonants /g/ or /k/, it assimilates into the velar nasal [ŋ]. Although /n/ and [ŋ] share the same nasal and voiced features, they differ in place features: /n/ changes from [+cor, +ant] to [-cor, -ant] to become homorganic with the following velar consonant. Phonologically, this is analyzed as regressive velar place assimilation, resulting in the more natural and economical sequences [ŋg] and [ŋk] in connected speech.

4.3 Place Identity and Assimilation Blocking

The following section discusses the behavior of the alveolar nasal /n/ when it occurs before other alveolar consonants in connected speech. Unlike the previous pattern, the Data show that the nasal sound remains unchanged because both sounds share a similar place of articulation.

Data 3: *maka**n*** + ***siang*** → [maka**n** siaŋ] 'eating lunch'
alveolar nasal + alveolar fricative → alveolar nasal

alveolar nasal

The analysis shows that alveolar nasal /n/ does not assimilate before the alveolar fricative /s/ because both already share the same alveolar place of articulation. Therefore, the original nasal sound is preserved. A similar pattern can also be observed in the following Data.

Data 4: kawin + lari → [kawin lari] 'elope'

To further illustrate the phonological relationship underlying the preservation of [n] in the sequence *kawin lari*, the following feature matrix presents the distinctive features shared by /n/ and the following lateral segment /l/.

Segment	Features
/n/	[+son, +nasal, +voice, +cor, +ant]
/l/	[+son, +cont, +voice, +cor, +ant]
[n]	[+son, +nasal, +voice, +cor, +ant]

share the same alveolar place feature [+cor, +ant]. Since no place adjustment is needed, assimilation does not occur and the original nasal sound is preserved.
Condition: Rule 1 does not apply when /n/ precedes consonants sharing the same alveolar place features [+cor, +ant].

When /n/ occurs before alveolar consonants, no assimilation occurs because both segments share the same place of articulation. This shows that assimilation in PM is conditioned by adjacent articulatory features.

The features [+cor] and [+ant] become the main determinants in PM nasal assimilation. When /n/ occurs before velar consonants /g/ or /k/, it changes into [ŋ] through regressive velar place assimilation to match the following [-cor, -ant] features. In contrast, /n/ remains [n] before alveolar consonants such as /s/ and /l/ because both segments already share the same [+cor, +ant] place features, so no assimilation is required.

4.4 Conditioned nasal fluctuation

The analysis on previous sections shows that the alternation between alveolar and velar nasals in PM is generally conditioned by assimilation. Nevertheless, several data indicate that both [n] and [ŋ] may occur interchangeably within the same phonological environment, resulting in conditioned fluctuation. The following data illustrate this pattern.

Data 5: de lari pelan 'he runs slowly'

Field data show that when no following segment is present, the alveolar nasal [n] commonly remains unchanged, as in *pelan*. However, some participants also produced the form *pelang*, even without a following consonant that would normally trigger assimilation.

Data 6: de lari pelan sekali 'he runs very slowly'

A similar pattern is also found when the alveolar nasal is followed by the alveolar fricative /s/. In this environment, both [n] and [ŋ] may still occur interchangeably across speakers, despite the absence of a velar consonant. Based on these findings, the alternation can be represented through the following **conditioned fluctuation pattern**: /n/ → [n] ~ [ŋ]. The realization of [n] instead of [ŋ] is consistent with the hypothesis of a universal phonetic tendency in spoken language production, particularly in high frequency lexical items, to reduce velar articulation in coda position. This phenomenon could potentially be observed among speakers of various native languages. Table 2 below illustrates this reduction pattern as observed in the speech of PM users.

Table 2. Realization of PM final /ŋ/ in coda position

Data	Underlying Form	Realization	English Translation
7	/uaŋ/	[u.an]	money
8	/oraŋ/	[oran]	person
9	/buruŋ/	[burun]	bird
10	/kuniŋ/	[kunin]	yellow
11	/pulaŋ/	[pulan]	go home
12	/toloŋ/	[tolon]	help
13	/lubaŋ/	[luban]	hole
14	/potoŋ/	[poton]	cut off

15	/tendaŋ/	[tendan]	kick
16	/kuciŋ/	[kucin]	cat

These data are consistent across most speakers. Table 2, based on the same set of speakers, demonstrates that final /ŋ/ is consistently reduced to [n] across multiple PM lexical items, aligning with the proposed universal tendency to weaken velar articulation in coda position. This reduction occurs regardless of the surrounding sound environment. In contrast, Table 3 presents data from a different set of speakers, where /n/ shifts to [ŋ] in coda position. Crucially, this change to a velar nasal is also not conditioned by adjacent phonological context.

Table 3. Velar nasal production in Papuan Malay words with orthographic final <n>

Data	Underlying Form	Realization	English Translation
17	/pelan/	[pelaŋ]	slow
18	/bulan/	[bulaŋ]	moon
19	/ikan/	[ikaŋ]	fish
20	/cincin/	[cinciŋ]	ring
21	/main/	[maiŋ]	play
22	/makan/	[makaŋ]	eat
23	/mesin/	[mesiŋ]	machine
24	/bukan/	[bukaŋ]	no
25	/hujan/	[hujaŋ]	rain
26	/kawin/	[kawiŋ]	married

This bidirectional pattern shows that coda nasal place is inherently fluctuative, shaped by universal phonetic pressures rather than language-specific rules. These patterns become clearer under autosegmental and moraic analysis.

4.5 Non-Linear Phonological Analysis of Nasal Fluctuation

The following analysis examines coda nasal fluctuation in PM using two non-linear phonological frameworks. Subsection 4.5.1 applies X-slot skeletal representation (cf. Clements & Keyser, 1983) to analyze surface realizations derived from the underlying form /pelan/. Subsection 4.5.2 then applies moraic representation to analyze surface realizations derived from the underlying form /pulaŋ/. In both subsections, the discussion focuses on how place feature changes occur without modifying syllable structure or skeletal organization.

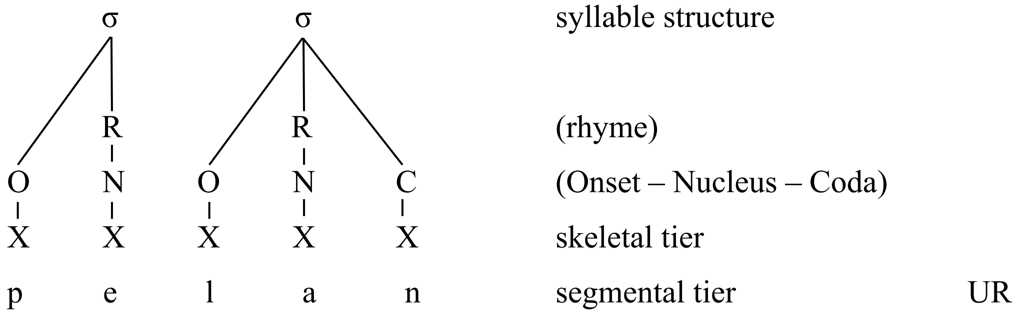
4.5.1 Coda Nasal Fluctuation in PM

The data presented in the previous section show that nasal fluctuation in PM does not occur randomly. The alternation between alveolar [n] and velar [ŋ] frequently appears in syllable-final position across comparable phonological environments. To understand this pattern more clearly, the following analysis examines how the nasal segment is organized within syllable structure. The discussion focuses on the relationship between segment position, coda structure, and the realization of the final nasal consonant in PM speech. To illustrate how nasal fluctuation operates within syllable structure, the following representations apply X-slot representation within a non-linear phonological framework to account for the realization of final nasal consonants in PM. The analysis begins with the underlying representation (UR) of the lexical form and examines how variation in place features produces different surface realizations (SR). Unlike the regressive assimilation discussed in the previous section, the fluctuation observed in word-final position is not triggered by an adjacent velar consonant. Instead, it reflects variation in coda realization influenced by multilingual speech habits, articulatory tendencies, and phonological instability in weak syllable positions.

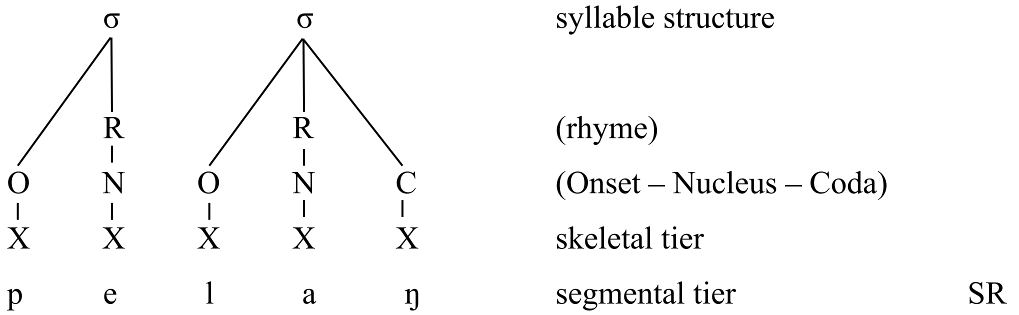
X-Slot Skeletal Representation of Coda Nasal Variation

The following representation illustrates an SR derived from the UR /pelan/.

Data 17a. UR of /pelan/



Data 17b. SR of /pelan/



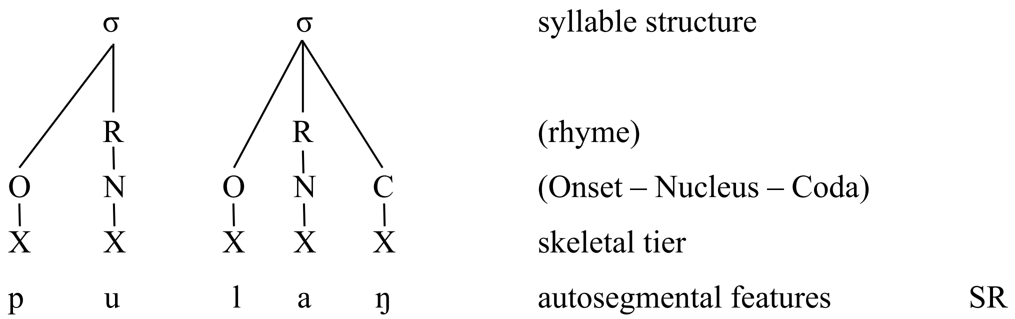
The representations above show that each segment occupies one X-slot on the skeletal tier, indicating a stable syllable structure. In the coda position of the second syllable, the final nasal surfaces as velar [ŋ] rather than alveolar [n]. The alternation reflects variability in the realization of the coda nasal, where the underlying alveolar nasal may surface as either [n] or [ŋ] in word-final position. However, the fluctuation does not affect the number of syllables or the consonant's structural position; only the feature specification of the nasal changes. This indicates that the fluctuation primarily involves changes in place features rather than changes in syllable structure. The coda position in [laŋ] is important because coda consonants generally have weaker articulatory prominence than onset consonants such as [p] and [l]. As a result, the final nasal is more susceptible to articulatory fluctuation and feature change.

The following representations compare forms with alveolar [n] and velar [ŋ], showing that the fluctuation affects only the realization of the coda nasal while preserving the same syllable structure. This suggests that the fluctuation does not involve restructuring of the syllable itself, but rather a variable realization of coda place features within an otherwise stable phonological framework.

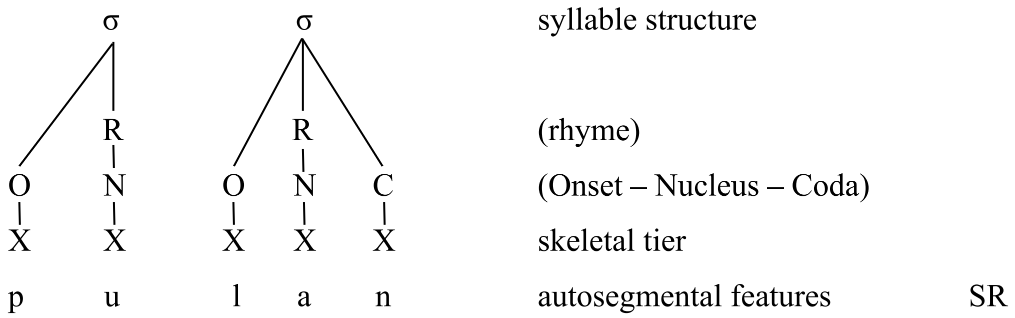
4.5.2 X-Slot Skeletal Representation of Coda Nasal Fluctuation

The following representations present two surface realizations (SR) derived from the same underlying representation (UR) /pulaŋ/, the Papuan Malay word meaning 'to return' or 'to go home'. In spoken discourse, this lexical item exhibits instability in the realization of its final nasal coda: some speakers produce the velar nasal [ŋ] (maintaining the underlying specification), while others produce the alveolar nasal [n] in the same phonological environment.

Data 27a. SR: [pulaŋ]



Data 27b. SR: [pulan]



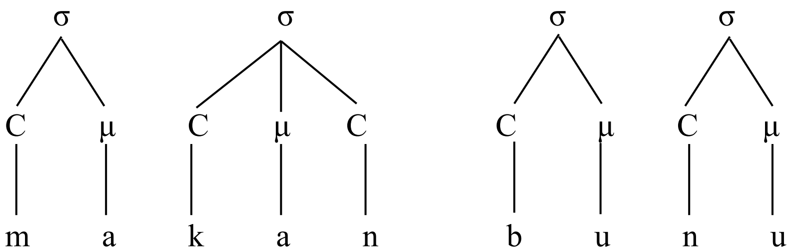
The representations above illustrate consonant fluctuation between the velar nasal [ŋ] and the alveolar nasal [n] in word-final position in PM. Both surface forms preserve the same syllable structure and skeletal tier, consisting of identical X-slots for /p/, /u/, /l/, /a/, and the final nasal consonant. The difference occurs only at the feature level: in Data 27a, the coda nasal surfaces as velar [ŋ] (maintaining the underlying specification), while in Data 27b, it surfaces as alveolar [n] (losing the velar feature).

This alternation demonstrates that the coda position is phonologically unstable in PM. The fact that the same underlying form /pulaŋ/ can be realized as either [pulaŋ] or [pulan] by different speakers or even by the same speaker in different speech contexts indicates that the fluctuation is not triggered by a following consonant (as in regressive assimilation) but reflects inherent variability in coda nasal realization. Since no segment is inserted or deleted, the fluctuation does not alter syllable weight or moraic structure. Instead, it represents an alternative articulatory realization of the final nasal consonant, where the velar feature is optionally neutralized to the more default alveolar place of articulation.

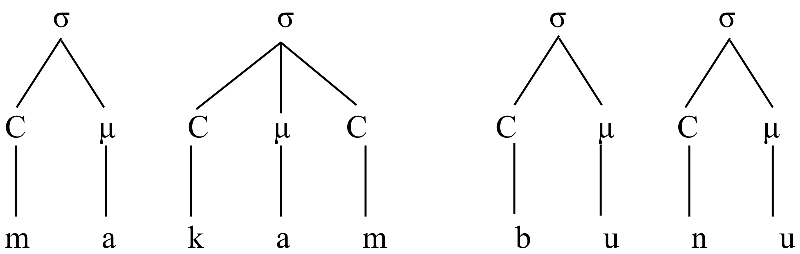
4.6 Moraic Representation of Bilabial Nasal Assimilation

From a moraic perspective, a similar process appears in Data 28 makan bunu 'to gorge'. The process may be analyzed as the transformation from an underlying representation (UR) /makan bunu/ into the surface representation (SR) [makam bunu] through the simultaneous operation of nasal place assimilation and resyllabification, whereby the coda nasal interacts with the following bilabial onset across a syllable boundary. The final alveolar nasal /n/ in makan occupies a weak coda position within the moraic structure and, when followed by the bilabial onset /b/ in bunu, undergoes regressive place assimilation, shifting its place of articulation from alveolar to bilabial and surfacing as [m].

Data 28a. UR: /makan bunu/



Data 28b. SR: [makam bunu]



The Data 28a. /makan bunu/, realized as 28b. [makam bunu], demonstrates a process of nasal assimilation across a word boundary. The alveolar nasal /n/ in the final syllable of *makan* changes into the bilabial nasal [m] when followed by the bilabial consonant /b/ in the subsequent word, *bunu*. This change occurs because the nasal segment assimilates to the place of articulation of the following consonant, facilitating smoother articulatory transition between segments. Syllabically, the form consists of four syllables, namely ma.kan.bu.nu in the underlying representation and ma.kam.bu.nu in the surface realization. The process does not alter the number of syllables or the overall moraic pattern, but instead involves a modification of the nasal's place feature from alveolar to bilabial under the influence of the following consonant. Turning from coda assimilation to onset phenomena, the following subsection examines prenasalization in word-initial position.

4.7 Prenasalization of Voiced Bilabial Stops in PM

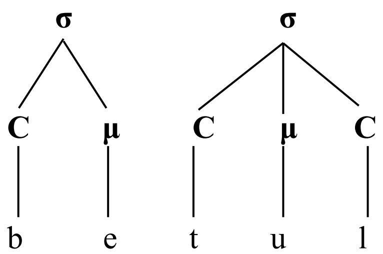
Beyond coda nasal alternation, PM also exhibits prenasalization in onset position. Table 4 below presents additional field data showing the emergence of [mb] before /b/ in word-initial position.

Table 4. Bilabial Prenasalization from /b/ to [mb]

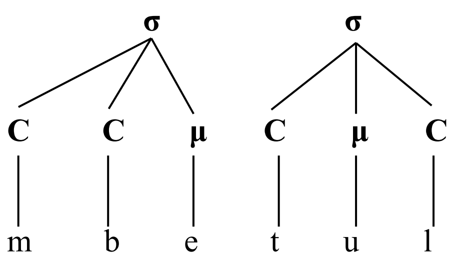
Data	UR	SR	Gloss/Meaning
29	betul	mbetul	'exactly!'
30	bakar	mbakar	'burn it'
31	binatang	mbinatang	'a profanity'
32	bukan	mbukan	'Absolutely not!'

The Table 4 shows a consistent alternation between /b/ and the surface form [mb] in onset position. Data 29 (betul → mbetul) illustrates this process, where the voiced bilabial stop /b/ surfaces with a preceding homorganic nasal segment [m] in word-initial position, suggesting that prenasalization operates as a phonological process conditioned by syllable or word-initial context rather than by local phonetic environment alone.

Data 29a. UR: /betul/



Data 29b. SR: [mbetul]



To further account for the structural relationship between /b/ and [m] in the prenasalized cluster [mb], the following feature matrix presents the shared and contrasting distinctive features of the two segments.

Feature Analysis of /b/ and /m/

Segment	Voiced	Bilabial	Nasal	Stop	Sonorant
/b/	+	+	–	+	-
/m/	+	+	+	-	+

The feature matrix shows that /b/ and /m/ share the features [+voice] and [+bilabial], indicating that both segments are produced with the same place of articulation and voicing specification. The primary distinction lies in the feature [+nasal], which characterizes /m/ as a nasal sonorant, while /b/ remains an oral stop. This featural similarity facilitates the emergence of the homorganic nasal element in the surface cluster [mb], since the transition between the two segments requires minimal articulatory adjustment.

Collectively, the data reveal a consistent tendency toward bilabial prenasalization in Papuan Malay, particularly in word-initial position. The recurring realization of /b/ as [mb] suggests that prenasalization functions as a systematic phonological pattern that preserves syllable structure while strengthening the onset through the addition of a homorganic nasal segment.

5. Conclusion

This study demonstrates that nasal fluctuation in Papuan Malay is systematic, not random. The alternation between alveolar [n] and velar [ŋ] occurs predictably: regressive place assimilation applies when /n/ precedes velar consonants, but blocking occurs when the following consonant shares alveolar place features. Many pronunciation forms perceived as irregular in everyday speech thus follow consistent phonological tendencies.

Crucially, segmental phonology alone cannot explain the fluctuation. Autosegmental and moraic analysis reveals that the alternation affects feature specification while preserving syllable structure and skeletal organization. The coda nasal occupies a weak moraic position, making it vulnerable to fluctuation, yet the overall prosodic framework remains stable. PM speakers maintain structural stability even while producing considerable phonetic variation in spontaneous speech. When speakers consistently produce surface variation without altering syllable count, the analyst must ask whether the search for a single underlying form serves the data or merely the elegance of the analysis.

The bidirectional alternation—/ŋ/ → [n] and /n/ → [ŋ]—demonstrates that coda nasal place features are inherently unstable in PM. This is not a deficiency but a systematic property of a spoken contact variety operating without fixed orthographic norms. If PM speakers cannot consistently agree on whether a word ends with [n] or [ŋ], then the very notion of a fixed underlying representation for coda nasals may be a convenient fiction of the analyst rather than a psychological reality for the speaker. Rather than resolving this indeterminacy by imposing a single underlying form, this study proposes that coda nasal variability in Papuan Malay is best understood as a phonological ecology, a structured space in which competing articulatory pressures, prosodic constraints, and multilingual contact each contribute to the shape of the surface form. The implication is uncomfortable but unavoidable: for some Papuan Malay words, there is no single correct nasal; there are only competing habits, and the phonology lives in the variation, not in spite of it.

Multilingual interaction further shapes these patterns. Some speakers favor [n] while others favor [ŋ] in identical lexical environments, reflecting the multilingual ecology of Manokwari where speakers navigate between Papuan languages, Austronesian languages, and Standard Indonesian. Bilabial prenasalization (*betul → mbetul*) further illustrates this dynamic, showing that variation also operates in onset position, often tied to emphasis rather than phonetic necessity. Studies of contact varieties cannot rely on idealized native speaker intuitions; they require naturalistic data that capture variation across speakers and contexts.

Across the dataset, variation in eastern Indonesian Malay varieties emerges from the interaction of articulatory efficiency, moraic structure, multilingual experience, and social practice. For phonological theory, underlying representations may need to be rethought for contact varieties where speaker agreement on lexical forms is inherently low. For contact linguistics, variation is not an obstacle to analysis but the primary evidence of how languages adapt to multilingual ecologies. Future research with larger speaker populations and acoustic measurement will clarify how these patterns evolve across contemporary PM communities.

Conflict of Interest

The author declares that there is no conflict of interest related to this research.

Author's contributions

The author solely conceived the research idea, designed the study, collected and analyzed the data, and wrote the manuscript. All parts of the work have been reviewed and approved by the author for submission.

Author's declaration

The author confirms that the manuscript is original, has not been published previously, and is not under consideration for publication elsewhere. All ethical standards of research and academic integrity have been observed in the preparation of this work.

Statement of AI Usage

The author would like to state that the only purpose of using generative AI techniques was to enhance the manuscript's general clarity, readability, and grammar. The writers thoroughly examined and confirmed every output produced with AI's help. The study's research data is wholly unique and hasn't been altered or produced by artificial intelligence.

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