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Spatial Patterns and Toponymic Complexity in Sepaku: A GIS-Based Analysis of Linguistic Variation in Indonesia's Future Capital

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ABSTRACT

The purpose of this study is to examine the spatial patterns and associations between language variation and place-name morphology in Sepaku Sub-district, the core area of Indonesia's future capital, Nusantara. Using two main approaches in this study, namely spatial pattern analysis and spatial association analysis. Spatial pattern analysis maps language use in Sepaku, particularly through kinship terms and toponymic morphology. Linguistic data were collected through interviews and adapted observations, while toponymic data were gathered across all villages and administrative units in the study area. Dialectometric analysis (Gutter's classification) was applied to measure inter-point divergence and delineate isoglosses, syllabic structure analysis (CV/CVC/VC patterns) characterized toponyms, and a Geographic Information

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System (GIS)-based. The results reveal four dominant language zones, namely Balik (north), Javanese (east), Paser (west), and Banjar (south), that are shaped by historical migration and state-led transmigration. Toponymic complexity varies spatially, where disyllabic names dominate the north and southwest, tri- to tetrasyllabic names prevail in the east and center, and polysyllabic (>4 syllables) names concentrate in the south. A clear spatial co-location pattern was identified between linguistic zones and toponymic structures, indicating that naming patterns reflect underlying cultural and linguistic diversity. The study concludes that Sepaku's linguistic and toponymic diversity highlights the cultural interplay between indigenous and migrant communities. Policy implications of incorporating linguistic heritage into Nusantara's planning through the protection and use of local toponyms and the recognition of multilingual communities will help preserve the region's pluralistic identity amid rapid development.

Keywords: Cultural Language; Toponymic; Dialectometric; Linguistic Landscape; Nusantara Capital City

1. Introduction

Indonesia, as an archipelagic state, has Jakarta as its national capital, serving both as the economic engine and the center of governmental administration. However, unchecked development that exceeds ecological limits has significantly degraded Jakarta's quality of life. This deterioration is driven by worsening air pollution and increasing marine debris^[1–3]. Using the Greenhouse gas–Air Pollution Interactions and Synergies (GAINS) model, Lestari et al.^[4] projected a continuous air quality decline in Jakarta through 2030. Water pollution has also become critical. Pemana et al. and Henny et al.^[5,6] report hazardous microplastic levels in public water bodies. Other urban stressors, such as excessive population density and unmanaged waste^[7], have exacerbated the crisis. As a strategic response, the government began relocating the capital to East Kalimantan's Sepaku Sub-district to relieve Jakarta's burden, promote regional equity, and support decentralization^[8–10]. Despite this policy shift and heightened attention to Nusantara Capital City (Indonesian: *Ibu Kota Nusantara*, abbreviated IKN) or IKN Nusantara, a focused sociolinguistic account of Sepaku remains limited, creating a clear empirical gap that this study addresses. A sociolinguistic study of Sepaku Sub-district is increasingly relevant as the region prepares for major internal migration following IKN's first development phase in 2024. The arrival of diverse ethnic groups into areas traditionally occupied by indigenous communities may reshape local language use and threaten the continuity of indigenous identities. Early documentation of the linguistic landscape is essential to preserving cultural heritage amid rapid socio-political change. While cultural interaction is often celebrated within the framework of national

unity, homogenization through the national language may risk eroding local languages and traditions^[11,12]. Thus, this study positions Sepaku as a case of long-term change that requires baseline evidence before large-scale in-migration into Indonesia.

Language mapping is a key method for identifying linguistic diversity. As discussed by Patriantoro; Sintia et al.; Saddhono and Hartanto; Larizky and Widyastuti^[13–16], dialect geography can delineate linguistic boundaries based on phonological and lexical distinctions. These boundaries evolve with time and require updated, context-sensitive research. Toponymy also plays a central role in language geography. Frazer^[17] states that toponomastics illustrates the spatial spread of language. Poenaru^[18] defines toponymy as the study of place names and their linguistic significance. Toponyms reflect community values and cultural identity^[18–21], affirming their value in revealing linguistic characteristics of a population. Within Indonesia, prior work has examined naming in West Kalimantan^[11] and national patterns of natural/constructed toponyms^[22]. However, these do not specifically resolve the IKN core area, motivating the present, site-specific analysis in Sepaku.

This study adopts a mixed-methods embedded design, where qualitative inquiry is the principal approach^[23]. Data are presented using spatial qualitative descriptive techniques, supported by tables and maps^[24]. Linguistic data were collected following the framework of language mapping^[25], through direct interviews and adjusted observations, limited by field constraints. Informants were selected purposefully to ensure spatial representation while maintaining sample manageability, specifically coverage targeted the east–west–north–south sectors of Sepaku and Adjacent Informant

Points (AIP) near suspected isoglosses, balancing access with representation at the sub-district scale. Kinship terminology was chosen as the main linguistic indicator due to its prevalence in daily speech and its utility for dialectometric isogloss identification^[26]. Geographic Information System (GIS) based spatial techniques were employed to quantify dialect variation^[27]. In parallel, toponymic data were collected through a census in Samboja and Sepaku, then analyzed morphologically to assess naming complexity. A spatial association analysis was conducted to explore correlations between kinship-based lexical differences and toponymic structures. The purpose of this study is to examine the spatial patterns and associations between language variation and place-name morphology in Sepaku Sub-district, the core area of Indonesia's future capital, Nusantara. It investigates lexical divergence in kinship terms and morphological features of toponyms across ethnic groups. Rather than predicting long-term trends, the study captures the present linguistic landscape, offering insights into the intersection of language and geography in a rapidly transforming socio-political context. This study contributes by 1) integrating dialectometry, toponymy, and GIS in one pipeline; 2) providing a reproducible dataset schema (points, names, coordinates); and 3) outlining policy levers for multilingual planning.

2. Methods

There are two main approaches in this study method, namely spatial pattern analysis and spatial association analysis. Spatial pattern analysis maps language use in Sepaku, particularly through kinship terms and toponymic morphology. Thirty-eight (30) kinship address terms were elicited from ten purposefully chosen informants in key linguistic areas. Informants provided pronunciations, variants, and meanings. These symbolic data were georeferenced to examine lexical variation and dialect boundaries. A dialectometric technique measured divergence between informants, following Gutter's classification as adapted by Ayatrohaedi^[25], identifying isoglosses and linguistic gaps. To make the thresholds explicit, Gutter's categories were used to label pairwise distances (see **Table 1**). Lauder's triangle method refined the analysis using triads of informant points. Additionally, toponymic data from forty-nine (49) place names were classified by syllable-structure types (e.g., VC = Vowel-

Consonant; CV = Consonant-Vowel; and CVC = Consonant-Vowel-Consonant) to assess complexity.

For the map of language distribution in Penajam Paser Utara Regency and the map of languages and toponyms distribution in Sepaku Sub-district, administrative boundaries were obtained from Indonesia's Geospatial Information Agency (BIG) shapefiles for East Kalimantan Province (2022). All overlays, including dialectometric isoglosses, toponym locations, and symbolization, were derived from field-survey data (2023). The cartography was produced by the authors and, where applicable, adapted in accordance with Indonesian cartographic standards and the licensing terms of the underlying datasets. Spatial mapping and overlay techniques were used to examine the alignment of linguistic variation and toponymic patterns, with agreement assessed via co-location counts and within-area summaries (percentage agreement across isogloss zones).

This sequence ensures that pattern identification (mapping and dialectometry) precedes association testing (overlay and agreement measures). The thresholds for lexical differences follow Gutter's classification (see **Table 1** below). All steps (elicitation list, distance thresholds, overlay agreement) are specified to enable replication in other districts, supporting cross-site comparison of linguistic-toponymic coupling. Purposive spatial sampling to ensure coverage of east-west-north-south sectors and AIP near suspected isoglosses while keeping the design tractable at the sub-district scale. Ten adult informants (N = 10) were selected across villages with contrasting linguistic profiles. Basic demographics such as age range, gender, education, length of residence, ethnic affiliation, and first language. This spatially-focused sample is standard for village-scale dialect surveys. It prioritizes geographic information over population representativeness and is appropriate for an exploratory baseline map.

Table 1. Degrees of difference in word classification (Gutter's thresholds).

Lexicon Word Difference (%)	Classification
<20	No Differences
21–30	Speech Differences
31–50	Sub-Dialectal Differences
51–80	Dialectal Differences
>80	Different Languages

Source: Gutter's classification by Ayatrohaedi^[25].

Toponymic data in Sepaku Sub-district were collected

through a field census covering all villages and administrative units in the study area. The analysis focused on toponyms referring to natural features (e.g., rivers, hills, forests) and administrative regions (e.g., hamlets, villages). Sampling prioritized locations near suspected linguistic boundaries and areas with higher linguistic diversity to test whether name morphology reflects cultural–linguistic distinctions. By including both natural and administrative to-

ponyms, the study aimed to capture diverse naming practices influenced by local languages and dialects. This approach enabled a comprehensive understanding of how language use is embedded in spatial and cultural contexts. In total, forty-nine (49) toponyms formed the empirical basis for classifying naming patterns and examining their spatial correspondence with the linguistic landscape; a detailed list and classification are provided in **Table 2** below.

Table 2. List and classification of toponyms in Sepaku Sub-district.

No	Description	Toponym (Village)	Coordinate (Lang/Lot)
1	Regional administration	Argo Mulyo	–0°55'37.012" with 116°51'3.245"
2		Binuang	–1°4'23.664" with 116°39'46.148"
3		Bukit Raya	–0°54'31.095" with 116°45'48.333"
4		Bumi Harapan	–0°57'9.623" with 116°44'20.394"
5		Karang Jinawi	–0°51'39.528" with 116°47'37.190"
6		Semoi Dua	–0°56'37.752" with 116°52'48.608"
7		Sukaraja	–0°54'41.434" with 116°47'15.591"
8		Suko Mulyo	–0°54'44.887" with 116°53'3.061"
9		Telemow	–1°4'47.766" with 116°41'23.855"
10		Tengin Baru	–0°54'46.184" with 116°48'59.871"
11		Wono Sari	–0°57'52.009" with 116°49'4.631"
12		Maridan	–1°5'46.093" with 116°41'22.481"
13		Mentawir	–1°1'18.460" with 116°46'14.054"
14		Pemaluan	–1°2'36.719" with 116°39'48.884"
15		Sepaku	–0°53'57.199" with 116°45'56.200"
16	Relief	Gunung Parung	–0°49'19.30" with 116°47'7.03"
17	Small island	Batu Payau	–1°6'23.130" with 116°43'48.373"
18		Benawa Besar	–1°4'31.547" with 116°43'56.750"
19		Benawa Kecil	–1°5'19.500" Lang 116°44'3.536"
20		Bumi Harapan Satu	–1°8'7.849" with 116°42'43.860"
21		Cempa Dua	–1°7'54.768" with 116°42'54.526"
22		Cempa Satu	–1°7'43.118" Lang 116°42'33.075"
23		CempaTiga	–1°7'41.384" with 116°42'52.918"
24		Datuk	–1°7'35.952" with 116°42'56.130"
26	Small island	Jawang	–1°7'33.992" with 116°42'52.133"
27		Jepang	–1°7'18.411" with 116°42'29.097"
28		Kelawasan	–1°5'52.569" with 116°43'5.267"
29		Kemantis	–1°5'15.020" with 116°43'34.907"
30		Lipan	–1°6'38.493" with 116°43'34.457"
31		Maridan	–1°2'57.039" with 116°43'37.102"
32		Mentawir Dua	–1°1'14.332" with 116°44'40.523"
33		Mentawir Satu	–0°59'28.406" with 116°46'23.526"
34		Mentawir Tiga	–0°59'2.129" with 116°46'53.777"
35		Pelarian	–0°58'54.405" with 116°46'53.723"
36		Selumut	–0°58'45.769" with 116°46'51.688"
37		Tempadung	–0°58'37.814" with 116°46'49.589"

Table 2. *Cont.*

No	Description	Toponym (Village)	Coordinate (Lang/Lot)
38	Water body	Sei Parung	–0°49'15.492" with 116°47'4.812"
39		Sei Seluang	–0°58'32.883" with 116°46'53.330"
40		Sei Sepaku	–0°57'46.577" with 116°45'32.214"
41		Sei Sepaku	–0°54'24.984" with 116°46'10.416"
42		Sei Sepaku	–0°53'1.190" with 116°41'27.907"
43		Sei Sanggai	–0°58'42.133" with 116°44'23.718"
44		Sei Sanggai	–0°57'54.801" with 116°44'53.300"
45		Sei Seluwong	–0°56'52.575" with 116°50'36.561"
46		Sei Tengin	–0°54'56.484" with 116°50'17.160"
47		Sei Tilmon	–1°1'10.236" with 116°50'36.564"
48		Sungai Trunen	–0°58'43.813" with 116°42'2.518"
49		Sei Trunen	–0°58'57.360" with 116°42'23.940"

Source: Analysis of survey data collected in 2023.

Toponym entries in **Table 2** were reconciled with field notes and map annotations to ensure consistent spelling and category labels (Regional Administration, Relief, Small Island, Water Body). Syllable codings used are CV, CVC, VC, etc. They were rechecked against the same name list to maintain one-to-one correspondence. For the dialectometric results, pairwise Calculation Results (CR) were re-computed and checked for symmetry and threshold assignment under Gutter's scheme (**Table 1**). Overlay alignment between AIP links and the regency-scale map was verified so that all plotted connections reflect AIP only. Geographic coordinates for every toponym were validated for plausibility within the Sepaku/Samboja. Spatial processing and cartographic compilation were carried out in a GIS with the reproducible inputs comprising names/categories and coordinates, which together permit independent re-mapping of the dataset.

3. Results

3.1. Spatial Pattern Analysis

The dialectometric calculations presented in **Table 3** and map in **Figure 1** serve as an important analytical framework to quantify linguistic variation among AIP in Sepaku Sub-district. **Table 3** and map in **Figure 1** offer a detailed classification of linguistic relationships between informants, organizing them into hierarchical categories of difference, namely Speech Differences (SD), Sub-dialectal Differences (SDD), Dialectal Differences (DD), and Different Languages (DL). These classifications allow for a structured interpretation of linguistic divergence and interaction across the study region. Across the AIP pairs listed in **Table 3**, eight (8) pairs

are classified as DL, five (5) as DD, one (1) as SDD, one (1) as SD, and one (1) as ND. E.g., cases include AIP 2–3, 3–5, 4–5, 5–6, 3–7, 4–7, 7–8, and 9–10 (CR ≥ 84%). DD classifications appear for AIP 3–4, 4–6, 4–8, 6–8, and 8–9 (58%–72%). Lower divergence is observed for AIP 2–7 (SDD, 34%), AIP 1–2 (SD, 21%), and AIP 1–7 (ND, 18%). These outcomes delineate contrasts and continuities among neighboring AIP pairs without assigning causal explanations.

Table 3. Degrees of difference in word classification.

AIP	CR	D	Term
1–2	21%	SD	Speech Differences
2–3	97%	DL	Different Language
3–4	71%	DD	Dialectal Differences
3–5	84%	DL	Different Language
4–5	84%	DL	Different Language
5–6	92%	DL	Different Language
4–6	66%	DD	Dialectal Differences
1–7	18%	ND	No Differences
2–7	34%	SDD	Sub-Dialectal Differences
3–7	95%	DL	Different Language
4–7	84%	DL	Different Language
7–8	82%	DL	Different Language
4–8	58%	DD	Dialectal Differences
6–8	72%	DD	Dialectal Differences
8–9	68%	DD	Dialectal Differences
9–10	89%	DL	Different Language

Source: Analysis of survey data collected in 2023.

Information: Adjacent Informant Points (AIP); Calculation Result (CR); Description (D).

Table 3 above shows measured differences among neighboring AIP, including DL pairs (e.g., AIP 2–3, 5–6), DD pairs (e.g., AIP 3–4, 6–8), and low differences (e.g., AIP 1–7, ND). Descriptions here report observed values and labels only. **Figure 1** below shows the broader spatial distribution of languages across Penajam Paser Utara

Regency, which includes the core development area of Indonesia's new capital, Nusantara. As shown on the map, the region is home to sixteen (16) distinct languages, including indigenous ones like Paser, Tunjung, and Kenyah, as well as migrant languages such as Javanese and Bugis. By visualizing the geographical spread of these linguistic communities, the map presents where languages are observed across the regency scale. Compared with the national language map by KEMDIKTISAINTEK RI for Indonesian Language and Maps^[27] based on data from 1992–2019^[26], **Figure 1** and the dialectometric results in **Table 3** show the descriptive differences, namely 1) Expansion of Javanese-speaking areas in parts of eastern Sepaku relative to KEMDIKTISAINTEK RI for Indonesian Language and Maps^[27]; this is consistent with the 97% difference between AIP 2 (Javanese-speaking) and AIP 3 (Paser-speaking); 2) More limited spatial coverage for some indigenous languages (e.g., Paser) relative to KEMDIKTISAINTEK RI for Indonesian Language and Maps^[27], with high CR values (e.g., 84%, 92%) indicating DL between selected AIP; 3) Sharper local separations among adjacent communities, e.g., 84% between AIP 5–6 (Paser vs. Balik) and 89% between AIP 9–10 (Banjar vs. Bugis); 4) Transitional/overlapping indications at intermediate levels, e.g., DD at 72% (AIP 6–8) and SDD at 34% (AIP 7–9); and 5) Recognition of smaller/previously under-represented groups (e.g., Tunjung, Basap) not differentiated in KEMDIKTISAINTEK RI for Indonesian Language and Maps^[27]. While **Figure 1** captures regency-scale distributions, fine-grained sub-district boundaries and interactions are summarized through AIP-level results in **Table 3**.

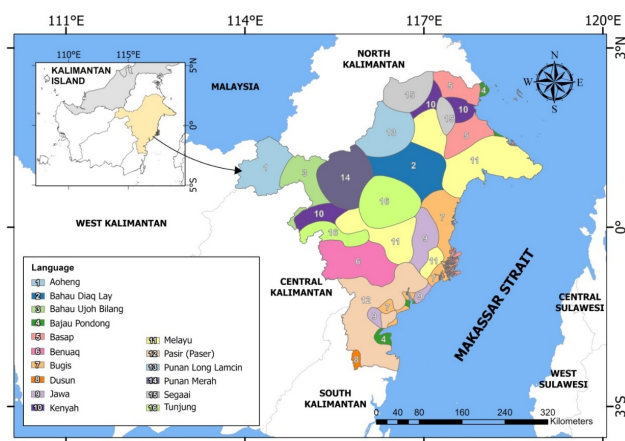


Figure 1. Map of language distribution in Penajam Paser Utara Regency.

Sources: Field survey and data analyses, 2023; and data shapefiles for administrative boundaries from BIG for East Kalimantan Province, 2022.

3.2. Toponymic Analysis

The toponymic data collected in this study were examined through syllabic structure analysis, offering insight into the linguistic complexity and morphological patterns of place names across the region. The analysis relied on official toponyms recorded in government documents and verified through field-based observations. While most toponyms are written and articulated in Indonesian, the official administrative language used in both Samboja and Sepaku Sub-districts, a considerable number of place names also reflect the linguistic influence of locally spoken languages, including Javanese, Paser, Banjar, and Balik. In numerous cases, place names display dual or layered linguistic identities. Official names in Indonesian frequently coexist with colloquial forms used within indigenous or local dialects. This coexistence demonstrates that toponyms serve not only as administrative identifiers but also as cultural expressions, preserving elements of traditional language and heritage. Such patterns resemble findings in multilingual regions like Voronezh, Russia, where official place names are accompanied by local variants in minority languages or dialects^[28]. The syllabic analysis identified clear distinctions between toponyms referring to administrative regions (e.g., villages) and those denoting natural features (e.g., rivers, islands, and ridges), as outlined in **Tables 4** and **5**. Guided by these tables, the principal observations are as follows.

- Administrative toponyms (**Table 4**): 1) The modal syllable count is four: 8/15 village names are four-syllable (Argo Mulyo, Bukit Raya, Pemaluan, Semoi Dua, Sukaraja, Suko Mulyo, Tengin Baru, Wono Sari); 2) Three-syllable forms occur in 5/15 (Binuang, Mari-dan, Mentawir, Sepaku, Telemow), and five-syllable forms occur in 2/15 (Bumi Harapan, Karang Jinawi); 3) Syllable shapes are dominated by CV and CVC, with limited VC and occasional single V tokens (e.g., Semoi Dua); 4) Vowel-final endings are frequent: 9/15 names end in a vowel (Argo Mulyo, Bukit Raya, Karang Jinawi, Semoi Dua, Sepaku, Sukaraja, Suko Mulyo, Tengin Baru, Wono Sari), while consonant-final endings (e.g., -ng, -n, -r, -w) are less common. These counts foreground the salient patterns in **Table 4**.
- Natural-feature toponyms (**Table 5**): 1) CV and CVC also predominate, where the only CCV onset recorded

is “Trunen” (CCV–CVC); 2) The longest sequence is seven syllables in “Bumi Harapan Satu” (CV–CV–CV–CV–CVC–CV–CV); 3) River names are typically concise (2–3 syllables; CV/CVC patterns such as Parung, Sanggai, Seluang, Seluwong, Sepaku, Tengin, Tilmon, Trunen), whereas small-island names more often span 4–6 syllables (e.g., Benawa Besar, Benawa Kecil, Kelawasan, Kemantis, Mentawir Dua, Mentawir Satu, Mentawir Tiga); and 4) Ridge entries in this dataset are sparse (e.g., Parung) and follow the same CV–CVC tendency.

- Syllable-structure note: Administrative names frequently adhere to the CV template common to Indonesian and local Austronesian languages; natural toponyms show greater variation in length while re-

maining CV/CVC-dominant. The detailed structural breakdown is provided in **Table 4** (villages) and **Table 5** (natural features), distinguishing syllable types (e.g., CV, CVC, VC; e.g., Ar-go, Bu-mi, Buk-it).

The overall analysis reveals that toponyms in Sepaku and Samboja embody a dynamic relationship between Indonesian, as the formal linguistic framework, and local vernaculars, which contribute to the richness of the region’s cultural-linguistic identity. These layered naming practices reflect historical settlement patterns, social integration, and evolving linguistic ecologies. The detailed structural breakdown of these toponyms is provided in **Tables 4** and **5** below, which distinguish between syllable types (e.g., CV, CVC, VC) and illustrate the differences in naming conventions across administrative and natural categories.

Table 4. Constituent syllables of villages named in Sepaku Sub-district.

No	Villages	Syl ¹	Syl ²	Syl ³	Syl ⁴	Syl ⁵
1	Argo Mulyo	VC	CV	CVC	CV	-
2	Binuang	CV	CV	VC	-	-
3	Bukit Raya	CV	CVC	CV	CV	-
4	Bumi Harapan	CV	CV	CV	CV	CVC
5	Karang Jinawi	CV	CVC	CV	CV	CV
6	Maridan	CV	CV	CVC	-	-
7	Mentawir	CVC	CV	CVC	-	-
8	Pemaluan	CV	CV	CV	VC	-
9	Semoi Dua	CV	CVC	CV	V	-
10	Sepaku	CV	CV	CV	-	-
11	Sukaraja	CV	CV	CV	CV	-
12	Suko Mulyo	CV	CV	CVC	CV	-
13	Telemow	CV	CV	CVC	-	-
14	Tengin Baru	CV	CVC	CV	CV	-
15	Wono Sari	CV	CV	CV	CV	-

Source: Analysis of survey data collected in 2023.

Description: VC = Vowel-Consonant (e.g.: Ar-go); CV = Consonant-Vowel (e.g.: Bu-mi); CVC = Consonant-Vowel-Consonant (e.g.: Buk-it); and V = Single vowel (e.g.: syllables a, i) “-” = No fifth syllable (short name).

Table 5. Constituent syllables of natural appearances named in Sepaku Sub-district.

Types	No	Toponym	Syl ¹	Syl ²	Syl ³	Syl ⁴	Syl ⁵	Syl ⁶	Syl ⁷
River (Sei/Sungai)	1	Parung	CV	CVC	-	-	-	-	-
	2	Sanggai	CVC	CVC	-	-	-	-	-
	3	Sanggai	CVC	CVC	-	-	-	-	-
	4	Seluang	CV	CV	VC	-	-	-	-
	5	Seluwong	CV	CV	CVC	-	-	-	-
	6	Sepaku	CV	CV	CV	-	-	-	-
	7	Sepaku	CV	CV	CV	-	-	-	-
	8	Sepaku	CV	CV	CV	-	-	-	-
	9	Tengin	CV	CVC	-	-	-	-	-
	10	Tilmon	CVC	CVC	-	-	-	-	-
	11	Trunen	CCV	CVC	-	-	-	-	-
	12	Trunen	CCV	CVC	-	-	-	-	-

Table 5. *Cont.*

Types	No	Toponym	Syl ¹	Syl ²	Syl ³	Syl ⁴	Syl ⁵	Syl ⁶	Syl ⁷
Small Island	13	Batu Payau	CV	CV	CV	CVC	-	-	-
	14	Benawa Besar	CV	CV	CV	CV	CVC	-	-
	15	Benawa Kecil	CV	CV	CV	CV	CVC	-	-
	16	Bumi Harapan Satu	CV	CV	CV	CV	CVC	CV	CV
	17	Cempa Dua	CVC	CV	CV	V	-	-	-
	18	Cempa Satu	CVC	CV	CV	CV	-	-	-
	19	Cempa Tiga	CVC	CV	CV	CV	-	-	-
	20	Datuk	CV	CVC	-	-	-	-	-
	21	Demis	CV	CVC	-	-	-	-	-
	22	Jawang	CV	CVC	-	-	-	-	-
	23	Jepang	CV	CVC	-	-	-	-	-
	24	Kelawasan	CV	CV	CV	CVC	-	-	-
	25	Kemantis	CV	CVC	CVC	-	-	-	-
	26	Lipan	CV	CVC	-	-	-	-	-
	27	Maridan	CV	CV	CVC	-	-	-	-
	28	Mentawir Dua	CVC	CV	CVC	CV	V	-	-
	29	Mentawir Satu	CVC	CV	CVC	CV	CV	-	-
	30	Mentawir Tiga	CVC	CV	CVC	CV	CV	-	-
	31	Pelarian	CV	CV	CV	VC	-	-	-
	32	Selumut	CV	CV	CVC	-	-	-	-
	33	Tempadung	CVC	CV	CVC	-	-	-	-
Ridge	34	Parung	CV	CVC	-	-	-	-	-

Source: Analysis of survey data collected in 2023.

In **Table 4** shows the constituent syllables of village names in Sepaku Sub-district, focusing on their phonological composition, specifically syllable structures such as VC, CV, and CVC. The majority of village names follow simple and regular patterns, dominated by CV and CVC structures. This reflects a regional preference for phonologically straightforward and easily articulated syllables, consistent with both the phonotactics of the Indonesian language and the structure of many local languages. However, several names, such as Karang Jinawi and Bumi Harapan, extend to four or five syllables, incorporating more complex morphophonemic constructions. These extended forms often reflect semantic elaboration, such as references to natural features (Karang, Bumi) or aspirational terms (Harapan, Mulyo), suggesting a blend of geographical and cultural significance in naming conventions. Similarly, natural feature names analyzed in **Table 5** exhibit structural similarities with village names, frequently employing CV and CVC patterns. However, they tend to show greater variability in syllable length and complexity, e.g., names such as Bumi Harapan Satu and Mentawir Tiga span five or more syllables, while others like Tilmon or Datuk remain concise. This variability is likely influenced by both linguistic factors and functional naming needs, especially in denoting specificity among geograph-

ically proximate features (e.g., Cempa Satu, Cempa Dua, Cempa Tiga).

A notable observation from both tables is the predominance of vowel-final syllables, particularly a, i, and u. This pattern, observed in at least thirteen instances, reinforces the tendency toward open syllables, which are typical in Austronesian languages and align with common pronunciation norms in both formal Indonesian and regional vernaculars. Another striking feature is the near absence of certain consonants such as f, q, v, x, and z across all recorded toponyms. This aligns with the phonological inventory of many local languages, which generally exclude these sounds, thereby influencing naming conventions even in formally registered place names. When analyzed collectively, toponyms in Sepaku Sub-district reveal a preference for three- to four-syllable constructions. Fourteen names in each category (village and natural features) fall within this range, indicating a consistent pattern. These names are especially concentrated in the eastern and southwestern zones of the sub-district, suggesting spatial clustering influenced by both linguistic tradition and settlement history. The integrated analysis of **Tables 4** and **5** shows how linguistic and cultural factors intertwine in the formation of place names. The widespread adoption of CV and CVC syllables across categories signals a shared

phonological template that underscores simplicity, clarity, and oral accessibility. Meanwhile, the diversity in syllable count and structural complexity reflects layered historical influences, ranging from indigenous traditions to administrative standardization, and responds to both environmental descriptors and sociocultural values. This pattern complements the dialectometric distinctions identified in **Table 3**, where regions of linguistic diversity correspond to areas with more complex and varied toponymic structures. The clustering of shorter names in more linguistically homogeneous areas, contrasted with longer, semantically loaded names in culturally diverse or transitional zones, suggests a dynamic interaction between language, geography, and identity in Sepaku Sub-district. These findings reinforce the importance of toponymy not merely as a labeling system, but as a window into the sociohistorical and linguistic landscape of a region undergoing significant transformation.

3.3. Spatial Association Analysis

As shown in the map of language and toponyms in **Figure 2**, a spatial analysis was conducted to examine the relationship between the distribution of languages and the structural characteristics of toponyms in the region. The map highlights patterns of correlation between linguistic usage and the morphological complexity of place names across different regions.

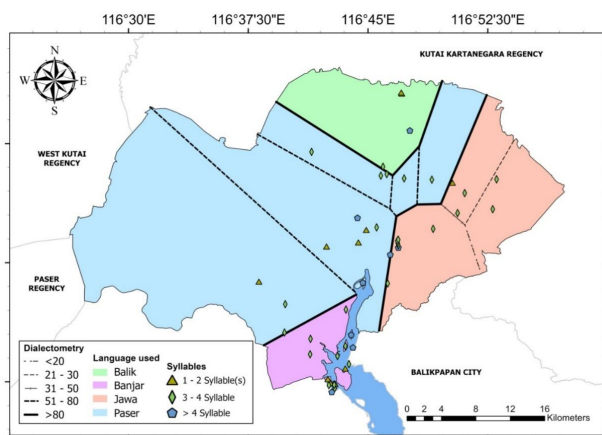


Figure 2. Map of languages and toponyms distribution in Sepaku Sub-district.

Sources: Field survey and data analyses, 2023; and data shapefiles for administrative boundaries from BIG for East Kalimantan Province, 2022.

Figure 2 above shows a clear spatial co-location pattern between language distribution and the syllabic complexity of toponyms in Sepaku Sub-district. A simple overlay-

agreement check also indicates non-random alignment across isogloss zones. In regions predominantly inhabited by Javanese-speaking communities, place names tend to exhibit greater structural complexity, typically comprising three to four syllables. This is consistent with the general naming tendencies found in other regions settled by Javanese migrants. In contrast, regions primarily occupied by Balik and Paser speakers are generally characterized by simpler toponyms, most of which consist of only one or two syllables. These patterns suggest a preference for concise phonological forms in regions where indigenous languages predominate.

However, several notable exceptions disrupt this general trend. One such anomaly is indicated by the pentagon symbol on the map, representing toponyms with more than four syllables, a category that appears in regions where simpler naming conventions would otherwise be expected. An e.g., found in Pulau Mentawir Satu and Pulau Mentawir Dua, both situated in a Javanese-dominated zone. The root name Mentawir originates from the Paser word Mentawar or Menawar, meaning “antidote”, which refers to a spring historically used as a traditional remedy for smallpox. This name has been consciously preserved as a result of a communal decision to retain regional linguistic identity, despite demographic shifts brought about by immigration. Conversely, in regions where Balik or Paser speakers reside, some place names display unexpected levels of morphological complexity, e.g., the village of Sukaraja, located near Informant 4 on the map, features a name that departs from the indigenous naming pattern. Sukaraja is an acronym for Sumatra, Kalimantan, Madura, and Java, representing the ethnic origins of migrants who settled in the region during the RE-PELITA. The toponym, therefore, reflects a layered cultural history shaped by government-led transmigration programs and inter-island migration. Despite these anomalies, the linguistic zones surrounding Sukaraja, as well as Balik- and Paser-speaking regions more broadly, still exhibit relatively limited toponymic variation compared to other parts of the sub-district. In particular, the southern region of Sepaku Sub-district, encompassing villages such as Telemow, Maridan, and Binuang (clustered around Informant 10), stands out for its high degree of syllabic and linguistic diversity. This elevated complexity is closely associated with the substantial influx of migrants arriving via riverine and coastal transport routes from Balikpapan City. As a result, these

three villages have become convergence points for multiple cultural and linguistic groups. The increased heterogeneity has led to the emergence of place names that are semantically abstract and often defy classification within standard toponymic frameworks. These naming patterns reflect both the evolving social fabric of the region and the cumulative influence of diverse migratory and linguistic processes.

4. Discussion

From study by Poenaru^[18] suggests that toponyms function as linguistic markers, reflecting the historical and cultural identity of a people. It investigates the relationship between spoken languages and the morphological complexity of place names in Sepaku Sub-district. The linguistic landscape is divided into four main zones, namely Paser, Balik, Javanese, and Banjar, shaped by demographic trends and state-sponsored transmigration programs. As Anderson; Suryanarayan and Khalil^[29,30] notes, population movements and subsequent settlement patterns significantly shape a region's linguistic and cultural composition. Methodological differences explain the contrast between this study's findings and official maps, which list only Paser and Bugis. Local languages were mapped using 38 kinship terms presented to 10 purposefully selected informants. Their locations were geo-referenced, and lexical variations were analyzed through the inter-village triangle method^[13]. Dialectometric differences were classified using Guitter's typology^[25], capturing patterns often missed by official surveys. These linguistic variations were quantified and visualized spatially to delineate dialect boundaries. Three key findings emerged, namely 1) Four dominant languages were identified, namely Javanese in the east, Paser in the west, Balik in the north, and Banjar in the south, differing from national language agency maps (see **Figure 1**); 2) Toponymic complexity varies spatially, namely disyllabic names dominate the north and southwest; tri- to tetrasyllabic names appear in the east and center; and the south features the most variation (**Figure 2**). This aligns with Darmayanti et al.^[26] claim that toponymic structure reflects community linguistics, as seen in contrasts like Teluk versus Karangjati; and 3) There is a strong spatial link between language zones and toponymic structures, as supported by Teerarojanarat and Tingsabadh; Di Carlo and Pizziolo; Liu et al.; Fernández et al.; Osrnita et al.^[31–35], suggest-

ing linguistic heterogeneity corresponds to naming diversity. Moreover, overlay mapping of kinship terms and place names revealed clear spatial correlations between lexical divergence and toponymic morphology. Despite its contributions, the study faces two limitations, namely its focus on kinship terms and restriction to administrative and natural toponyms. Cacciapoco and Cavallaro; Fadillah and Cholsy; Tent^[36–38] encourages broader toponymic research to better capture sociolinguistic dynamics. Our lexical scope centers on kinship terms, and our toponym sample emphasizes administrative and natural features; expanding to phonology/morphosyntax and constructed/commercial toponyms will test robustness. Multi-site replications and formal spatial statistics (e.g., permutation-based overlay agreement, join-count for categorical surfaces) can further generalize the approach.

Interpreting spatial pattern analysis results, the identification of DL pairs (e.g., AIP 2–3, 5–6), DD/SDD transitions (e.g., AIP 6–8; AIP 7–9), and ND (AIP 1–7) indicates sharp contrasts coexisting with graded interfaces, consistent with contact, diffusion, and multilingual practices at local scales. In Sepaku, the east–west and north–south patterning is consistent with demographic mobility and state-led settlement histories noted by Anderson^[29], including the Five-Year Development Plan (REPELITA) era transmigration that increased the presence of Javanese-speaking communities in more accessible/eastern areas, while Paser, Balik, and Banjar communities retained core territories elsewhere. This helps explain divergences from KEMDIKTISAINTEK RI for Indonesian Language and Maps^[27] based on earlier data^[26], since the present study captures recent sub-district dynamics that are coarser or absent in prior surveys. Historical maritime exchange along the Makassar Strait aligns with concentrations of Malay- and Banjar-speaking communities, while inland migratory trajectories of Dayak groups (e.g., Kenyah, Bahau) align with northern/central distributions, consistent with broader accounts in the study of Osrnita et al.^[35]. Zones with intermediate CR (DD/SDD) reflect transition belts where shared vocabulary and phonological features accumulate through proximity, commuting, and intermarriage, producing the observed gradients in **Table 3** and **Figure 1**. The study shows that language use and toponymy reflect cultural memory and heritage. Local languages serve as anchors of identity and tradition. The coexistence of Paser,

Balik, Javanese, and Banjar names reflects the cultural interplay shaped by transmigration. Amid IKN Nusantara's development, documenting and integrating local linguistic assets into planning is needed so that mobility and infrastructure expansion do not erode community linguistic capital. Preserving these languages and names amid IKN Nusantara's development is crucial to safeguarding Indonesia's rich socio-cultural fabric. As local languages encode identity and oral history, they should be integrated into national development strategies, particularly in dynamic regions like Sepaku.

5. Conclusions

Based on the analysis and discussion presented in this study, the linguistic landscape of Sepaku Sub-district is divided into four dominant zones, namely Balik in the north, Javanese in the east, Paser in the west, and Banjar in the south. This configuration reflects the influence of historical migration, especially the REPELITA-era transmigration program, and ongoing sociolinguistic dynamics. Toponymic complexity also shows spatial variation, categorized into three morphological patterns, namely 1) simple toponyms, with two syllables, dominate the north and southwest; 2) moderately complex names, with three to four syllables, appear in the eastern and central regions; and 3) complex toponyms, with more than four syllables, are found in the south. The strong spatial alignment between dialectal boundaries and toponymic structure confirms a significant association between language zones and naming patterns. Although a few anomalies appear, such as longer names in zones of simpler linguistic structure, these can be interpreted through the lens of migration history and sociocultural adaptation. The linguistic and toponymic diversity in Sepaku, as evidenced by dialectometric and spatial analyses, highlights the cultural interplay between indigenous and migrant communities. This study underscores the importance of integrating linguistic and cultural insights into policy-making, particularly in development zones like Indonesia's future capital, Nusantara. As Sepaku experiences rapid demographic and infrastructural shifts, safeguarding its linguistic heritage becomes essential for maintaining the region's pluralistic identity. Beyond Sepaku, the integrated workflow provides a practical template for documenting and planning in multilingual settings subject to rapid demographic change.

Author Contributions

Conceptualization, N.M. and Y.; methodology, T., B.H.S.P., and N.D.; field survey, N.M., Y., T., B.H.S.P., M.R., A.R., A.P., M., H., W., and O.D.; formal analysis, N.M., Y., T., A.R., N.D., I.Y., and A.P.; writing—original draft preparation, N.M., Y., N.D., I.Y., and A.P. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This study involved non-identifiable linguistic elicitation (kinship terms) and toponymic field observations at the settlement level. No personal data was collected, recorded, or published. In accordance with our institution's guidance, this work was assessed as minimal-risk and exempt from formal Institutional Review Board (IRB) review because it does not involve a human subjects study as defined by applicable regulations. The study adheres to the principles of the Declaration of Helsinki, where relevant to social study ethics (voluntariness, anonymity, and non-harm). There is no evidence in the text of plagiarism, fabrication, duplicate publication, or simultaneous submission.

Informed Consent Statement

Before brief elicitation, adult informants provided verbal informed consent after being told the purpose of the study, that participation was voluntary, and that no names or personal identifiers would be collected. No individually identifiable information is reported.

Data Availability Statement

Administrative boundary shapefiles were sourced from the BIG and East Kalimantan (2022), and used in accordance with licensing terms. Field toponym coordinates and anonymized lexical summaries (aggregate, non-identifiable) can be shared upon reasonable request to the corresponding author.

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Conflicts of Interest

The authors declare no conflict of interest.

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