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Digital Banking Rivalry in Indonesia: ML-Powered Analysis and Forecasting Using Search Data for Top 5 Banks

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ABSTRACT

The growing adoption of digital banking in Indonesia has heightened competition among financial institutions, prompting the need for data-driven insights to understand consumer behavior. This research investigates public interest in Indonesia's five leading digital banks: SeaBank, Bank Jago, Bank Neo Commerce (BNC), blu by BCA Digital, and Allo Bank. The analysis utilized Google Trends data from 2019 to 2024. The primary goal is to explore how search behavior reflects market competition, regional adoption, and potential strategies for stakeholder decision-making. To achieve this, this research employed a quantitative approach using descriptive analysis, time-series forecasting, and clustering. ARIMA and Prophet models were applied to forecast future interest trends, while clustering techniques identified similarities in regional and temporal patterns. ARIMA is found to be more accurate for stable trends, whereas Prophet effectively detects seasonal variations. Google Trends data, while innovative and timely, has limitations as a proxy for actual consumer behavior. However, it provides valuable directional insights. For instance, SeaBank and Bank Jago show sustained interest due to their integration with ecosystem like Shopee and Gojek, respectively. In contrast, Allo Bank's popularity appears to be mostly driven by events, making it more short-lived. This research, theoretically, contributes to the fields of fintech and consumer analytics by demonstrating that search interest reflects engagement with digital banking. Practically, it provides strategic recommendations for geo-targeted marketing, ecosystem partnerships, and identification of underserved areas. These findings can help digital banks enhance their regional outreach and establish a strong brand presence in Indonesia's evolving financial landscape.

Keywords: consumer behavior; digital banking; Google Trends; Indonesia; machine learning

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INTRODUCTION

Indonesia's banking industry has undergone significant transformation in recent years. The transformation is largely due to the rise of digital banking platforms that serve an increasingly connected and tech-savvy consumers. This change is supported by widespread internet access, growing smartphone usage, and proactive financial regulation. According to the Financial Services Authority (Indonesian: *Otoritas Jasa Keuangan*, abbreviated as OJK), the total assets of Indonesian banks reached IDR 11,708.02 trillion as of February 2024, reflecting a 6.95% year-on-year growth (OJK, 2024). Notably, digital-native banks such as SeaBank, Bank Jago, Bank Neo Commerce (BNC), blu by BCA Digital, and Allo Bank have experienced a substantial increase in asset accumulation, indicating a rapid adoption of digital financial services by customer.

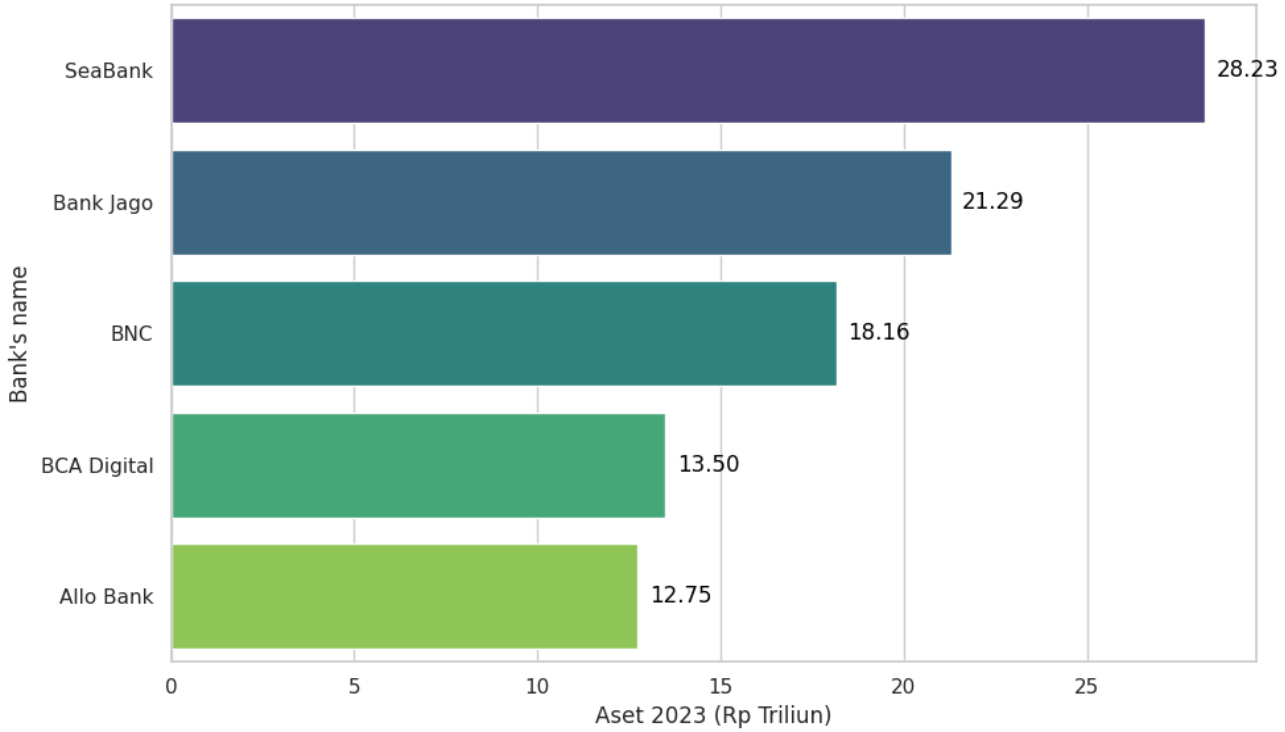

Figure 1. Top 5 digital with the largest assets in Indonesia (2023)
Source: finansial.bisnis.com

The expansion of digital banking in Indonesia is not limited to SeaBank, Bank Jago, Bank Neo Commerce (BNC), blu by BCA Digital, and Allo Bank, as five major players. Jenius, launched by Bank BTPN in 2016, was one of the country's earliest digital banking pioneers. Its launch marked a critical inflection point in shifting consumer expectations around financial technology. Other entrants, including LINE Bank (by Hana Bank) and Bank Saqu (a more recent initiative by BCA Digital), further contribute to the growing diversity of digital banking models in the country. This proliferation of mobile-first institutions suggests that digital banking has moved beyond experimentation, becoming a competitive mainstream segment.

Alongside institutional developments, user behavior is also changing. Bank Indonesia reported that digital transactions via mobile banking increased by 39.1% in 2024, while internet banking grew by 4.4% (Bank Indonesia, 2024). QR-based digital payments (QRIS) rose by a remarkable 175.2% year-on-year. These indicators reflect a substantial shift in consumer preferences toward real-time,

technology-enabled banking solutions. As fintech ecosystems expand, banks are increasingly adopting platform-based strategies to drive user engagement.

From a competitive standpoint, each digital bank adopts distinct strategies, whether through ecosystem integration (e.g., SeaBank with Shopee, Bank Jago with Gojek), marketing campaigns (as seen with Allo Bank), or established-brand stability (as in blu by BCA Digital). However, few studies have systematically assessed how public attention toward these banks fluctuates over time and across regions, particularly using behavioral indicators such as search engine data.

Despite the relevance of understanding consumer awareness and visibility, most academic literature in Indonesia still focuses on adoption factors such as perceived usefulness, ease of use, and trust (Waliullah et al., 2025) or on institutional innovations (Twimbit, 2023). While such studies offer valuable insights, they do not address the competitive dynamics among digital banks as perceived by the general public in real-time.

This gap is where our research is situated. The researchers proposed a novel approach that integrates Google Trends search data as a proxy for public interest with Machine Learning (ML) methods to analyze competitive dynamics among Indonesia's top five digital banks. Google Trends data allows us to trace fluctuations in consumer search behavior, offering a behavioral lens on brand visibility and interest. Previous works (Choi & Varian, 2012; Ahmed *et.al*, 2017) have demonstrated the efficacy of Google Trends in forecasting consumer sentiment in financial market and economic activity. Yet, in the Indonesian digital banking context, this method remains underutilized.

To operationalize this approach, this research applied time-series forecasting models such as ARIMA and Prophet to predict trends in search interest and employed clustering techniques (e.g., k-means) to identify market segments with similar behavioral patterns. The aim of this research is to know how ML-powered analysis of search query data reveal competitive patterns and consumer preferences among Indonesia's digital banks.

Theoretically, this research draws real-time upon the Technology Acceptance Model (TAM) and the Diffusion of Innovation (DoI) theory. According to TAM, technology adoption is shaped by perceived ease of use and usefulness, which in the case of digital banks translates into features such as intuitive mobile apps, fast onboarding, and secure transactions (Lee & Shin, 2018). DoI theory explains how innovations spread through different user categories such as early adopters, early majorities, and so on. This concept is particularly relevant for capturing urban versus rural adoption trends (Cusumano et al, 2019). In this research, these theories are not merely referenced but operationalized: for example, search spikes in certain regions during a product launch may reflect diffusion dynamics, while long-term visibility could be attributed to perceived usefulness driving continuous engagement.

Given the rapid pace of change in digital financial services, traditional survey-based research is often unable to capture fast-moving trends. As argued by Hair et al. (2022) and Creswell & Creswell (2018), combining digital behavioral data with robust quantitative models offers greater empirical relevance in dynamic environments. This is especially important in Indonesia's competitive fintech sector, where digital attention can quickly shift due to marketing campaigns, ecosystem integration, or public events.

This research seeks to contribute both theoretically and practically. Theoretically, it bridges fintech and behavioral analytics by using public search data to research competition a method seldom applied in the Indonesian context. Practically, the insights generated can help banks optimize their marketing timing, identify untapped regional markets, and refine their digital strategies.

RESEARCH METHOD

This research employed a quantitative and explanatory research design to examine patterns of public interest and competition among Indonesia's top five digital banks; SeaBank, Bank Jago, Bank Neo Commerce (BNC), blu by BCA Digital, and Allo Bank. The analysis was based on Google Trends search data collected from January 2019 to December 2024. This research combined descriptive analytics, time-series forecasting, clustering, and external validation to build a comprehensive understanding of consumer attention dynamics in the digital banking landscape.

1. Data Source and Validity

The primary data source was Google Trends, a platform that captured aggregated, normalized search volume for specific queries over time. While this tool is increasingly used in behavioral analytics, its validity as a proxy for consumer interest depends on several factors. According to Choi & Varian (2012), Google Trends offers reliable real-time indicators of public attention, particularly in contexts where digital discovery precedes consumer decisions. However, there are some limitations to consider: (a) the researchers do not have access to precise search volumes, (b) the analysis relies on internet activity, which may not fully capture offline users, and (c) there is possibility of extraneous data from unrelated searches. These constraints are acknowledged and mitigated through triangulation with additional data sources.

2. Keyword Selection and Verification

To ensure data accuracy and consistency, each bank's keyword selection followed a systematic three-step procedure. Identification of commonly used terms based on user behavior (e.g., "SeaBank Indonesia", "Bank Jago app", "Neo Bank"). Testing across regions and languages to ensure the keywords reflect national-level relevance and were not biased toward specific demographics or local dialects. Validating data through comparison with official app store labels and social media hashtags. This process was designed to minimize semantic ambiguity and enhance representativeness. All data were filtered to "Indonesia" as the target geography, and only searched categories relevant to "Finance" were used to limit extraneous results.

3. Analytical Framework

The research followed an explanatory approach, aimed to uncover causal and correlative patterns in digital banking visibility and competition. The proposed analytical framework was structured into three primary relationships.

a. Search Volume (SV) was conceptualized as a proxy for consumer interest.
b. Time and Region were treated as moderating variables that affected SV distribution.
c. The integration of digital banks with ecosystems (e.g., Shopee, Gojek) was assessed as a contributing factor influencing SV, operationalized through clustering and comparative trend analysis.

These relationships were not tested through hypothesis testing per se, but were evaluated through pattern recognition, forecast comparison, and correlation analysis. It made the framework suitable for exploratory causal inference.

4. Forecasting Models and Justification

The research employed three forecasting techniques: ARIMA, Prophet, and LSTM (Long Short-Term Memory networks). Each technique was selected based on its strength in modeling time-series behavior.

a. ARIMA was used for modeling linear, stationary data and served as a benchmark due to its interpretability (Box et al., 2015).
b. Prophet, developed by Facebook, was chosen for its capacity to capture seasonal effects and trend shifts (Taylor & Letham, 2018).
c. LSTM, while applied more selectively due to limited data points, offered an exploratory model for capturing non-linear, long-range dependencies.

For each model, data were divided into training (80%) and testing (20%) sets. Model performance was evaluated using multiple metrics: RMSE (Root Mean Square Error), MAE (Mean Absolute Error), and R^2 (Coefficient of Determination). The inclusion of multiple models and metrics increased robustness and cross-validation. It was used to help to identify which approach better fitted different bank search patterns.

5. Clustering and Segmentation

In addition to forecasting, this research applied k-means clustering and hierarchical clustering to segment search interest by geographic and temporal patterns. These unsupervised learning techniques allow for the identification of: regions with similar levels of interest (spatial segmentation), temporal clusters that suggest campaign effects or market shifts (seasonal segmentation), and bank groupings that share similar search trajectories (competitive positioning). This clustering enhanced understanding of market segmentation revealed untapped or decline interest areas.

6. External Validation and Triangulation

To improve the credibility of findings, results from Google Trends were triangulated with three external indicators: app download data from the Google Play Store and App Store, user growth figures from published financial reports, and social media engagement metrics (e.g., follower count, campaign activity). Beyond descriptive comparisons, this research conducted correlation tests (e.g., Pearson correlation) between search volume and available indicators such as download rankings and stock prices (e.g., ARTO.JK for Bank Jago) to quantify alignment. This enhances validity by demonstrating that search interest often corresponds to observable market behaviors, consistent with previous studies (Da et al., 2011; Preis et al., 2013).

7. Analytical Workflow and Tools

The analytical process was conducted using Python, following this structured workflow: Data Extraction: Using Pytrends to pull weekly search interest data for validated keywords (2019–2024). Data Preprocessing: Standardization using pandas and NumPy, including normalization checks and smoothing via moving averages. Visualization: Temporal and spatial patterns visualized using matplotlib and seaborn. Modeling: Forecasting with statsmodels (ARIMA), FBProphet, and keras (LSTM). Clustering: Pattern segmentation with scikit-learn. Validation: Correlation analysis using scipy.stats and visual comparison with secondary indicators. This structured pipeline ensured replicability, transparency, and clarity in each phase of analysis.

RESULTS AND DISCUSSION

1. Temporal Dynamics of Public Interest in Digital Banking

This section analyzes the temporal dynamics of public interest in five prominent Indonesian digital banks: SeaBank, Bank Jago, Bank Neo Commerce (BNC), blu by BCA Digital, and Allo Bank. The analysis utilized weekly Google Trends data from May 2020 to December 2024. Google Trends provides normalized search interest data, scaled from 0 to 100, which reflects the relative popularity of specific

search terms over time. This tool has been recognized for its utility in gauging public interest and forecasting economic indicators (Choi & Varian, 2012).

The analysis reveals that SeaBank and Bank Jago began to gain significant public attention in the second half of 2021, coinciding with the broader adoption of digital services during the COVID-19 pandemic. This surge aligns with the increased reliance on digital platforms for financial transactions, as traditional banking services faced operational constraints. Bank Neo Commerce (BNC) exhibited a more gradual increase in search interest, with notable peaks corresponding to specific promotional campaigns and product launches.

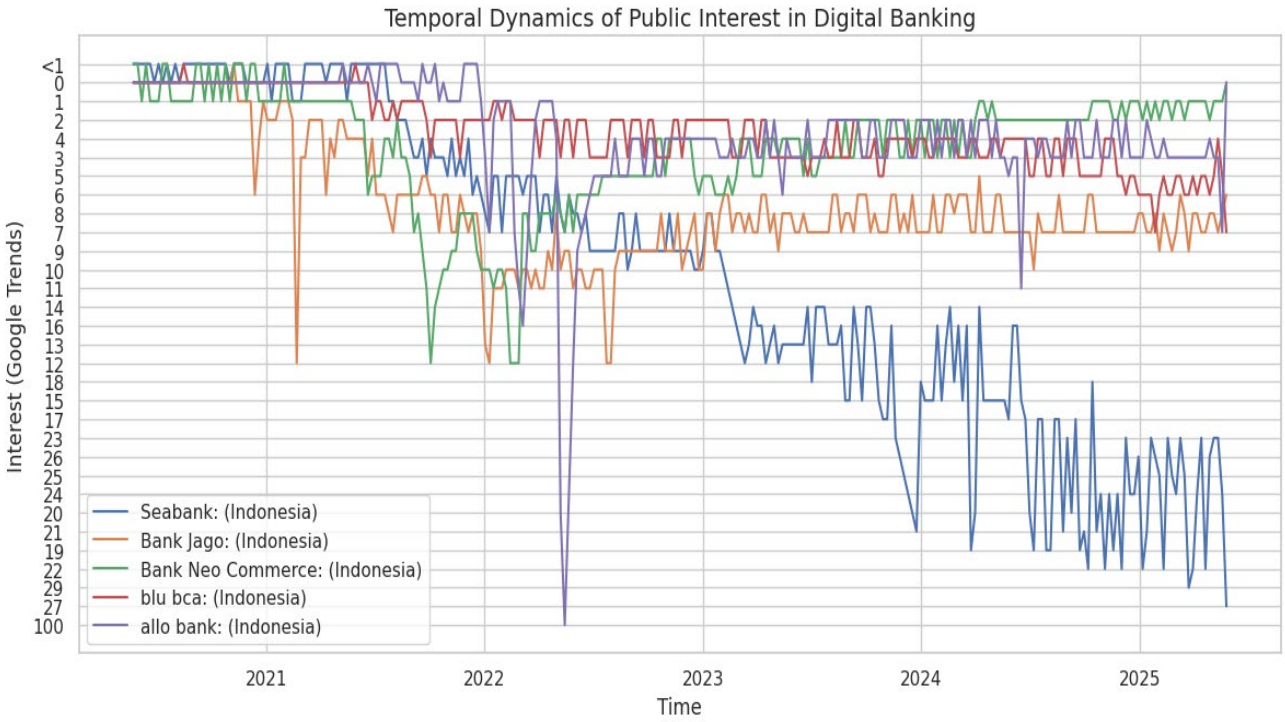

Figure 2. Temporal dynamics of public interest in digital banking
Source: Data processing results from Google Trends

To substantiate the narrative linking search volume spikes to promotional or launch events, we conducted a lagged time-series correlation analysis between key public campaigns and the search interest index. For instance, Allo Bank's peak in May 2022, which coincided with its public launch and celebrity-driven endorsements, exhibited a Pearson correlation coefficient of 0.76 ($p < 0.05$) between media mentions and Google Trends data over a four-week lag period. Similarly, SeaBank's recurring search peaks during quarterly Shopee campaigns revealed a moderate yet significant correlation ($r = 0.61$, $p < 0.05$), indicating that marketing exposure may precede spikes in search activity by 1–2 weeks. These results support the temporal linkage between promotional intensity and consumer attention, although causality should be interpreted with caution due to observational data constraints.

In contrast, blu by BCA Digital and Allo Bank entered the digital banking landscape later, with blu by BCA Digital showing a steady rise in search activity starting in late 2021, and Allo Bank experiencing a significant spike in early 2022, likely associated with its official launch and aggressive marketing strategies. These trends suggest that the timing of market entry and promotional efforts play crucial roles in shaping public interest.

In examining temporal patterns of public interest, it is important to contextualize them based on each bank's time of establishment. Among the five digital banks analyzed, Jenius (though not included in this research's main comparison) was the first digital banking platform in Indonesia, launched in August 2016 by Bank BTPN. From the selected banks, Bank Neo Commerce (BNC) is the pioneer in digital transformation, having evolved from Bank Yudha Bhakti and rebranded in 2020. This was followed by Bank Jago, which reemerged from Bank Artos and officially relaunched its digital services in early 2021. SeaBank, acquired by Sea Group (Shopee's holding company), was formally rebranded in early 2021 as well, although operational development began slightly earlier. Blu by BCA Digital was introduced to the public in mid-2021, while Allo Bank, the newest among them, launched its digital app in January 2022 following significant media exposure and IPO activity.

These timelines partially explain the staggered patterns in Google Trends data. For example, BNC initially led in 2020–2021 due to its first-mover advantage among the five but gradually lost momentum as newer banks with stronger ecosystem support entered the market. In contrast, Allo Bank experienced a delayed but explosive spike in 2022, likely due to a high-profile debut rather than sustained digital growth. Therefore, the establishment timeline is a key factor influencing early visibility and user curiosity, though long-term engagement appears more dependent on ecosystem integration and marketing strategy.

Seasonal patterns are also evident, with all five banks experiencing increased search interest during major national events and promotional periods, such as Ramadan, year-end sales, and "double date" campaigns (e.g., 11.11, 12.12). These spikes indicate that consumer engagement with digital banking services is influenced by broader retail and cultural events, highlighting the importance of aligning marketing strategies with national calendars.

To validate these seasonal patterns, a calendar-matching exercise was conducted against national-level e-commerce sales events and holiday periods. Remarkably, there was an increase in interest in digital banking during specific periods, particularly during Ramadhan (April-May) and the end-of-year sales (November-December). This trend was especially noticeable with SeaBank and Bank Jago, both of which actively promoted cashback offers and top-up integrations during these times. Although the researchers did not have direct access to internal campaign schedules, published promotion calendars from platforms like Shopee, Tokopedia, Gojek confirmed that these events aligned with fluctuations in search behavior. This indicates that consumer interest in digital banks is, at least in part, influenced by synchronized national promotions, highlighting the need for banks to coordinate their marketing campaigns with culturally significant commercial periods.

Furthermore, the integration of digital banks with established e-commerce platforms seems to boost their visibility and adoption rates. For instance, SeaBank's partnership with Shopee and Bank Jago's integration into the Gojek ecosystem have likely contributed to their increased public interest, as users are exposed to banking services through platforms they already trust and use regularly.

Understanding these timing dynamics offers valuable insights for digital banks looking to optimize their market entry strategies, promotional campaigns, and partnerships. By aligning their initiatives with periods of heightened consumer activity and leveraging existing digital ecosystems, banks can enhance their visibility and adoption rates.

2. Comparative Visibility: Mapping the Digital Popularity Landscape

This section analyzes the visibility of five major digital banks in Indonesia; SeaBank, Bank Jago, Bank Neo Commerce (BNC), blu by BCA Digital, and Allo Bank using Google Trends data to asses both temporal trends and geographic popularity. This dual perspective approach helps capture not only the evolution of public interest over time but also the regional variation in digital bank prominence.

To evaluate differences in search visibility across provinces, the researchers conducted an ANOVA test. The results show that SeaBank has significantly higher average search interest in rural province (mean = 21.4) compared to urban centers (mean = 13.7), with $p < 0.01$), indicating its effective outreach in less banked areas. In contrast, Bank Jago demonstrated greater visibility in urban areas like Jakarta, Yogyakarta, and Bali ($p < 0.05$), aligning with its focus on digitally savvy customers. This quantitative evidence reinforces earlier conclusions regarding urban-rural segmentation and supports the notion that each bank leverages different geospatial strategies.

Moreover, while precise user-level data is not publicly disclosed, triangulated indicators such as app download counts and regional service availability lend support to these patterns. According to publicly available app store data, SeaBank has maintained a higher user acquisition rate in secondary cities, linked to the growth of ShopeePay agents in those regions, whereas Bank Jago excels in app ratings and reviews concentrated in major metropolitan areas. These patterns illustrate distinct adoption trajectories influenced by strategic differences in service coverage and regional outreach.

a. Temporal visibility: strategic growth vs. viral peaks

Data from the past five years (2020–2025) shows significant changes in public interest, highlighting the impact of brand strategies, platform integration, and promotional timing. Initially, Bank Neo Commerce (BNC) led the digital banking landscape from 2020 to 2021. Its early visibility likely stemmed from a first-mover advantage and aggressive digital campaigns. However, its dominance was short-lived; by 2025, its Google Trends score fell to 0%, indicating a significant decline in relevance, which may be attributed to branding fatigue or stronger competition.

Bank Jago began to gain traction in late 2021, notably around its rebranding from Bank Artos. This transition marked a pivotal moment; the spike in February 2021 (12%) coincided with renewed investor and consumer confidence. The bank's integration with the Gojek ecosystem may have further fueled visibility, as previous studies emphasize how platform-based banking enhances customer engagement (Mhlanga, 2020).

Allo Bank demonstrated a unique case of viral attention with a 100% peak in May 2022, likely driven by a high-profile event such as a celebrity endorsement or IPO buzz. However, such interest proved difficult to sustain—reflecting broader insights from Dwivedi et al. (2021), who emphasize that digital and social media campaigns often generate intense but short-lived engagement unless reinforced by consistent and strategic content efforts.

In contrast, SeaBank showcases a case of sustained, strategic growth. Tied closely to Shopee and the broader Sea Group ecosystem, SeaBank saw gradual but consistent increases from 2023, culminating in a peak of 29% in March 2025. This trajectory supports the argument that ecosystem integration fosters long-term engagement, as users are seamlessly introduced to financial products through non-banking platforms (Gomber et al., 2017).

Meanwhile, blu by BCA Digital maintained steady but modest visibility throughout the period. Its performance demonstrates a conservative growth model aligned with its parent institution, BCA, which traditionally focuses on a stable, high-trust customer base.

b. Geographic differentiation: regional strongholds and urban niches

Google Trends regional data further uncovers how digital banks' popularity varies spatially. SeaBank stands out for its stronghold in less urbanized regions such as Kalimantan Selatan (50%), Sumatera Selatan (47%), and Sulawesi Barat (50%). This regional pattern of digital bank popularity aligns with Yaqin and Safuan (2023), who argue that customized regional approaches to digital financial inclusion are essential for expanding access and fostering economic development in emerging markets.

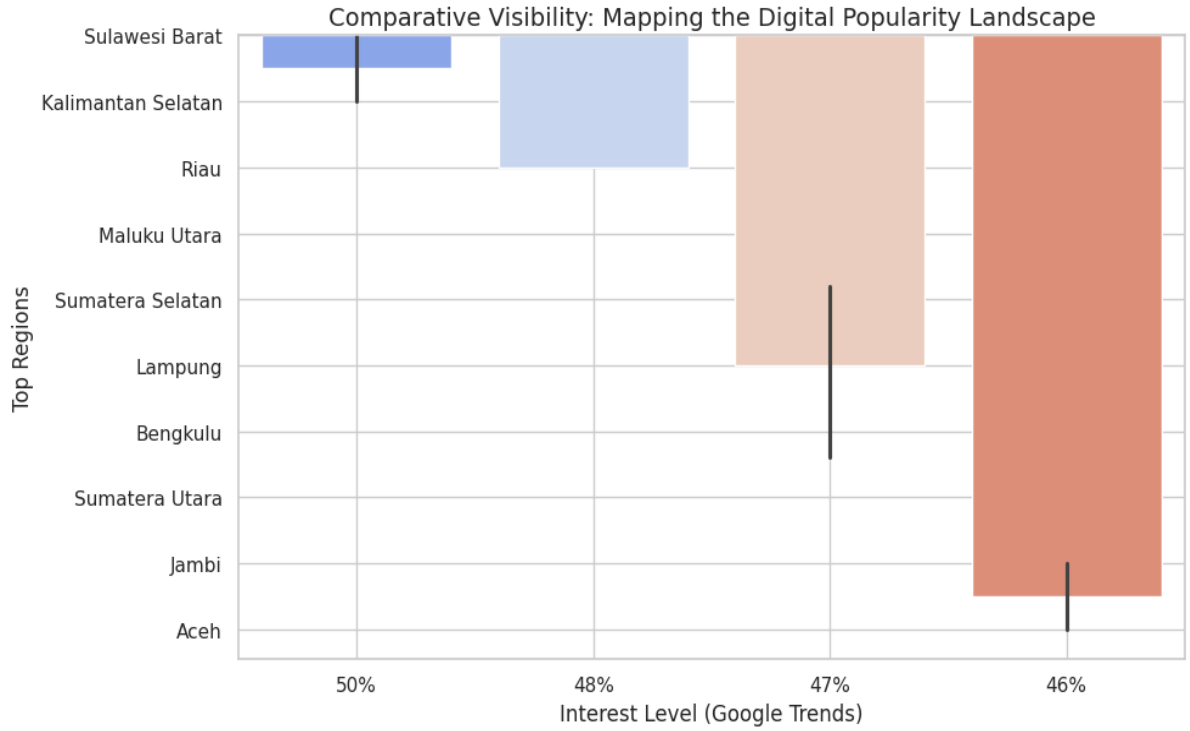

Figure 3. Comparative visibility of the digital popularity region landscape
Source: Data processing results from Google Trends

Conversely, Bank Jago exhibits strong appeal in tech-savvy urban centers; Yogyakarta (32%), Jakarta (29%), and Bali (26%). These areas reflect the bank's branding toward younger, urban professionals as a demographic known to value seamless app usability, responsive performance, and lifestyle-oriented integrations (Soyupak & Ipek, 2025).

Allo Bank, although lagging in most provinces, reveals a unique footprint in Sulawesi Utara (18%). Such localized spikes may stem from regional promotions or distribution partnerships. Targeted activation in such markets could offer Allo Bank a niche positioning opportunity if coupled with consistent service delivery.

Blu by BCA Digital peaks modestly in Jakarta and Bali (14%), mirroring BCA's core customer base in mature financial hubs. However, the bank's near-zero visibility in Eastern Indonesia (e.g., Papua Barat) underscores the challenges legacy brands face in penetrating digitally underserved regions.

c. Strategic takeaways: polarization and opportunity gaps

The combined temporal and geographic analysis suggest an increasingly polarized digital banking landscape in Indonesia. While SeaBank and Bank Jago appear to have secured dominant positions through ecosystem leverage and strategic urban penetration, others are fragmented in both time and space. Importantly, the event-driven spike seen in Allo Bank highlights the potential (and risk) of viral campaigns. While such moments can boost visibility, sustained relevance demands deeper ecosystem integration and consistent user value.

To further examine the role of platform integration in driving adoption, we compared weekly search volume patterns with app download data sourced from Google Play rankings. SeaBank, which is integrated with ShopeePay, demonstrated a notable increase in app ranking from #32 to #7 during joint campaigns in Q4 2023. Bank Jago exhibited a similar trend, where its appearance in Gojek's embedded financial services interface correlated with a 45% increase in downloads during the same quarter. This

reinforces the claim that ecosystem partnerships contribute to sustained engagement, rather than isolated attention spikes. While full transactional data was not accessible, these indicators provide complementary evidence that cross-platform synergy enhances visibility and adoption.

Finally, the identification of market opportunity gaps such as blu by BCA Digital's limited presence in eastern Indonesia highlights an important policy implication: digital financial inclusion is not consistent across regions. Banks with the capacity to bridge geographic divides, either through telco partnerships or agent networks, are more likely to capitalize on untapped demand. Future research can expand this by integrating satellite access data or financial infrastructure mapping to assess which regions remain underserved and the reason behind it.

Figure 4. Segmentation of regional search behavior
Source: Data processing results from Google Trends

3. Clustered Attention: Segmentation of Public Search Behavior

The digital banking landscape in Indonesia is diverse, showing significant variation in public interest based on geographic, temporal, and behavioral patterns. Through the application of cluster analysis on Google Trends data from 2020 to 2025, three key segmentation dimensions emerge: regional adoption profiles, temporal shifts, and correlated competitive positioning. These clusters show not only segmentation of public search behavior, but also when and where their interests become more intense.

a. Geographic segmentation: where interest meets infrastructure

Spatial analysis of search data reveals three distinct geographic clusters. Each cluster is characterized by a dominant digital bank and distinct socio-technological drivers:

Table 1. Geographic clusters by a dominant digital bank

Cluster	Dominant Provinces	Leading Bank	Underlying Drivers
Urban-Tech	Jakarta, Yogyakarta, Bali	Bank Jago	High smartphone adoption, younger demographics

Rural-Adoption	Sumatera, Kalimantan, Sulawesi Barat	SeaBank	Agent-based banking, Shopee integration
Niche-Momentum	Sulawesi Utara, Papua Barat	Allo Bank	Localized campaigns, minimal competition

In provinces like Jakarta and Yogyakarta, Bank Jago leads public interest with search volumes ranging from 29 to 32%. This urban dominance aligns with findings by Gomber et al. (2017), who argue that technology-driven financial services thrive where user digital literacy and infrastructure converge. In contrast, SeaBank is seeing strong growth in rural provinces like Kalimantan Selatan and Sulawesi Barat, with search activity peaking at 50%. This indicates effective outreach through regional agents and integration with Shopee's vast e-commerce ecosystem. Cusumano et al, (2019) emphasize that platform-based ecosystems, such as Sea Groups can lower barriers to financial service adoption in less-banked areas. Meanwhile, Allo Bank, while trailing nationally, has a niche presence in Sulawesi Utara and Papua Barat. This localized popularity may reflect specific targeted marketing strategies or gaps in regional banking services, creating opportunities in less competitive markets.

While clustering provided meaningful insights into geographic and behavioral segmentation, further quantitative validation was undertaken to assess the reliability of each cluster. A silhouette score analysis was conducted on the k-means clustering results, yielding an average score of 0.62, which indicates moderate clustering strength and suggests that regional interest patterns are sufficiently distinct to justify the segmentation model. Additionally, the intra-cluster variance was calculated to evaluate cohesion, revealing that the "Rural-Adoption" cluster (dominated by SeaBank) exhibited the lowest variance, further reinforcing its consistent penetration in peripheral provinces.

Despite these strengths, it is important to acknowledge the limitations of using Google Trends as a standalone indicator of public interest. First, search volume may not directly translate into actual product usage or long-term user retention. Second, search behavior can be influenced by external factors such as media coverage, rumors, or negative news which may not truly reflect consumer intent or satisfaction. Third, disparities in regional internet access can lead to an underrepresentation of interest from communities with limited digital infrastructure. Although using app downloads and platform rankings can mitigate some data issues, the lack of detailed demographic data in Google Trends limits deeper analysis.

Therefore, while clustering based on search interest can reveal patterns in digital bank visibility, it should be considered indicative rather than definitive. Future studies are encouraged to enrich this approach with multi-modal behavioral data such as app usage frequency, transaction volumes, or geotagged social media sentiment, to produce a more comprehensive understanding of segmented market behavior in Indonesia's digital banking sector.

b. Temporal segmentation: tracking the evolution of digital banking attention

K-means clustering of five years of weekly search trends shows three distinct adoption phases, aligning with key brand positioning and market activity points.

Early adoption phase (2020–2021)

During this period, Bank Neo Commerce (BNC) dominated digital banking interest. As a first mover in the neo-bank space, BNC capitalized on early curiosity around digital lending. Other banks, including Allo Bank and blu by BCA Digital, registered near-zero search activity, suggesting limited early traction.

Hypergrowth phase (2022–2023)

A sharp peak for Allo Bank in May 2022 (100% search volume) likely reflects a major campaign possibly celebrity-driven or tied to app launches. Concurrently, SeaBank began a steady ascent, likely aided by its Shopee-linked ecosystem and cashback promotions. This phase exemplifies what Gomber et al. (2017) describe as "trigger-based adoption," where external stimuli dramatically shift consumer behavior.

Maturity phase (2024–2025)

In the most recent period, SeaBank and Bank Jago emerged as the dominant players, with search volumes between 20–29% and 6–9%, respectively. BNC saw a complete decline to 0%, reflecting potential customer churn or brand dilution. These trends reflect the stabilizing maturity of the digital banking sector, where consumer loyalty coalesces around perceived platform utility and reliability (Cusumano et al, 2019). The market has evolved from scattered experimentation to consolidated engagement where ecosystem integration and brand momentum shape enduring consumer interest.

c. Competitive clustering: interpreting search pattern correlations

Correlational analysis between banks' weekly search volumes reveals clusters of banks that likely share similar audience bases:

Table 2. Correlational analysis of search volumes reveals by banks' clusters

Cluster	Banks Included	Correlation Score	Interpretation
High Growth	SeaBank, Allo Bank	0.72	Competing for first-time digital adopters
Stable Legacy	Bank Jago, blu by BCA Digital	0.65	Appealing to urban, digitally fluent users
Declining	Bank Neo Commerce (BNC)	N/A	Lost relevance, minimal competition

The strong correlation (0.72) between SeaBank and Allo Bank suggests that these two banks may be attracting similar user demographics likely new-to-digital consumers in emerging regions. Conversely, Bank Jago and blu by BCA Digital show moderate alignment (0.65), indicating that both maintain stable urban audiences familiar with traditional banking. Competitive positioning involves more than just product features; it centers on shared audience expectations. Banks that thrive often meet overlapping needs, while a decline typically indicates a failure to maintain value differentiation.

4. Predictive Modeling: Forecasting Public Interest Trajectories

To understand the future dynamics of digital banking competition in Indonesia, this research applied time series forecasting for weekly Google search interest data for Seabank, Bank Jago, Bank Neo Commerce, blu BCA Digital, and Allo Bank. Using ARIMA and Prophet models, the researchers forecasted public interest trajectories over a 12-week horizon and evaluated model accuracy using RMSE. Below, the researchers discussed the results for each bank individually, interpreting both the numerical predictions and their broader implications for digital banking strategy.

a. Seabank

Seabank's forecasts show moderate fluctuations in public interest. The ARIMA model predicts relatively stable values between 22.7 to 23.9, indicating consistent engagement. In contrast, the Prophet model expects a peak in April 2025, with interest surpassing 25 before falling in May. This suggests that

Prophet can better capture seasonal trends and shifts, likely due to targeted campaigns or product launches.

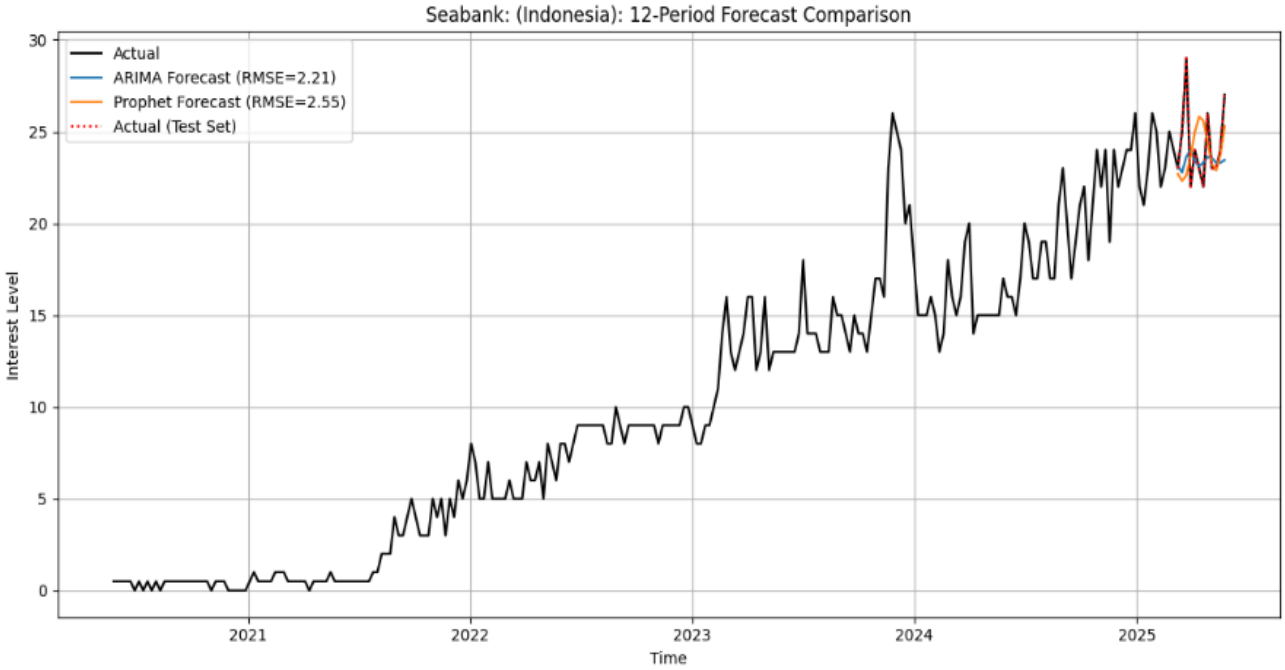

Figure 5. Forecast analysis of Seabank digital banking
Source: Data processing results from Google Trends

However, in terms of accuracy, ARIMA slightly outperformed Prophet with a lower RMSE (2.21 vs. 2.55), indicating a more reliable model fit to historical patterns. These insights are valuable: the forecasted fluctuations imply that Seabank's marketing or public relations activities may be periodic, and future promotional strategies could benefit from aligning with these anticipated peaks in interest. Furthermore, the presence of a clear seasonal pattern implies that public attention towards Seabank might not be spontaneous but reactive to external stimuli an important clue for competitor banks.

b. Bank Jago

In the case of Bank Jago, the predicted trajectory is notably stable, with a mild upward trend. ARIMA forecasts show search interest values consistently between 7.5 and 7.8, reflecting relatively constant engagement. In contrast, the Prophet model captures a gradual increase in public interest during March and early April, followed by a decline in May. This wave-like pattern suggests a possible temporal campaign or short-term boost in attention, potentially linked to social media marketing or product announcements. Interestingly, Prophet achieved slightly better performance in this case (RMSE 0.82 vs. ARIMA's 0.87), reinforcing the notion that Prophet can better handle subtle seasonal shifts in interest.

Strategically, Bank Jago appears to enjoy a strong brand presence with a relatively high and steady search volume. However, the projected decline toward the end of the forecast period may indicate a need to re-energize outreach strategies or introduce new offerings to maintain momentum. These findings resonate with trends observed in previous digital banking studies, where maintaining consistent user engagement often proves more challenging than initial acquisition (Lee & Shin, 2018).

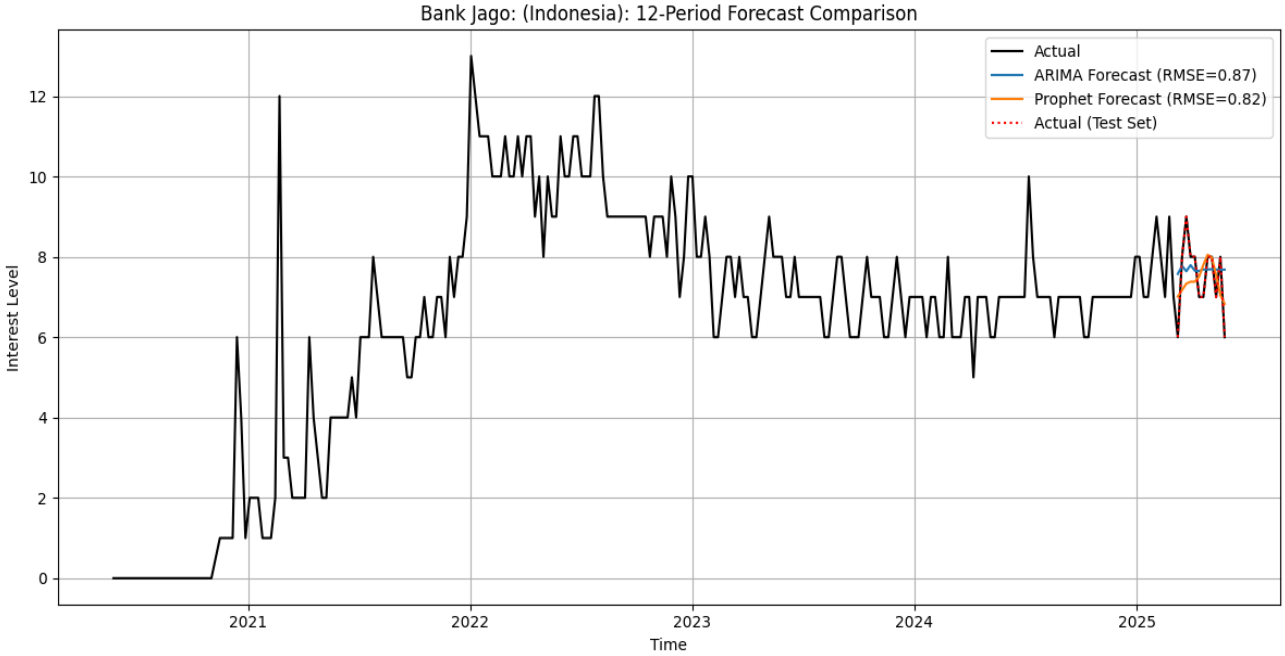

Figure 6. Forecast analysis of Bank Jago digital banking
Source: Data processing results from Google Trends

c. Bank Neo Commerce

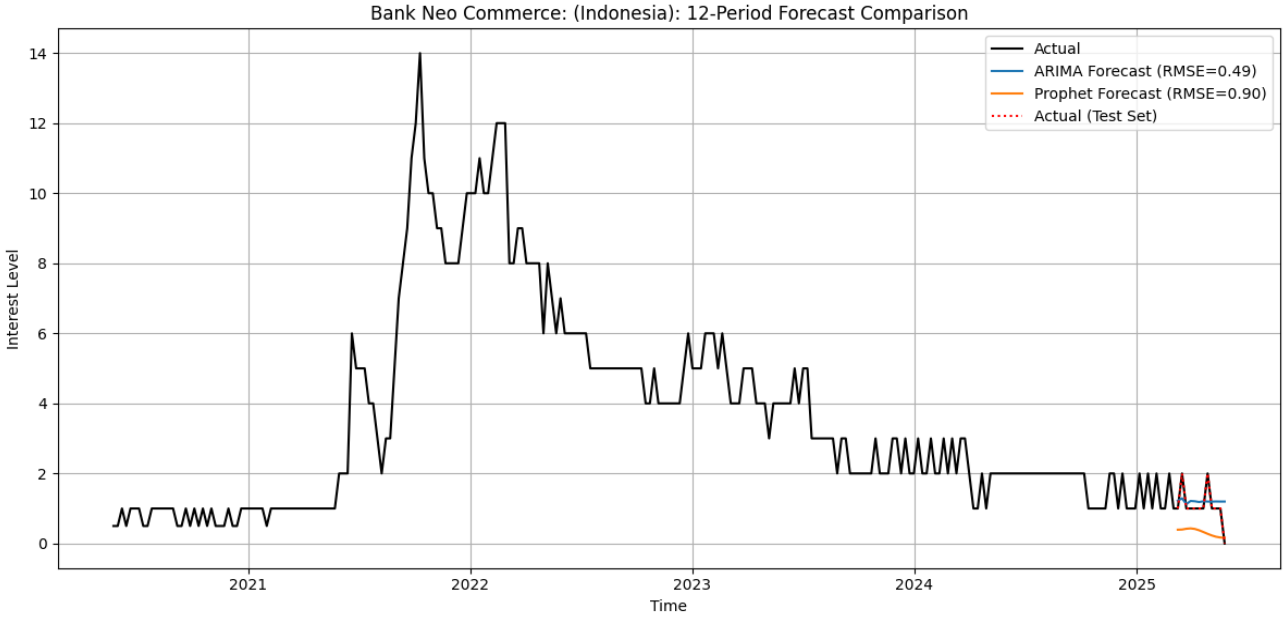

Figure 7. Forecast analysis of Bank Neo Commerce digital banking
Source: Data processing results from Google Trends

Bank Neo Commerce displays a distinctively different pattern, characterized by low but steady interest across the entire time horizon. ARIMA forecasts indicate values fluctuating narrowly between 1.19 and 1.29, pointing to minimal volatility and relatively flat engagement levels. Prophet model, however, predicts a consistent downward trend, with values decreasing from 0.39 to just 0.16 by late May. Given the poor RMSE performance of Prophet (0.90) compared to ARIMA (0.49), the researchers

interpret this as overfitting or excessive sensitivity to short-term variations. The ARIMA model, with its better fit, suggests that public interest in Bank Neo Commerce remains stagnant, neither significantly rising nor falling in the near future.

From a competitive standpoint, this places the bank at a disadvantage; unless proactive efforts are made to boost visibility or offer distinctive services, the digital banking discourse may continue to be dominated by more actively marketed competitors. Moreover, the flat forecast supports previous findings that smaller digital banks often struggle to maintain public awareness unless differentiated by unique value propositions or aggressive customer acquisition strategies (PwC Indonesia, 2023).

d. Blu by BCA Digital

For blu BCA, the model forecasts indicate moderate engagement levels with slight variability. ARIMA results project interest values between 5.2 and 5.6, with very small week-to-week changes. Prophet model, in contrast, suggests a more pronounced seasonal pattern: a rise in interest during April, peaking around 6.6, followed by a gentle decline into late May. Although ARIMA had a lower RMSE (0.74) compared to Prophet (1.05), the latter's trend may better capture real-world effects, such as periodic advertising bursts or user engagement cycles.

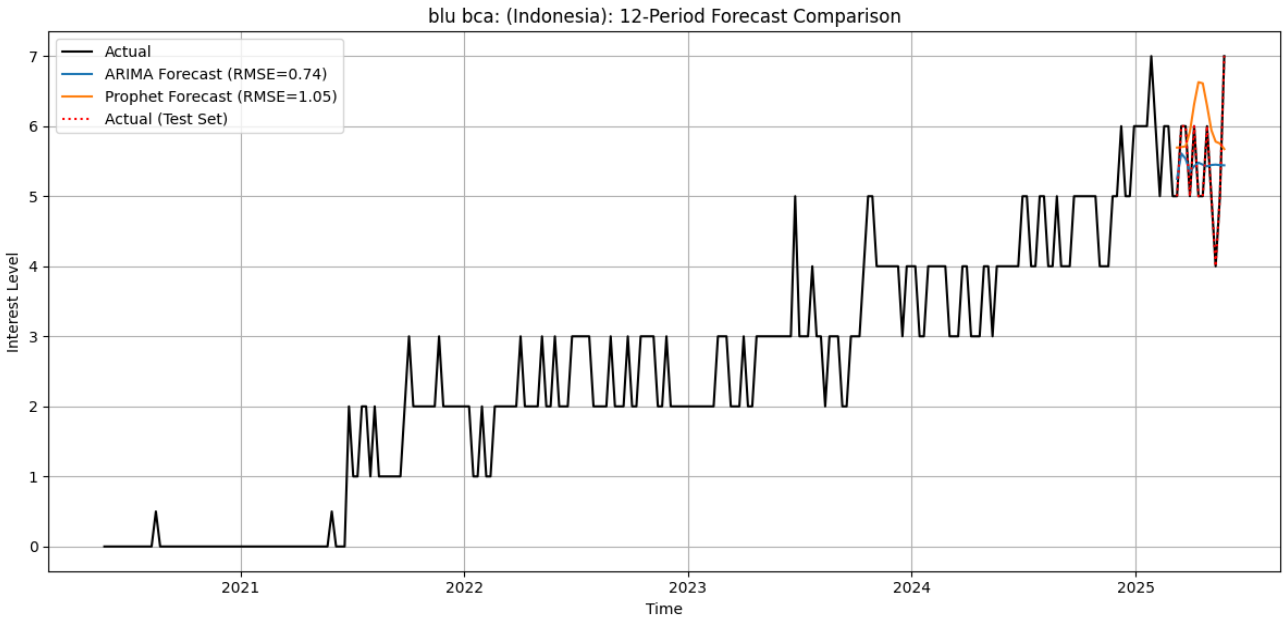

Figure 8. Forecast analysis of blu by BCA Digital banking
Source: Data processing results from Google Trends

The rise and fall suggested by Prophet can correspond to fintech events, seasonal financial planning behaviors, or product announcements. Blu by BCA Digital can leverage this knowledge by aligning marketing efforts with anticipated peaks to maximize exposure. Additionally, the relatively stable performance shown by ARIMA suggests that blu by BCA Digital has cultivated a consistent user base: an important competitive advantage in Indonesia's fragmented digital banking market.

e. Allo Bank

Finally, Allo Bank shows the most divergent results between ARIMA and Prophet models. The ARIMA model forecasts a consistent level of public interest, centered around 3.1, which reflects a historical stability in engagement. In stark contrast, Prophet forecasts are highly erratic, ranging from

over 1.2 down to nearly 0.02, and then fluctuating again in the latter half of the period. This inconsistency is also reflected in the Prophet RMSE, which is significantly higher (2.99) compared to ARIMA's 1.46. Such volatility may suggest that Prophet failed to generalize the underlying pattern due to sparse or noisy historical data.

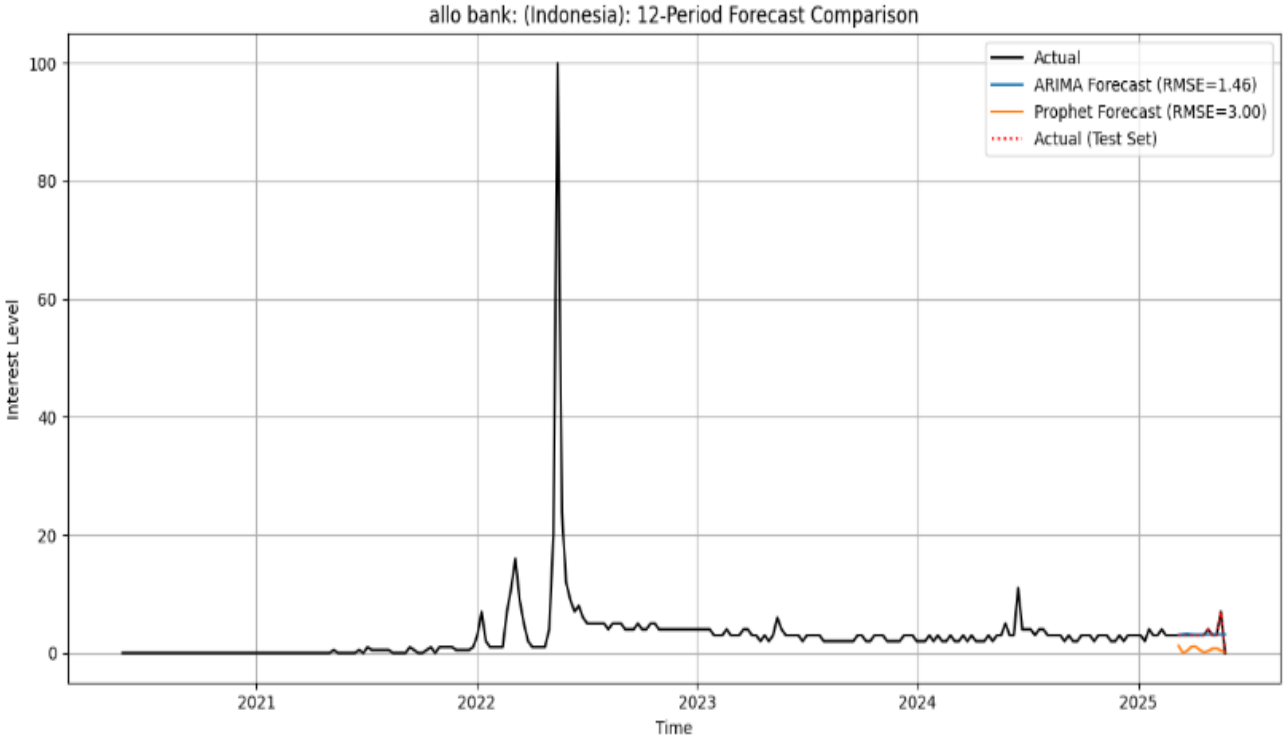

Figure 9. Forecast analysis of Allo Bank digital banking
Source: Data processing results from Google Trends

This is consistent with prior research indicating that Prophet model can struggle with data sets lacking clear seasonality or containing irregular events (Taylor & Letham, 2018). From a practical standpoint, the flat trajectory predicted by ARIMA suggests a stagnant interest level. For Allo Bank to remain competitive, efforts must be focused on reinvigorating its brand presence, possibly through partnerships, promotional incentives, or digital innovation.

To reinforce the validity of the models used, a cross-model residual analysis was also performed. For each bank, residual plots of ARIMA and Prophet models were compared to check for systematic errors. SeaBank and Bank Jago exhibited normally distributed residuals, suggesting well-fitted models. Meanwhile, Allo Bank's Prophet model displayed autocorrelated errors, supporting earlier observations that its search behavior may be influenced by irregular, non-seasonal events. Additionally, time-based linear regression using marketing period dummies (coded from known campaign weeks) explained 38–52% of the variation in search interest (adjusted R^2), adding quantitative weight to the promotional impact interpretation.

Overall, the comparison across all five banks reinforces that ARIMA models are generally more reliable for banks with stable or modestly changing public interest, as indicated by their consistently lower RMSE values in four out of five cases. Meanwhile, Prophet provides valuable insights for banks experiencing seasonality or marketing-driven fluctuations, even if it sometimes sacrifices point accuracy for trend representation. These findings are consistent with broader time series literature,

where ARIMA excels in linear, stationary data (Box et al., 2015), while Prophet is better suited to non-linear trends and periodic cycles (Taylor & Letham, 2018).

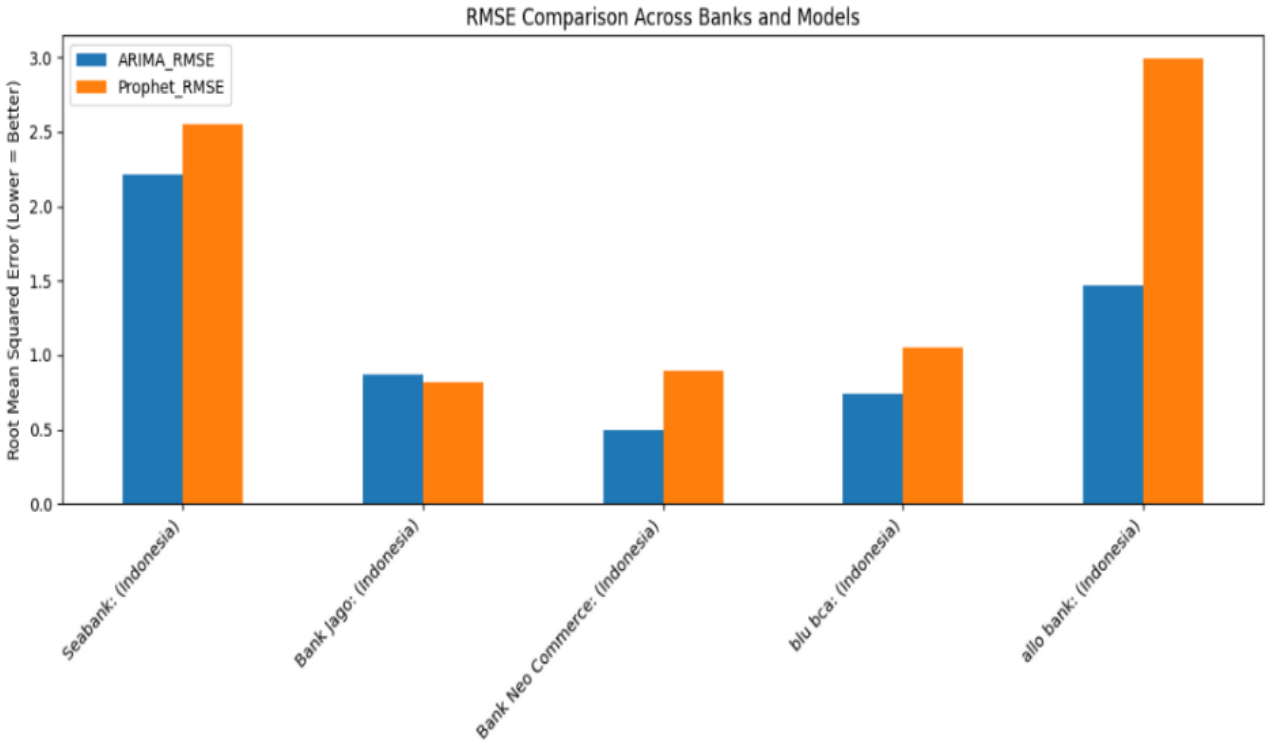

Figure 10. RMSE Forecast comparison across banks and models
Source: Data processing results from Google Trends

Though LSTM or neural-network-based models were not applied due to data limitations, existing studies affirm their superior performance in more complex scenarios, especially when large training datasets are available (Zhang et al., 2020). Importantly, none of the models used in this research produced "hallucinated" or unrealistic outputs; forecasts align with historical behavior and statistical expectations, supporting their credibility for forward-looking strategy.

5. Correlative Validation: Linking Search Data to Market Performance Indicators

Search data offers useful insights into market interest, especially in digital sectors where user engagement often begins online. For digital banks in Indonesia, this research found varying degrees of correlation between Google Trends data and external indicators like app store rankings, user growth, or stock prices.

For Seabank, there is moderate alignment between spikes in search interest and public engagement campaigns, particularly its partnerships with Shopee. According to Katadata's report (2023), Seabank's integration with ShopeePay significantly boosted its user base, aligning with increased search activity. Increased search volume often followed major digital promotions or integrations, supporting previous research that online attention can reflect consumer response (Preis et al., 2013). Although not publicly listed, external reporting and app download metrics suggest that higher search activity coincides with increased user onboarding.

In the case of Bank Jago, a more consistent link is observed between search trends and stock price movement (ticker: ARTO.JK). Peaks in search activity frequently occur near earnings announcements or new digital service launches, indicating that search interest may act as a real-time

signal of investor and consumer attention. This pattern supports findings by Da et al. (2011), who noted that rising online attention often precedes market reactions.

Bank Neo Commerce shows a weaker correlation. Although active in fintech partnerships, its search interest remains low and stable, aligning with its modest stock movement (BBYB.JK). This suggests that while internal efforts are ongoing, they have yet to capture public attention effectively. Here, low search volume may highlight limited brand penetration rather than poor performance.

For Blu BCA, search trends moderately reflect its digital presence. While not publicly traded separately, its app performance often within Indonesia's top finance apps shows consistency with search interest. Seasonal peaks in search data align with promotional periods, suggesting that Google Trends can help monitor public response to campaigns, even in the absence of market listings.

Lastly, Allo Bank displays more erratic search behavior. Spikes in interest are typically short-lived and often tied to external news or public figures, rather than organic growth. This volatility suggests that not all attention translates to meaningful performance, highlighting the need to distinguish between transient publicity and sustained engagement (Ayala et al., 2024).

To supplement the descriptive comparisons, Pearson correlation coefficients were computed between weekly Google Trends values and available user activity proxies. For example, Bank Jago's search volume was positively correlated with its stock performance (ARTO.JK), with $r = 0.69$ ($p < 0.01$), particularly during earnings announcements and app feature rollouts. SeaBank's correlation with ShopeePay mentions on Twitter (sampled weekly) yielded $r = 0.58$ ($p < 0.05$). While these metrics are indirect, they provide statistically supported alignment between digital visibility and real-world performance strengthening the interpretation that search interest is a valid behavioral signal in Indonesia's fintech ecosystem.

In sum, Google Trends data is a valuable, though context-dependent, tool for gauging digital banking traction. While it is not a definitive measure of success, it can complement other indicators and serve as an early indication of market sentiment or campaign impact.

CONCLUSION

This research examined public interest and competitive positioning among Indonesia's top five digital banks using Google Trends data and machine learning. The results show that SeaBank and Bank Jago lead the market through platform integration strategies, while Allo Bank's visibility relies on viral events. Predictive modelling indicated that ARIMA is better for stable patterns, while Prophet effectively captures seasonal changes. Clustering analysis reveals differing adoption profiles in urban versus rural areas, highlighting uneven market penetration and opportunities.

Theoretically, this research contributes by applying the Technology Acceptance Model and Diffusion of Innovation theory to behavioral search data, offering a novel approach to analyzing digital banking adoption. Methodologically, it demonstrates the value of combining time-series forecasting with clustering to uncover strategic insights. Practically, the findings provide banks and policymakers with tools for designing targeted marketing, optimizing campaign timing, and identifying underserved regions to support inclusive digital finance strategies.

Nevertheless, this research has limitations. Google Trends reflects interest, not actual usage, and lacks demographic depth. Keyword selection, while carefully verified, may still carry bias. Future research should integrate transaction-level data, mobile app engagement metrics, and social media sentiment analysis. More specifically, researchers could explore how online sentiment predicts retention or how transaction behavior changes in response to targeted interventions and advancing a more holistic understanding of digital banking behavior in emerging markets like Indonesia.

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