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Modeling Internal Migration Dynamics Through Markov Chains: Empirical Findings of Long-Term Population Redistribution in Antipolo City

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https://doi.org/10.5281/zenodo.22761620

ABSTRACT

Internal migration shapes population distribution, urban growth, and local development in rapidly urbanizing areas. Anchored on Lee's Push–Pull Theory of Migration, this study modeled internal migration dynamics among the sixteen barangays of Antipolo City, Rizal, Philippines, using Markov Chain analysis to examine migration transitions and long-term population redistribution. It determined transition probabilities, steady-state probabilities, and expected population distribution; identified Economic and Non-Economic Push and Pull factors influencing migration decisions; and assessed significant differences among these factors. An applied quantitative, non-experimental, descriptive-analytical design was used. Data were gathered from 384 qualified internal migrants selected through proportionate stratified random sampling. Frequency and percentage distribution, weighted mean, Kruskal-Wallis test, Dunn's post hoc test with Bonferroni correction, and Markov Chain modeling were applied. Findings showed that migration decisions were influenced more strongly by destination-side attractions than by origin-based pressures. Better livelihood or business opportunities, better employment and income opportunities, and better and more affordable housing options emerged as leading pull factors, while high cost of living and low income or financial difficulty were the main economic push factors. The Kruskal–Wallis results showed significant differences among all factor groups. Markov Chain results indicated convergence toward San Roque, San Isidro, and Cupang. The findings emphasize integrating migration analytics into local planning for infrastructure, housing, livelihood, service delivery, and governance interventions.

Keywords: *internal migration, Markov Chain analysis, Push-Pull Theory, population redistribution, urban planning*

INTRODUCTION

Internal migration is a major driver of demographic change and urban development worldwide. Unlike international migration, it occurs within national boundaries and is influenced by economic, social, environmental, and demographic conditions that encourage population movement between localities (International Organization for Migration [IOM], 2024). In developing countries, internal migration plays a significant role in urbanization by redistributing populations toward areas with better economic opportunities, improved infrastructure, and greater access to public services (United Nations Department of Economic and Social Affairs [UN DESA], 2024). Consequently, understanding migration patterns is essential for governments seeking to manage urban growth, allocate resources efficiently, and promote sustainable local development.

The Philippines has experienced considerable internal population mobility over the years, driven by employment opportunities, educational access, housing availability, and differences in living conditions across localities (Philippine Statistics Authority [PSA], 2023). While migration enables individuals and households to improve their socioeconomic circumstances, it also influences the demographic composition of destination communities. Increasing population concentration in urban centers can place pressure on housing, transportation networks, public services, and environmental resources, underscoring the importance of evidence-based planning and policy interventions (PSA, 2023).

To explain these migration patterns, this study adopts Lee's Push–Pull Theory, which posits that migration occurs when unfavorable conditions in the place of origin push individuals to move, while attractive conditions in the destination encourage relocation (Lee, 1966). Push factors may include unemployment, high living costs, environmental hazards, and inadequate public services, whereas pull factors often consist of better employment prospects, improved housing, educational opportunities, and enhanced quality of life. Recent studies suggest that migration decisions are shaped by the interaction of multiple economic and non-economic factors operating across different spatial scales (de Haas, Castles, & Miller, 2020). Existing research has shown that migration affects population distribution, labor mobility, housing demand, and regional economic transformation; however, most studies focus on national or regional migration patterns rather than localized community-level dynamics (Bell et al., 2015).

Antipolo City, the capital of Rizal Province and one of the fastest-growing urban centers adjacent to Metro Manila, provides a relevant setting for examining these localized migration dynamics. Continued residential and economic expansion has generated substantial population movement among its sixteen barangays, resulting in varying levels of growth, concentration, and service demand. However, empirical studies that model barangay-level migration transitions and their long-term demographic consequences remain limited. To address this gap, the present study applies Markov Chain analysis to estimate transition probabilities and steady-state population distribution, while also examining the Economic

and Non-Economic Push–Pull factors that explain why migrants move. By linking migration determinants with probabilistic population redistribution, the study provides evidence that can support migration-responsive urban planning and sustainable local development.

Research Problem

This study aimed to analyze internal migration patterns within Antipolo City through the application of a Markov Chain model, with particular emphasis on understanding the role of economic and non-economic factors influencing population movement.

Specifically, it sought to answer the following questions:

1. What are the transition probabilities of migration, the corresponding steady-state probabilities, and expected population distribution of each state?
2. What are the economic and non-economic push and pull factors that influence the migration decisions of the respondents?
3. Is there a significant difference in the Push and Pull factors, based on economic and non-economic reasons, affecting respondents' migration across each location?

Assumptions of the Study

This study was guided by the following assumptions:

1. The respondents provided accurate, honest, and reliable information regarding their migration history, socio-economic characteristics, and the factors influencing their migration decisions.
2. The Economic and Non-Economic Push and Pull Factors included in the study adequately represent the primary determinants of internal migration among residents of Antipolo City.
3. The Markov Chain Model is an appropriate tool for analyzing migration transitions and estimating the long-term population distribution of migrants across the barangays of Antipolo City.

Objectives of the Study

The study aimed to analyze and evaluate internal migration patterns within the sixteen barangays of Antipolo City, Rizal using Markov Chain Analysis and to determine the Economic and Non-Economic Push and Pull factors influencing migration decisions. The findings were intended to provide empirical inputs for migration-responsive policy and planning recommendations.

Theoretical Framework

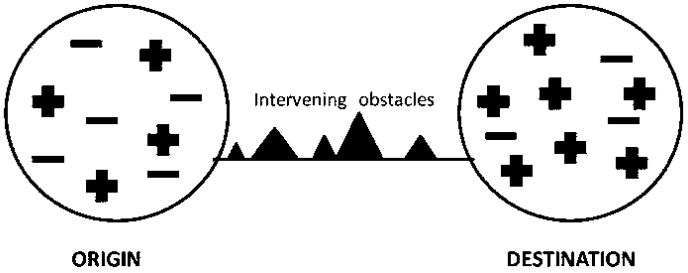
Push-Pull Theory

Figure 1 below presents the Lee's Push-Pull Theory of Migration, which explains migration as the result of conditions that push individuals away from their place of origin and factors

that pull them toward a destination. It emphasizes that migration decisions are shaped by the interaction of origin and destination factors, intervening obstacles, and personal considerations. This theory remains relevant in explaining internal migration because recent studies affirm that migration is influenced by combined economic, social, and environmental factors rather than by a single cause (Lee, 1966; Motadegbe and Mogaji, 2025; Soto Nishimura and Czaika, 2024).

Figure 1

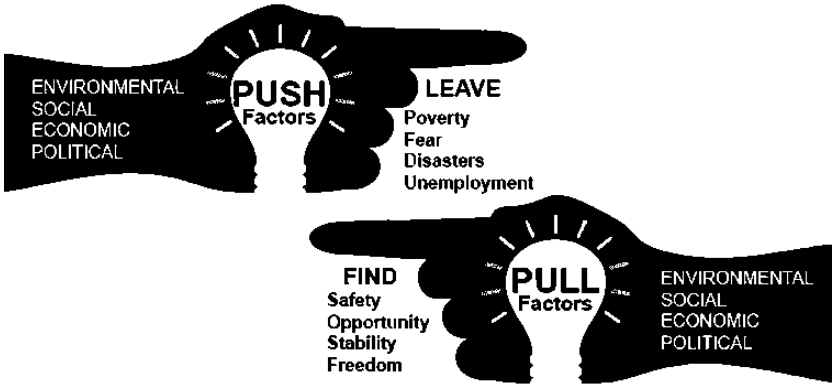
Lee's Push-Pull Theory



Source: Rashid Faridi. (2018, April 5). Migration theories: Lee's push-pull theory. https://rashidfaridi.com/2018/04/05/migration-theories-lees-push-pull-theory/

Figure 2

Push and Pull Factors



Source: Niyitunga, Eric Blanco & Musembi, Patrick. (2022). A Threat without Borders: Assessing the Effects of Covid-19 on Managing Human Migration and Economic Security African Journal of Public Administration and Environmental Studies (AJOPAES). 1. 5-37. https://doi.org/10.31920/2753-3182/2022/v1n2a1

Building from Lee's theory, Figure 2 illustrates the economic and non-economic Push and Pull factors considered in this study. Economic factors include employment opportunities, income potential, housing affordability, and cost of living, whereas non-economic factors include access to education, healthcare, safety, infrastructure, environmental quality, and social networks. These dimensions show that migration is not explained by one factor alone; rather, individuals and households compare risks, opportunities, and quality-of-life

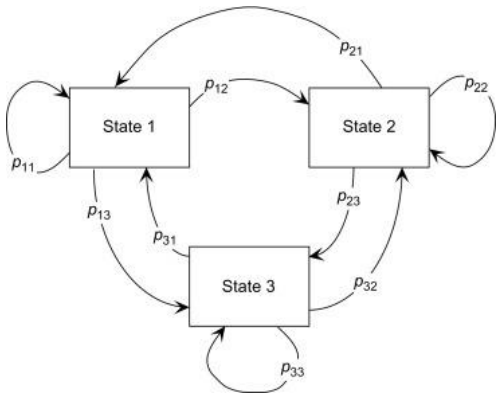
conditions across locations before deciding to move or remain (Jia, Molloy, Smith, and Wozniak, 2023; Urbański, 2022; Blumenstock, Chi, and Tan, 2025; Vacca, Bilecen, and Lubbers, 2025; Yu, Asif, Zhang, Shabaz, Ahmad, and Shahzad, 2025).

Markov Chain Model

While the Push–Pull framework explains the reasons behind migration, the Markov Chain model provides a way to examine how repeated movements reshape population distribution over time. Markov Chains are stochastic models that describe systems moving from one state to another based on transition probabilities, where the next state depends only on the present state. This memoryless property makes the model appropriate for analyzing migration because it focuses on the likelihood of moving from a current location to a future location over successive period (Markov, 1906).

Figure 3

Markov Chain Transition State Diagram



Source: Wilks, D. S. (2020). Statistical methods in the atmospheric sciences (Fourth Edition). Elsevier. https://doi.org/10.1016/C2017-0-03921-6

Figure 3 translates this modeling logic into a transition state diagram, where migration is represented as movement among locations or states. In this study, the states correspond to the sixteen barangays of Antipolo City and additional spatial categories outside the city, while the arrows represent probabilities of movement and the loops indicate the probability of remaining in the same location. Through this structure, the framework captures both mobility and residential stability within the migration system using transition probabilities such as $\boldsymbol{P_{ij}}$ (Wilks, 2020).

Figure 4

Transition Probability Matrix

$$P = \begin{bmatrix} P_{1,1} & P_{1,2} & \dots & P_{1,j} & \dots & P_{1,\alpha} \\ P_{2,1} & P_{2,2} & \dots & P_{2,j} & \dots & P_{2,\alpha} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ P_{i,1} & P_{i,2} & \dots & P_{i,j} & \dots & P_{i,\alpha} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots \\ P_{\alpha,1} & P_{\alpha,2} & \dots & P_{\alpha,j} & \dots & P_{\alpha,\alpha} \end{bmatrix}$$

The transition probabilities are then organized in the matrix shown in Figure 4, which served as the main analytical tool of the Markov Chain model. Each row represents the origin of migration, each column represents the destination, and each value indicates the probability that a person would either remain in the same location or move to another location. By repeatedly applying the matrix, the model estimates long-run or steady-state population distribution, thereby linking observed migration movements with projected population redistribution in Antipolo City (Wilks, 2020).

METHODOLOGY

Following the theoretical and modeling framework, the methodology was designed to generate quantitative evidence on internal migration patterns in Antipolo City. The study combined survey-based data collection, descriptive and inferential statistical analysis, and Markov Chain modeling to describe the characteristics and migration experiences of internal migrants, examine the Economic and Non-Economic Push and Pull factors influencing their decisions, and estimate long-term population redistribution across the city's barangays (Creswell & Creswell, 2022; Bell et al., 2015; Wilks, 2020).

Research Design

This study employed an applied quantitative, non-experimental, descriptive-analytical research design. It was applied in nature because the analysis was intended to generate evidence that could support migration-responsive planning and local development decision-making in Antipolo City. It was quantitative because the study used numerical survey data, migration transition counts, Likert-scale responses, and statistical procedures to describe migration characteristics, assess Push-Pull factors, and model long-term population redistribution (Creswell & Creswell, 2022; Hassan, 2024).

The descriptive component was used to summarize the demographic, socio-economic, migration, and residency characteristics of respondents, as well as the frequency, percentage distribution, and weighted mean ratings of Economic and Non-Economic Push and Pull factors. The analytical component was used to determine whether significant differences existed among the migration factors through the Kruskal-Wallis test and Dunn's

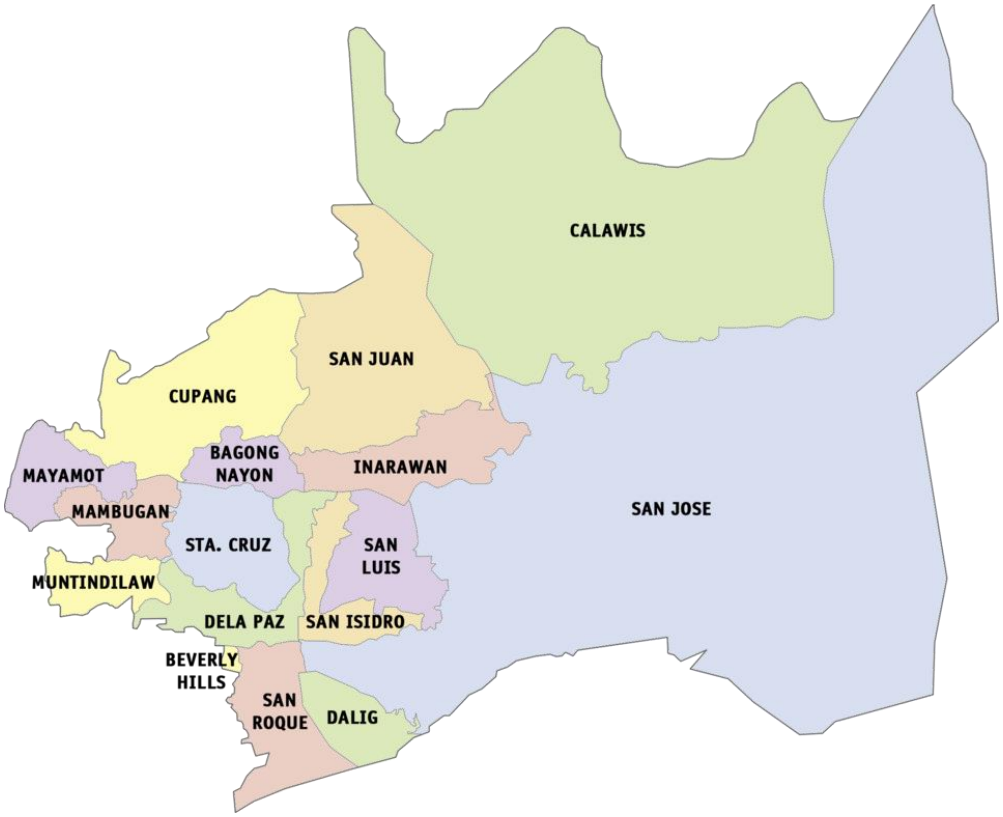
post hoc test with Bonferroni correction. In addition, the design incorporated Markov Chain modeling to estimate transition probabilities, steady-state probabilities, and expected population distribution across the identified spatial states. This combination of descriptive analysis, nonparametric inference, and probabilistic modeling made the design appropriate for examining both the determinants and long-term spatial outcomes of internal migration in Antipolo City (Siedlecki, 2020; Kim, 2017; Dinno, 2015; Qin et al., 2018).

Research Locale or Study Setting

The study was conducted in Antipolo City, Rizal, Philippines, a component city that evolved from a historic religious and agricultural settlement into a rapidly urbanizing suburban growth center. Historically, development was concentrated in the original población barangays of San Roque, San Jose, Dela Paz, and San Isidro, which became the center of religious, administrative, commercial, and institutional activities.

Figure 5

Antipolo City's Barangays



Source: Ph fil rizal antipolo barangay. (2013, April 2). Wikimedia.Org. https://commons.wikimedia.org/wiki/File:Ph_fil_rizal_antipolo_barangay.png

Over time, the city expanded outward as improved accessibility through major transportation routes such as Marcos Highway, Sumulong Highway, and Ortigas Avenue

Extension encouraged residential development, commercial activity, and migration from nearby urban and peri-urban areas (City Government of Antipolo, n.d.; PhilAtlas, n.d.; PSA, 2025).

The research locale covered all sixteen barangays of Antipolo City as shown in Figure 5: Bagong Nayon, Beverly Hills, Calawis, Cupang, Dalig, Dela Paz, Inarawan, Mambugan, Mayamot, Muntingdilaw, San Isidro, San Jose, San Juan, San Luis, San Roque, and Santa Cruz. These barangays represent different stages and functions of urban development. San Roque, San Jose, Dela Paz, and San Isidro form part of the historic urban core; Cupang, Mayamot, Mambugan, Dalig, and San Luis function as major urban growth centers; Bagong Nayon, Santa Cruz, and Muntingdilaw serve as residential expansion areas; Calawis, Inarawan, and San Juan remain important environmental and frontier development zones; and Beverly Hills is characterized as a low-density planned residential community. These geographic and functional differences made Antipolo City an appropriate setting for examining barangay-level internal migration, population redistribution, and migration-responsive planning (City Government of Antipolo, n.d.; PhilAtlas, n.d.; PSA, 2025).

Participants or Data Sources

Consistent with this design, the study gathered data from 384 qualified internal migrants residing in Antipolo City. An internal migrant was defined as a respondent whose current barangay of residence differed from his or her barangay or place of residence five years prior to the survey period, following the five-year migration framework used in Philippine migration statistics (PSA, 2020; PSA & UPPI, 2019).

To ensure that the sample reflected the spatial distribution of the city, the sample size was determined using Cochran's sample size logic as operationalized through the Raosoft Sample Size Calculator, using a 95% confidence level, 5% margin of error, and 50% response distribution. Proportionate stratified random sampling was then used to obtain representation from all sixteen barangays based on their respective population shares (Setia, 2016; Lynn, 2016).

Research Instruments or Materials

Table 1

Likert Scale Interpretation

Scale Value	Verbal Interpretation
4.51 – 5.00	Strongly Agree
3.51 – 4.50	Agree
2.51 – 3.50	Neutral
1.51 – 2.50	Disagree
1.00 – 1.50	Strongly Disagree

To collect comparable data across barangays, the study used a structured survey questionnaire composed of four parts: demographic characteristics, migration and residency characteristics, socio-economic characteristics, and Economic and Non-Economic Push–Pull factors. Push and Pull factors were measured using a five-point Likert as shown in Table 1, with a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree), a common scaling approach for measuring attitudes and perceptions in social science research (Sullivan & Artino, 2013; Joshi et al., 2015).

The questionnaire was pilot tested with 30 respondents who met the inclusion criteria, and reliability testing yielded an overall Cronbach's alpha of 0.9074, indicating excellent internal consistency (Whitehead et al., 2016; Bell et al., 2018).

Data Gathering Procedure

Data gathering was conducted systematically after the preparation and orientation of six field researchers who assisted in administering the survey across the barangays. The survey instrument was pilot tested before full implementation to assess clarity, feasibility, and consistency, consistent with the role of pilot testing in strengthening research procedures and instrument performance (Whitehead et al., 2016; Bell et al., 2018). During the actual data collection, respondents were informed about the purpose of the study, their voluntary participation, and the confidentiality of their responses. Completed questionnaires were reviewed for completeness, coded, encoded, and cleaned prior to statistical processing.

Data Analysis

The data were analyzed using descriptive statistics, nonparametric inferential statistics, and Markov Chain modeling. Frequency and percentage distribution were used to summarize respondent profiles and selected migration factors, while weighted means were used to interpret the respondents' level of agreement on Push and Pull factors (Alabi & Bukola, 2023; Lindner & Lindner, 2024). The Kruskal–Wallis test was used to determine significant differences among migration factors, and Dunn's post hoc test with Bonferroni correction identified specific pairwise differences (Kim, 2017; Dinno, 2017). Markov Chain analysis was applied to construct the transition probability matrix, compute steady-state probabilities, and estimate expected population distribution across the identified spatial states (Bell et al., 2015; Qin et al., 2018; Wilks, 2020).

Ethical Considerations

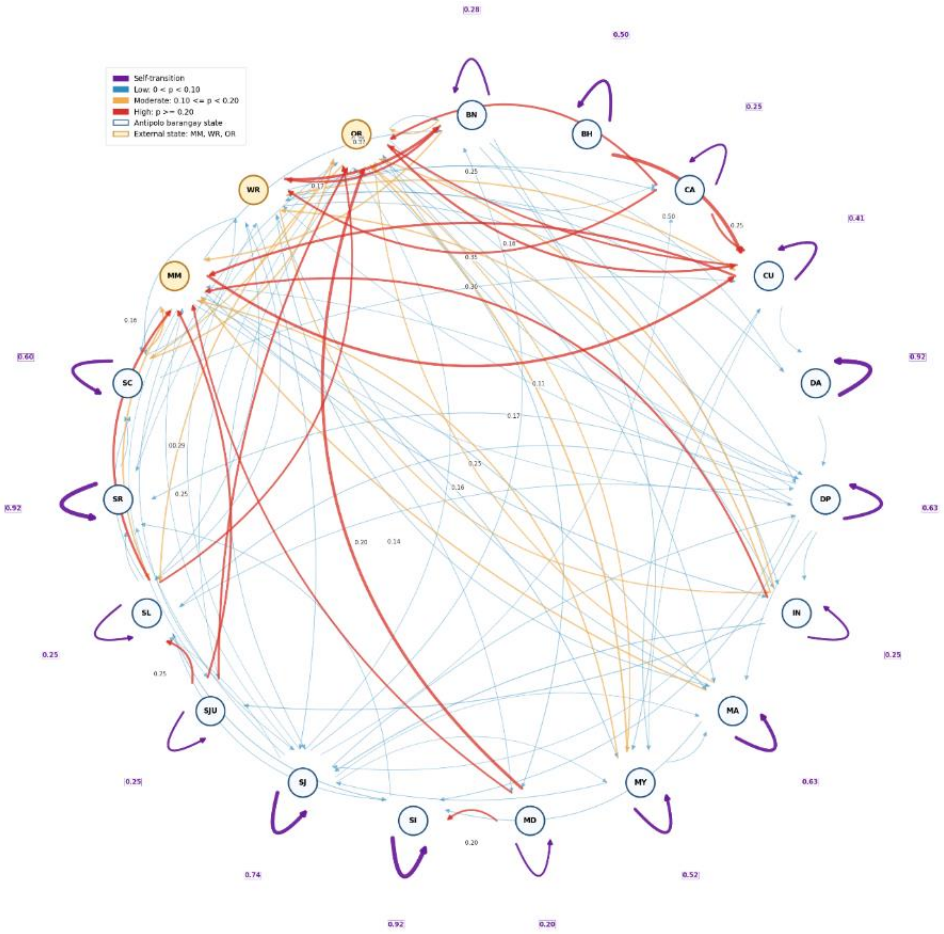
The study observed ethical principles related to informed consent, voluntary participation, confidentiality, and responsible data handling. Respondents were informed of the nature and purpose of the study before participating, and the information gathered was treated with strict confidentiality in accordance with the Data Privacy Act of 2012 (Republic Act No. 10173). The manuscript also includes an ethics review clearance in the appendices of the thesis manuscript, which should be retained or cited in the final journal submission when required by the target journal.

RESULTS AND DISCUSSION

Objective 1: Transition Probabilities, Steady-State Probabilities, and Expected Population Distribution

The first objective examined how population movement was distributed across the identified spatial states. The Markov Chain results showed that migration in Antipolo City was characterized by both high residential retention and directional movement toward selected barangays as presented in Figure 6. Dalig, San Roque, and San Isidro recorded the highest self-transition probabilities at approximately 0.92, indicating strong likelihoods of remaining in the same location. This pattern suggests that these barangays possess conditions that support residential stability, such as accessibility, established settlement structures, livelihood opportunities, and social integration.

Figure 6
Transition State Probabilities Diagram



Note. Acronyms of the states are as follows: BN = Bagong Nayon; BH = Beverly Hills; CA = Calawis; CU = Cupang; DA = Dalig; DP = Dela Paz; IN = Inarawan; MA = Mambugan; MY = Mayamot; MD = Muntingdilaw; SI = San Isidro; SJ = San Jose; SJU = San Juan; SL = San Luis; SR = San Roque; SC = Santa Cruz; MM = Metro Manila;

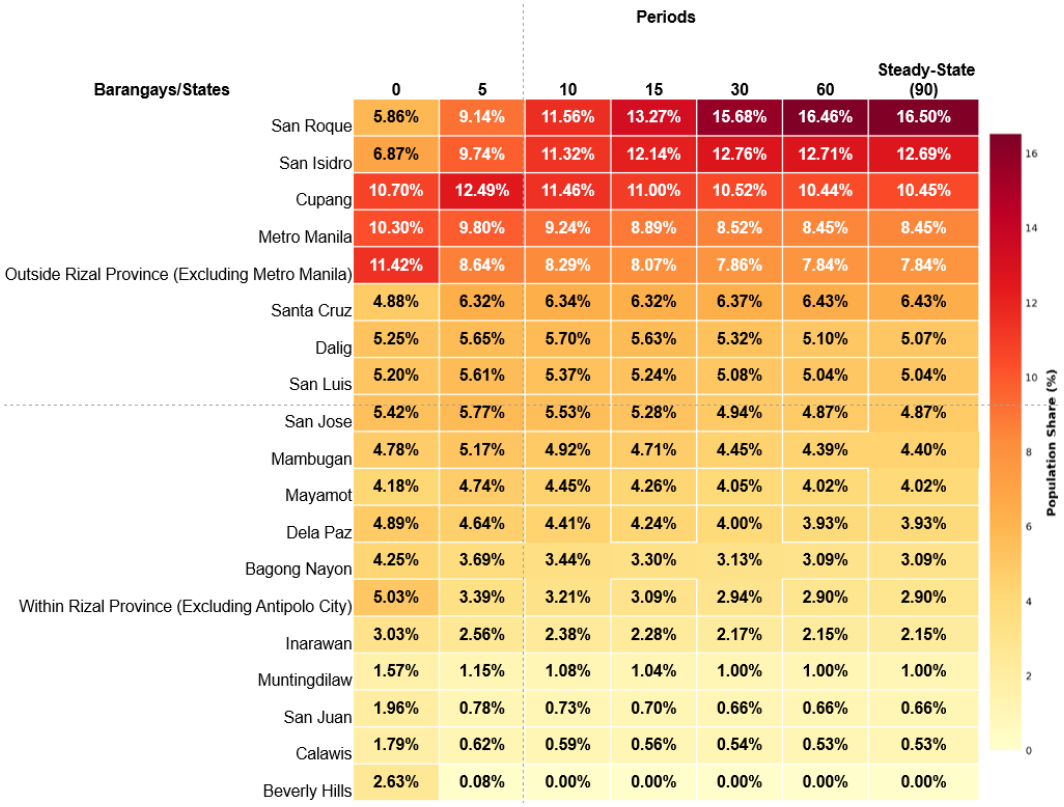
WR = Within Rizal Province (Excluding Antipolo City); and OR = Outside Rizal Province (Excluding Metro Manila). Figure generated using Microsoft Copilot.

In contrast, Muntingdilaw, Inarawan, Calawis, San Juan, and Bagong Nayon showed lower self-transition probabilities, suggesting greater outward movement or weaker long-term retention. Similar migration studies emphasize that internal migration is often selective and spatially patterned, with certain locations retaining or attracting residents because of stronger opportunities and greater connectivity (Bell et al., 2015; Bernard & Bell, 2018).

The strongest inter-state migration pathways included Beverly Hills to Cupang, Within Rizal Province to Bagong Nayon, Metro Manila to Cupang, Cupang to Metro Manila, San Luis to Metro Manila, and Outside Rizal Province to Cupang. These results suggest that Cupang functions as a major migration hub connecting Antipolo City with Metro Manila and external areas, while selected barangays serve as important corridors in the broader migration system. This finding is consistent with literature indicating that internal migration flows are shaped by accessibility, employment linkages, infrastructure, and proximity to urban centers (Lucas, 2006; Navarro, 2023). The observed movement between Antipolo barangays and Metro Manila further reflects the continuing role of metropolitan proximity in shaping suburban settlement and commuting-related migration patterns.

Figure 7

Steady-State Probabilities and Expected Population Redistribution per period



The steady-state probabilities as shown in Figure 7 further indicated that population redistribution is expected to converge toward San Roque, San Isidro, and Cupang. San Roque recorded the highest steady-state probability at 0.17, followed by San Isidro at 0.13 and Cupang at 0.10. These findings demonstrate that, under existing migration patterns, future population concentration is likely to become increasingly centered in these barangays. This is consistent with the Markov Chain principle that repeated transitions may lead to a long-run equilibrium distribution, where locations with stronger retention or inward movement accumulate larger population shares over time (Qin et al., 2018; Wilks, 2020). From a planning perspective, this implies that future infrastructure, housing, transport, education, and health service demand may intensify in these dominant barangays.

Objective 2: Economic and Non-Economic Push and Pull Factors Influencing Migration Decisions

Table 2

Respondent's Level of Agreement on the Push Factors (Economic Reasons)

Push Factors (Economic Reasons)	Mean	Verbal Interpretation
High Cost of Living	3.76	Agree
Low Income or Financial Difficulty	3.72	Agree
Limited Livelihood Opportunities	3.46	Neutral
Lack of Employment or Unstable Income	3.45	Neutral
Poor Access to Markets or Transportation	3.11	Neutral
Overall Mean	**3.50**	**Neutral**

After establishing the spatial movement patterns, the second objective examined the factors that shaped respondents' migration decisions. The results in Table 2 show that pull factors were generally more influential than push factors. Among the Economic Push factors, high cost of living and low income or financial difficulty received the highest agreement ratings, indicating that financial pressure and affordability concerns encouraged migration from previous locations. This supports the Push–Pull perspective that unfavorable conditions in the place of origin motivate people to relocate when their current environment no longer supports household welfare or economic stability (Lee, 1966; de Haas et al., 2020). However, the overall mean for Economic Push factors was interpreted as Neutral, suggesting that economic hardship was recognized but was not uniformly experienced by all respondents.

Table 3

Respondent's Level of Agreement on the Push Factors (Non-Economic Reasons)

Push Factors (Non-Economic Reasons)	Mean	Verbal Interpretation
Environmental Problems or Disaster Risk	3.16	Neutral
Limited Access to Basic Services	3.03	Neutral
Housing Problems	3.02	Neutral
Health and Safety Risks	3.02	Neutral
Social or Family Related Issues	2.72	Neutral
Overall Mean	**2.99**	Neutral

Beyond economic pressure, respondents also considered non-economic conditions in their previous locations. As shown in Table 3, environmental problems or disaster risks, limited access to basic services and healthcare, housing problems, and health and safety risks were identified as relevant concerns, although all received Neutral interpretations. This indicates that non-economic pressures contributed to migration decisions but were generally less influential than destination-side advantages. The result aligns with studies showing that migration decisions are not purely economic; they may also reflect concerns about environmental risk, service availability, safety, family welfare, and overall quality of life (Ayeb-Karlsson & Uy, 2022; Bernard & Kalemba, 2022). In this study, these factors appeared to operate as supporting rather than dominant motivations for relocation.

Table 4

Respondent's Level of Agreement on the Pull Factors (Economic Reasons)

Pull Factors (Economic Reasons)	Mean	Verbal Interpretation
Better Livelihood or Business Opportunities	4.01	Agree
Better Employment and Income Opportunities	3.92	Agree
Better Transportation and Infrastructure that Support Work	3.76	Agree
Proximity to Workplaces or Economic Centers	3.71	Agree
More Opportunities due to Urban or Regional Growth	3.51	Agree

Pull Factors (Economic Reasons)	Mean	Verbal Interpretation
Overall Mean	**3.78**	**Agree**

In comparison with origin-based pressures, destination-side opportunities were more strongly affirmed by the respondents. As shown in Table 4, Economic Pull factors obtained higher agreement ratings, with better livelihood or business opportunities and better employment and income opportunities emerging as the leading motivations for migration. This finding indicates that respondents tended to view migration as a strategy for accessing improved income, work, and livelihood prospects, consistent with literature emphasizing that labor market opportunities and income differentials remain central drivers of internal migration (Greenwood, 1997; Jia et al., 2023; Lagakos, 2020).

Table 5

Respondent's Level of Agreement on the Pull Factors (Non-Economic Reasons)

Pull Factors (Non-Economic Reasons)	Mean	Verbal Interpretation
Better and More Affordable Housing Options	4.09	Agree
Less Disaster Prone or More Resilient Location	3.85	Agree
Better Access to Education	3.85	Agree
Safer and More Secure Environment	3.84	Agree
Better Quality of Life and Family Related Reasons	3.81	Agree
Better Access to Basic Services and Healthcare	3.64	Agree
Overall mean	**3.85**	**Agree**

The same pattern was observed for Non-Economic Pull factors as shown in Table 5, where respondents placed importance on better and more affordable housing options, better access to education, safer and more secure environments, and less disaster-prone or more resilient locations. Taken alongside the economic pull results, this indicates that migration decisions were shaped by a combined search for livelihood improvement, residential security, service access, and better living conditions. This reinforces the view that migration decisions combine economic aspirations with household welfare and settlement considerations (Abalos & Yeung, 2023; Bernard & Kalemba, 2022).

Objective 3: Significant Differences Among Push and Pull Factors

To determine whether these Push and Pull factors were perceived with equal importance, the third objective tested for significant differences among the four migration factor groups. Table 6 below presents the Kruskal-Wallis test results, which showed statistically significant differences across Economic Push factors, Non-Economic Push factors, Economic Pull factors, and Non-Economic Pull factors, with all reported p-values below the 0.05 level of significance. Thus, the null hypothesis was rejected for each factor group, indicating that respondents did not perceive all migration determinants as equally influential. The use of the Kruskal-Wallis test was appropriate because the data were based on ordinal Likert-scale responses and involved comparisons among more than two factor categories without assuming normal distribution (Kim, 2017; Dinno, 2017; Sullivan & Artino, 2013; Joshi et al., 2015).

Table 6
Test of Significant Differences Among Push and Pull Factors

Factors	H-stat	P-value (a=0.05)	Decision
Push Factors (Economic Reasons)	86.06	0.00	**Reject Ho**
Push Factors (Non-Economic Reasons)	23.96	0.00	**Reject Ho**
Pull Factors (Economic Reasons)	59.67	0.00	**Reject Ho**
Pull Factors (Non-Economic Reasons)	49.24	0.00	**Reject Ho**

Note. The p-value was interpreted at the 0.05 level of significance. A p-value less than or equal to 0.05 ($p \leq 0.05$) indicates a statistically significant difference among the migration factors, while a p-value greater than 0.05 ($p > 0.05$) indicates no statistically significant difference. Values reported as 0.00 were interpreted as $p < 0.001$.

The significant differences shown in Table 6 further suggest that migration decisions were shaped by a hierarchy of motivations rather than by a uniform set of Push and Pull factors. This interpretation is consistent with Lee's Push-Pull Theory, which explains migration as the interaction of origin-based pressures, destination-based attractions, intervening obstacles, and personal circumstances (Lee, 1966). It also supports contemporary migration scholarship emphasizing that migration decisions are influenced by aspirations, capabilities, household welfare, employment opportunities, housing conditions, accessibility, and perceived quality of life (Carling & Schewel, 2018; de Haas et al., 2020; Bernard & Kalemba, 2022). In the context of Antipolo City, the statistically significant variation among factor groups indicates that respondents differentiated between economic hardship, service access, livelihood opportunities, housing, safety, and resilience when evaluating their migration decisions.

Because the omnibus test showed significant differences, Dunn's post hoc test was used to identify which specific factor pairs differed from one another.

For Economic Push factors as presented in Table 7, the post hoc results showed that high cost of living and low income or financial difficulty were not significantly different from each

other, suggesting that respondents viewed both as closely related forms of financial hardship. Meanwhile, significant differences involving transportation, livelihood, and employment-related comparisons indicate that not all economic pressures were experienced with the same intensity. This supports the interpretation that financial strain was the most salient origin-based economic pressure, while other economic constraints varied in perceived influence.

Table 7
Post Hoc Test Dunn's Test for Push Factors (Economic Reasons)

group 1	***group 2***	***p-value***	***Significant***
High Cost of Living	Lack of Employment or Unstable Income	0.00	**Yes**
High Cost of Living	Limited Livelihood Opportunities	0.00	**Yes**
High Cost of Living	Low Income or Financial Difficulty	0.61	No
High Cost of Living	Poor Access to Markets or Transportation	0.00	**Yes**
Lack of Employment or Unstable Income	Limited Livelihood Opportunities	0.81	No
Lack of Employment or Unstable Income	Low Income or Financial Difficulty	0.00	**Yes**
Lack of Employment or Unstable Income	Poor Access to Markets or Transportation	0.00	**Yes**
Limited Livelihood Opportunities	Low Income or Financial Difficulty	0.00	**Yes**
Limited Livelihood Opportunities	Poor Access to Markets or Transportation	0.00	**Yes**
Low Income or Financial Difficulty	Poor Access to Markets or Transportation	0.00	**Yes**

Note. The p-value was interpreted at the 0.05 level of significance. A pairwise comparison was considered statistically significant when the p-value was less than or equal to 0.05 ($p \leq 0.05$), indicating a significant difference between the two Economic Push Factors. Conversely, a p-value greater than 0.05 ($p > 0.05$) indicated that there was no statistically significant difference between the paired factors. Values reported as 0.00 were interpreted as $p < 0.001$.

Table 8 below shows that most pairwise comparisons among Non-Economic Push factors were not statistically significant, suggesting that environmental problems, housing problems, limited access to basic services, and health and safety risks were generally perceived by respondents as closely related migration pressures. Significant differences were observed only between Limited Access to Basic Services and Social or Family-Related Issues, and between Health and Safety Risks and Social or Family-Related Issues, indicating that family-related concerns were viewed differently from broader place-based conditions. This finding suggests that non-economic migration pressures function more as overlapping community-level disadvantages than as isolated factors, which is consistent with studies emphasizing that housing, service access, safety, environmental conditions, and family welfare interact in shaping migration decisions (Ayeb-Karlsson & Uy, 2022; Bernard & Kalemba, 2022).

Table 8
Post Hoc Test Dunn's Test for Push Factors (Non-Economic Reasons)

group 1	***group 2***	***p-value***	***Significant***
Environmental Problems or Disaster Risk	Housing Problems	0.13	No
Environmental Problems or Disaster Risk	Limited Access to Basic Services	0.11	No
Environmental Problems or Disaster Risk	Health and Safety Risks	0.10	No
Environmental Problems or Disaster Risk	Social or Family-Related Issues	0.00	No
Housing Problems	Limited Access to Basic Services	0.93	No
Housing Problems	Health and Safety Risks	0.92	No
Housing Problems	Social or Family-Related Issues	0.00	No
Limited Access to Basic Services	Health and Safety Risks	0.99	No
Limited Access to Basic Services	Social or Family-Related Issues	0.00	**Yes**
Health and Safety Risks	Social or Family-Related Issues	0.00	**Yes**

Note. The p-value was interpreted at the 0.05 level of significance. A pairwise comparison was considered statistically significant when the p-value was less than or equal to 0.05 ($p \leq 0.05$), indicating a significant difference between the two Non-Economic Push Factors. Conversely, a p-value greater than 0.05 ($p > 0.05$) indicated that there was no statistically significant difference between the paired factors. Values reported as 0.00 were interpreted as $p < 0.001$.

For Economic Pull factors, the post hoc findings in Table 9 show that better employment and income opportunities were not significantly different from better livelihood or business opportunities, indicating that respondents viewed work, income, and livelihood improvement as interconnected motivations. However, significant differences involving infrastructure, proximity to workplaces, and urban or regional growth suggest that destination attractiveness is not limited to employment alone. Rather, respondents distinguished between direct income-related opportunities and broader place-based advantages that support access to work and economic activity.

Table 9
Post Hoc Test Dunn's Test for Pull Factors (Non-Economic Reasons)

group 1	***group 2***	***p-value***	***Significant***
Better Employment and Income Opportunities	Better Livelihood or Business Opportunities	0.17	No
Better Employment and Income Opportunities	Better Transportation and Infrastructure that Support Work	0.01	**Yes**
Better Employment and Income Opportunities	More Opportunities due to Urban or Regional Growth	0.00	**Yes**
Better Employment and Income Opportunities	Proximity To Workplaces or Economic Centers	0.00	**Yes**
Better Livelihood or Business Opportunities	Better Transportation and Infrastructure that Support Work	0.00	**Yes**
Better Livelihood or Business Opportunities	More Opportunities due to Urban or Regional Growth	0.00	**Yes**
Better Livelihood or Business Opportunities	Proximity to Workplaces or Economic Centers	0.00	**Yes**
Better Transportation and Infrastructure that Support Work	More Opportunities due to Urban or Regional Growth	0.00	**Yes**

group 1	*group 2*	*p-value*	*Significant*
Better Transportation and Infrastructure that Support Work	Proximity to Workplaces or Economic Centers	0.61	No
More Opportunities due to Urban or Regional Growth	Proximity to Workplaces or Economic Centers	0.01	**Yes**

Note. The p-value was interpreted at the 0.05 level of significance. A pairwise comparison was considered statistically significant when the p-value was less than or equal to 0.05 ($p \leq 0.05$), indicating a significant difference between the two Economic Pull Factors. Conversely, a p-value greater than 0.05 ($p > 0.05$) indicated that there was no statistically significant difference between the paired factors. Values reported as 0.00 were interpreted as $p < 0.001$.

Lastly, in Table 10, for Non-Economic Pull factors, the post hoc findings show that housing emerged as a distinct and highly influential consideration, while education, safety, family-related quality of life, and resilience were generally perceived as related destination advantages. These results complete the pattern observed across the Push and Pull factors: migration in Antipolo City was shaped by both livelihood and settlement considerations, but respondents appeared to place stronger emphasis on destination conditions that offered practical improvements in housing, safety, accessibility, and quality of life. This is consistent with studies noting that employment, income, housing, and quality-of-life factors often interact in shaping internal migration decisions rather than operating independently (Bernard & Kalemba, 2022; Dias et al., 2025; Navarro, 2023).

Table 10
Post Hoc Test Dunn's Test for Pull Factors (Non-Economic Reasons)

group 1	*group 2*	*p-value*	*Result*
Better Access to Basic Services and Healthcare	Better Access to Education	0.00	**Yes**
Better Access to Basic Services and Healthcare	Better and More Affordable Housing Options	0.00	**Yes**
Better Access to Basic Services and Healthcare	Safer and More Secure Environment	0.00	**Yes**
Better Access to Basic Services and Healthcare	Better Quality of Life and Family-Related Reasons	0.01	**Yes**
Better Access to Basic Services and Healthcare	Less Disaster Prone or More Resilient Location	0.00	**Yes**

group 1	*group 2*	*p-value*	*Result*
Better Access to Education	Better and More Affordable Housing Options	0.00	**Yes**
Better Access to Education	Safer and More Secure Environment	0.58	No
Better Access to Education	Better Quality of Life and Family Related Reasons	0.52	No
Better Access to Education	Less Disaster Prone or More Resilient Location	0.75	No
Better and More Affordable Housing Options	Safer and More Secure Environment	0.00	**Yes**
Better and More Affordable Housing Options	Better Quality of Life and Family-Related Reasons	0.00	**Yes**
Better and More Affordable Housing Options	Less Disaster Prone or More Resilient Location	0.00	**Yes**
Better and More Affordable Housing Options	Better Quality of Life and Family-Related Reasons	0.23	No
Better and More Affordable Housing Options	Less Disaster Prone or More Resilient Location	0.81	No
Better Quality of Life and Family-Related Reasons	Less Disaster Prone or More Resilient Location	0.34	No

Note. The p-value was interpreted at the 0.05 level of significance. A pairwise comparison was considered statistically significant when the p-value was less than or equal to 0.05 ($p \leq 0.05$), indicating a significant difference between the two Non-Economic Pull Factors. Conversely, a p-value greater than 0.05 ($p > 0.05$) indicated that there was no statistically significant difference between the paired factors. Values reported as 0.00 were interpreted as $p < 0.001$.

General Discussion

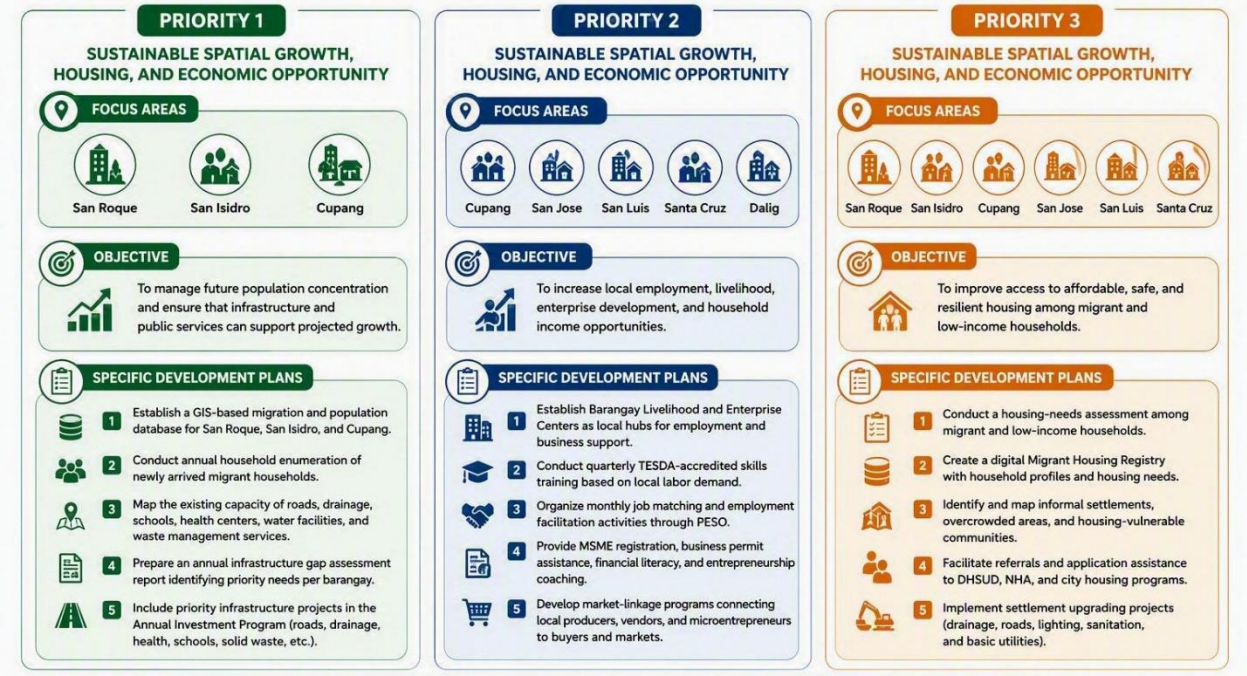
Taken together, the findings demonstrate that internal migration in Antipolo City is both socially motivated and spatially patterned. The dominance of San Roque, San Isidro, and Cupang in the steady-state results suggests that migration contributes to future population concentration in already strategic and accessible barangays. At the same time, the stronger influence of pull factors indicates that migration was not merely a response to hardship but

also a proactive household strategy for accessing livelihood, housing, education, safety, and improved living conditions. This interpretation is consistent with Lee's Push–Pull Theory, which explains migration as the combined effect of origin-based pressures and destination-based attractions (Lee, 1966), and with contemporary migration scholarship emphasizing that migration depends on aspirations, capabilities, household welfare, and local opportunity structures (Carling & Schewel, 2018; de Haas et al., 2020). The findings also reinforce the value of combining Push–Pull Theory with Markov Chain modeling because the former explains why individuals migrate, while the latter shows how repeated migration decisions reshape long-term population distribution (Bell et al., 2015; Qin et al., 2018; Wilks, 2020).

RECOMMENDATIONS

Figure 8

Proposed Strategic Development Priorities



Note. Figure generated using Microsoft Copilot.

Based on the findings, the Strategic Community Development Plan is reframed into three priority recommendations for migration-responsive local development.

Priority 1: Sustainable Spatial Growth and Infrastructure Planning. The City Government of Antipolo should prioritize infrastructure expansion, public service capacity enhancement, and land-use management in San Roque, San Isidro, and Cupang, as these barangays are projected to become the dominant long-term population centers. This priority should include road and drainage improvement, transport accessibility, school and health facility capacity expansion, and regular infrastructure gap assessment to reduce future service pressure in high-growth barangays.

Priority 2: Housing, Livelihood, and Economic Opportunity Development. Local government units should strengthen livelihood training, employment facilitation, enterprise development support, market-linkage programs, and affordable housing interventions for migrant and low-income households. This priority responds to the strong influence of livelihood, employment, income, and housing-related pull factors in migration decisions.

Priority 3: Human Development, Community Resilience, and Data-Driven Governance. Antipolo City should improve access to education, healthcare, family support services, community safety programs, and disaster preparedness initiatives while institutionalizing a migration and population analytics system under the City Planning and Development Office.

This system should regularly monitor migration flows, update Markov Chain-based population projections, and integrate migration indicators into the Comprehensive Development Plan, Comprehensive Land Use Plan, Local Development Investment Program, and Annual Investment Program. Collectively, these three priorities aim to promote balanced urban growth, inclusive service delivery, resilient communities, and evidence-based governance in Antipolo City.

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