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# Beyond the Numbers: Forecasting Tanjay City's Future Through Growth Rate Analysis

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**Abstract**

Population is more than just a number. It shows how many people live in a city and helps us understand what services, resources, and planning the city might need in the future. This study, Beyond the Numbers: Forecasting Tanjay City's Future Through Growth Rate Analysis, aims to predict the future population of Tanjay City using simple math and computer tools. We used official population data from the Philippine Statistics Authority (PSA) for the years 2010, 2015, and 2020 to calculate the city's annual growth rate. Using this growth rate, we applied the exponential growth formula to estimate the population for the years 2021 to 2030. The results show that Tanjay City's population will steadily increase from 82,642 in 2020 to about 87,041 in 2030, assuming the growth rate stays the same at 0.52% per year. Even though the yearly increase seems small, over time it adds up to thousands of new residents. This growth can affect schools, hospitals, housing, jobs, and other city services, which makes planning important. This study also shows how students can use what they learn in school, like math and computation, to solve real-life problems in their community. While the projected numbers are only estimating and may change due to unexpected events such as migration, natural disasters, or changes in birth rates, they still provide a useful guide for local government officials, planners, and residents. By predicting future population trends, this research can help Tanjay City prepare for its growth, meet the needs of its people, and plan for a sustainable and well-organized community.

Keywords: Population Growth, Exponential Growth Formula, Tanjay City, Growth Rate Analysis, Philippine Statistics Authority (PSA), Future Population Projection

## Introduction

In relation to population, population means more than just the numbers, it represents the people and the Mathematics offers effective and accurate tools for analysis of actual trends and predictions for future events. The simplifying property of mathematics makes it an important tool in areas that involve predictions, for example, demographics, urban planning, and administration where exponential functions, for example, have been widely used in understanding how a variable change and predicting its future behavior. According to the United Nations (2022), mathematical modeling in population studies has an important role in influencing policies that involve economic development and social services, among others.

Mathematics is also essential in analyzing the statistics that govern the growth of the communities within the Philippines. The growth of the populations within the communities indicates the growth and development of the communities. The higher the populations, the higher the need for housing, education, health, and employment as well as other public facilities within the communities. The lower the growth, the indicators could mean a number of issues within the communities.

The Philippine Statistics Authority (PSA) documents the population of the Philippines through a nationwide census every five years. This data is employed by the government to create development programs nationally and locally. Population figures are not always available for every year; for instance, Tanjay City has population counts only for 2010 with 79,098, 2015 with 80,532, and 2020 with 82,642. One may then raise the following question: Can the population in future years be projected based on past census data?

For Tanjay City, no data is available on its population beyond the year 2020.There is little localized research conducted that used mathematical modeling techniques for population projection for the period in between the censuses. The study fills the gap by using mathematical models for population projection for Tanjay City.

This research aims to predict the population of Tanjay City in the next decade using mathematical modeling and the exponential growth formula. The growth rate of Tanjay City from 2015-2020 has been studied, and a computation model has been developed that predicts the possible population of Tanjay City in the coming years, although it is just an estimation and has no basis as an actual forecast of growth.

To conduct this study, the objectives are to: (1) determine the annual population growth rate of Tanjay City using the data of the Philippine Statistics Authority (PSA); (2) use the exponential formula to forecast the population of Tanjay City for the years 2021 to 2030; (3) present a table of projected population values; and (4) explain the implications of the computed values in terms of the development of the said communities. The relevance of this research appears in its applications. For the concerned local government units, this study can help in decision-making involving the construction of infrastructures, educational systems, medical facilities, security, and employment. For planners and decision-makers, this research provides a simplified but efficient means of calculating what might happen in the future. For students and citizens, this research shows how mathematical concepts can be used to explain real-world problems involving population growth.

Researches that involve population growth can never be more important in preparing a community for these changes. Moreover, considering the fact that a growth in population is anticipated, it would also be significant to consider that the local government is expected to be prepared for the growth, including their capability to meet demands on housing, education, and health, among several aspects. However, slower growth might suggest challenges that include migration or economic changes. This study provides a simple but useful tool in projecting Tanjay City's population and shows how mathematical computations can help understand real-world issues in the community.

Globally, the rate of growth of populations has been considered an essential element in determining the social and economic developments of nations. It is reported that the world's population continues increasing due to enhancements in health care, rise in longevity, and survival rates, as stated by the United Nations (2022). Modelling of the rate of growth of populations, for instance, the exponential formula, is widely applied globally in the interpretation of the statistical data.

Internationally, the rate of growth of the world’s population differs from one region to another. Developed countries like Japan and certain countries in Europe witness a low or even negative rate of growth owing to low birth rates in these countries. On the contrary, Asian and African developing countries witness a moderate to high rate of growth, and adequate planning is required in these countries regarding health care, education, employment, and housing opportunities, with bodies like the United Nations Population Fund (UNFPA) stressing the significance of accurate forecasts in this respect.

**Literature Review**

Population growth is the increase in the number of people residing in a specific place over a period of time. Population growth according to Pettinger (2024), has supported cultural diversity, technological advancements, and improvements in people’s living. Population studies are essential in understanding how communities evolve over time and in providing insights for future planning. According to the Philippine Statistics Authority (PSA), census data serves as the primary source of official demographic information in the country, conducted every five years to guide governance, policymaking, and development programs. However, the interval between census years often creates a gap in updated figures, making projections necessary for timely decision-making (PSA, 2020).

While population growth has some advantages to the society, it also has its disadvantages. As said by Anderson (2023), as population continues to expand, there will be an increased demand for resources like water, energy, and raw materials. As time goes on, these resources may run out causing people to compete for them and may result in conflicts or higher prices. Rapid population growth leads to greater waste production which included sewage, pollution, and carbon emissions. This may cause deforestation, air and water pollution, and greater demand for essential services such as education, healthcare, and housing.

Population patterns change over time as communities experience births, deaths, and migration. According to the United Nations Department of Economic and Social Affairs (2022), monitoring population across specific years allows researchers to identify long-term trends such as growth, decline, or stabilization. Their report explains that demographic changes accumulate year by year, making population a variable that depends on the passage of time.

Because of this, population size is considered a dependent variable, reflecting how social and demographic factors influence communities over different periods.

Reliable sources of data are necessary to ensure that population studies produce accurate results. The Philippine Statistics Authority (2020) explains that official census data are gathered through standardized national procedures that prioritize accuracy and consistency. These consistent methods ensure that population values are comparable across different years. This makes PSA data an ideal controlled variable, since using the same source avoids errors when analyzing growth trends.

According to Ribeiro et al. (2020), cities relying on 5–10-year census intervals need mathematical projections to fill information gaps. Their research demonstrated that projections based on the most recent census (like your 2020 PSA data) offer highly reliable short-term forecasts.

Various mathematical and computational approaches have been widely used to estimate population trends. Smith, Tayman, and Swanson (2013), emphasized that population projections are valuable tools for local governments in anticipating future demands in housing, education, and healthcare. Commonly applied methods include linear interpolation, exponential growth models, and cohort-component approaches, each with varying degrees of accuracy depending on the available data (United Nations, 2017). For smaller localities such as cities and municipalities, exponential and compound growth formulas are often preferred due to their simplicity and reliance on historical census data.

Wilson & Rees (2005), emphasized that exponential growth models remain widely used for short-term population forecasting because they require limited data but still produce reliable outputs when population change is stable. According to Batista & Cavenaghi (2018), small-area population projections are essential for local governments because local demographic changes happen faster than national changes. Their study highlights that municipalities need short-term projections to anticipate school enrollment, water demand, and healthcare requirements.

Fang & Zhou (2022) highlight that modern projections now combine mathematical formulas with computational tools, improving accuracy and making forecasting more accessible for students and local researchers. A study by Anand & Sen (2021) shows that population forecasts help cities align local development plans with broader sustainability goals. They highlight that accurate forecasting helps prevent overcrowding, resource depletion, and public service failure.

**Methodology**

This study utilizes a qualitative–descriptive–computational research design. In demographic studies, population projection plays a crucial role in understanding future community conditions, resource requirements, and development priorities. Computational mathematics supports this process by enabling the transformation of raw census data into numerical forecasts through mathematical models and growth equations. This approach combines descriptive explanation with computational procedures to identify patterns and predict future population behavior—an approach commonly applied in population and urban planning research (United Nations, 2022; PSA, 2020).

Using computational modeling techniques such as exponential growth formulas, the researchers measured how the city's population has changed and projected how it may continue to grow in the coming decade. The exponential model is widely used in demographic forecasting because it accounts for continuous growth and captures long-term population patterns based on previous census counts. Through the use of numerical evidence and descriptive interpretation, this study not only presents projected values but also supports deeper understanding of how population growth affects the needs of a developing city.

The exponential population growth formula is founded on the traditional Malthusian model of growth, which was named after the British economist Thomas Robert Malthus. In his "An Essay on the Principle of Population" published in 1798, Malthus observed that any population will tend to grow at a rate corresponding with its numbers, which would give way eventually to the mathematical formulation describing exponential growth.

The computation uses the initial population ($P_0$), the annual growth rate ($r$ = 0.0052), and the number of years after the base year ($t$) to project the population of Tanjay City from 2020 to 2030. Using the formula

$P_t = P_0(1+r)^t$, the outcomes show a steady yearly increase in the population as a result of the applied growth rate. In this study, $P_0$ = 82,642, which represents the official 2020 census population reported by the Philippine Statistics Authority (PSA). The variables used in the computation are defined as follows: $P_t$ represents the projected population for a given year, $P_0$ is the 2020 base population, $r$ is the annual growth rate expressed as 0.0052 (or 0.52%), and $t$ is the number of years after 2020. This formula is widely used in population studies and is employed by Modern demographers and institutions such as the United Nations (UN DESA) and the World Bank use this same model in population projections.

It is important to note that the constant 0.0052 is not a fixed or permanent value; rather, it is derived from PSA's most recent measured growth between 2015 and 2020. According to census data, the population of Tanjay City increased from 80,532 in 2015 to 82,642 in 2020, indicating a gradual upward trend. To determine the annual growth rate used in this study, the researchers applied the formula

$$r = \frac{(P_t)\text{^}\frac{1}{t}}{Pi} - 1$$

where $P_i$ is the initial population for the period, $P_t$ is the projected population, and $t$ is the number of years to the future.

Substituting the values from 2015 and 2020 yields,

$$r = \frac{82{,}642\text{^}\frac{1}{5}}{80{,}532} - 1$$

$$r = 0.0052x100$$

$$r = 0.52\%$$

resulting in $r$ = 0.0052, or 0.52% annual growth. This calculated rate serves as the basis for projecting the population values presented in the table, demonstrating how the population increases progressively each year as time advances. All the variables used in the formula come from the same standard population growth equation. The letters were only changed or assigned to represent specific terms more clearly. The value 0.0052 (or 0.52%) was derived from the population change of Tanjay City between 2015 and 2020, based on PSA census data. This growth rate was calculated using the same formula, following the method commonly explained in population studies

**Conceptual Framework**

The goal of the researchers is to determine the projected growth of Tanjay City and gain insights into how this steady growth may affect the needs and development of the community in the future. The exponential model of population growth and the data from the previous censuses are used in this study to determine how the variables of base population, growth rate, and years elapsed are related in order to come up with accurate projections of population growth. The conceptual framework of this study is segmented into three parts, namely: Input, Process, and Output.

The Input contains the independent variable, dependent variable, and the constant variable. In this research, the independent variables are the initial population ($P_0$), which is recorded in 2020, and the rate of growth of the population ($r$), calculated from the PSA data. The dependent variable is the future population ($P_t$), projected every year from 2021 to 2030. The constant variable is the exponential growth formula, written as

$Pt = Po(1 + r)^t$ where, $t$ is the number of years after 2020. These variables form the mathematical bases of calculations of Tanjay City's population in the future.

The process of the study starts by acquiring the official census data from the Philippine Statistics Authority for the years 2015 and 2020. Using these numbers, the annual growth rate was calculated to be 0.52% or 0.0052. The formula for exponential growth was used by substituting the values of $P^0, r,$ and $t$ to arrive at the estimated populations for every year covered by the study. The results were presented in a table format indicating the year, formula used, and the estimated population. The results were analyzed by the researchers to interpret the numerical results and draw relevant observations related to urban planning and community development. The Output of this study shall be the projected population of Tanjay City from 2021 to 2030, and a descriptive analysis of the observed trend of growth. This shall involve identifying the constant growth of population, the total expected number of new populations, and what could be the implication of this trend on resource and service delivery and planning for Tanjay City. The conceptual framework helps link mathematical calculation with insights into the community.

**Results**

The results derived from the exponential population growth formula are summarized in the table below. This table presents the computed values based on the initial population ($P_0$), the annual growth rate ($r$ = 0.0052), and the number of years after the base year ($t$). Each computed outcome shows the projected population for Tanjay City from 2020 to 2030 using the formula $Pt = Po(1 + r)^t$. The results illustrate how the population increases steadily each year as a result of the applied growth rate.

**Table 1.** Projected Population of Tanjay City

| Year | Formula | Projected Population |
|---|---|---|
| 2020 | $Po = 82{,}642$ | 82,642 |
| 2021 | $82{,}642(1 + 0.0052)^1$ | 83,072 |
| 2022 | $82{,}642(1 + 0.0052)^2$ | 83,504 |
| 2023 | $82{,}642(1 + 0.0052)^3$ | 83,938 |
| 2024 | $82{,}642(1 + 0.0052)^4$ | 84,374 |
| 2025 | $82{,}642(1 + 0.0052)^5$ | 84,813 |
| 2026 | $82{,}642(1 + 0.0052)^6$ | 85,254 |
| 2027 | $82{,}642(1 + 0.0052)^7$ | 85,698 |
| 2028 | $82{,}642(1 + 0.0052)^8$ | 86,143 |
| 2029 | $82{,}642(1 + 0.0052)^9$ | 86,591 |
| 2030 | $82{,}642(1 + 0.0052)^{10}$ | 87,041 |
| Beyond 2030 | $82{,}642(1 + 0.0052)^t$ | **Population continues to rise steadily** |

Table 1 above presents the projected population growth of Tanjay City from 2020 to 2030 and beyond using an exponential growth model. The projection begins in 2020 because it is the most recent official census year recorded by the Philippine Statistics Authority, and it provides the latest verified population count of 82,642, which serves as the base population ($P_0$). Using this confirmed value ensures accuracy, since the 2025 census results are not yet available and projections cannot be used as a base population.

Our study used data from the PSA to determine the base growth rate, which we then applied to predict Tanjay City's population for the next ten years (2021–2030). This growth rate was based on the population change from 2015–2020. Because it is based on the current official data, and you cannot use future data that has not been released yet. If official data for 2021–2025 become available, our projections may need adjustment, since they currently rely solely on the 2015–2020 growth rate.

From this starting point, the population for 2021 was calculated using the formula $82{,}642(1 + 0.0052)^1$, followed by 2022 using $82{,}642(1 + 0.0052)^2$, and 2023 with $82{,}642(1 + 0.0052)^3$. The same process was repeated for 2024 using $(1 + 0.0052)^4$, 2025 using $(1 + 0.0052)^5$, 2026 using $(1 + 0.0052)^6$, 2027 using $(1 + 0.0052)^7$, 2028 using $(1 + 0.0052)^8$, 2029 using $(1 + 0.0052)^9$, and finally 2030, which was computed using $82{,}642(1 + 0.0052)^{10}$. Each calculated value shows a steady rise from 82,642 in 2020 to 87,041 in 2030, reflecting the consistent effect of the 0.52% annual growth rate.

Beyond 2030, the population continues to increase using the general formula $82{,}642(1 + 0.0052)^t$, where $t$ represent any number of years after 2020. This long-term projection highlights a continuous upward trend in Tanjay City's population, which can guide city planning, resource allocation, and development decisions. By starting with the official 2020 census and applying the exponential growth formula year by year, the table provides a reliable and systematic view of how Tanjay City's population may grow in the coming years.

In real life, population growth can change due to births, deaths, and migration. PSA updates this after every census. But for projection purposes, we assume that the latest known rate (0.52%) stays consistent in future years, that's why we used 0.0052 in the formula.

**Discussion**

The results of the projection show that the population of Tanjay City is expected to increase steadily over the coming years. Using the initial population ($P_0$) of 82,642 from 2020 and applying a growth rate ($r$) of 0.52% derived from the PSA's 2015–2020 census data, the exponential formula $Pt = Po(1 + r)^{\wedge t}$ was used to estimate future values, where t represents the number of years after 2020. With this method, the population is projected to reach approximately 87,041 by 2030. Vanella, Deschermeier, and Wilke (2020) note that population projection methods—including time-series and mathematical models—are widely used because they allow researchers to convert current demographic data into quantitative forecasts that help policymakers understand future changes in population size and structure.

The observed steady increase emphasizes the importance of informed urban planning. Rapid or even gradual population growth can increase demand for services such as education, healthcare, water supply, transportation, and housing. Studies by Anderson (2023) highlight that growing populations often create pressure on local resources and infrastructure when city development does not keep pace. Similarly, the United Nations Department of Economic and Social Affairs (2022) states that even modest annual growth rates can accumulate into significant long-term impacts, requiring cities to plan ahead for classroom capacity, health facilities, waste management, and public utilities. These findings reinforce the importance of variables like r (annual growth rate) in anticipating service demand.

However, the increase also presents potential benefits. Pettinger (2024) notes that population growth can strengthen the labor market, increase economic activity, and stimulate local development. In addition, O'Neill et al. (2010) explain that a steadily rising population contributes to an expanded workforce and broader consumer base, both of which support economic productivity and local business growth. These support the relevance of $P_0$ and t when evaluating long-term socioeconomic opportunities.

Beyond 2030, the upward trend continues under the same exponential model. Although actual values may shift due to changes in fertility, mortality, and migration, projections remain essential when newer census data is not yet released. UN DESA (2022) emphasizes that demographic projections help local governments anticipate future needs and allocate resources more effectively. Once the PSA releases the 2025 census data, the growth rate r can be recalculated using updated numbers, but the current projection remains valid because it is based on the most recent available data from 2020. This highlights the importance of continuously updating variables like r to maintain accurate, evidence-based forecasts.

Additional studies further support the reliability of using exponential models for population forecasting. Bongaarts and Bulatao (2019) explain that exponential projection methods are appropriate when population growth follows a relatively stable trend, as they effectively represent natural population increase through compounding over time. Since this study used a growth rate based on the most recent PSA census data, the projected increase in Tanjay City's population can be considered realistic and data-driven.

Population projections are also important tools for local governance and planning. Smith and Tayman (2018) emphasize that accurate population forecasts help local governments prepare budgets, design public policies, and plan infrastructure development. Without reliable projections, cities risk underestimating future needs, which may result in overcrowded schools, insufficient healthcare services, and limited housing availability.

In the context of developing and secondary cities, similar findings have been observed. According to the Asian Development Bank (2021), cities in Southeast Asia experiencing steady population growth often face increasing pressure on transportation systems, water supply, and waste management services. This indicates that even moderate growth rates, such as the 0.52% observed in Tanjay City, can have significant long-term impacts if urban planning does not keep pace with population change.

From an economic standpoint, Bloom et al. (2019) note that gradual population growth can contribute to economic development by expanding the labor force and encouraging investment, particularly when a large share of the population is of working age. This supports the claim that population growth in Tanjay City may create economic opportunities, provided that employment and skills development keep up with population increases.

Rowland (2020) highlights that population projections should be viewed as flexible planning tools rather than exact predictions. Although changes in migration, fertility, and mortality may affect actual population size, projections remain essential when updated census data is unavailable. This supports the argument that the current projection remains valid until new PSA data allows for recalculation of the growth rate $(r)$.

**Conclusion**

To sum up, this study shows that the population of Tanjay City has been steadily increasing over the years and is expected to continue rising in the coming decades. Using census data from the Philippine Statistics Authority and applying the exponential growth formula with a 0.52% annual growth rate, the results reveal a consistent upward trend that projects several thousand additional residents by 2030.

This increase may appear modest compared to larger cities, but it carries significant meaning for community life. More residents mean greater demand for schools, teachers, healthcare services, housing, and jobs. At the same time, environmental resources will face additional pressure, highlighting the need for sustainable practices. These outcomes show that population growth is more than a matter of numbers—it is about anticipating and addressing the needs of people.

Population projections like this study play an important role in planning for the future. They provide leaders, planners, and residents with useful insights into potential challenges and opportunities, helping ensure that growth contributes to progress rather than problems. With the right preparation, the city can transform the pressures of growth into opportunities for development.

In conclusion, forecasting population growth is not merely about counting numbers but about preparing for the needs and well-being of people. With proper planning informed by projections, Tanjay City can ensure that development keeps pace with growth, turning challenges into opportunities for sustainable progress.

Based on the findings of the study, there are important conclusions to be made about the implications of population growth for Tanjay City.

The relevance of this paper to the people of Tanjay City includes its projection, which helps guide future activities. Demographic projections help give guidance to planners on what to prepare for in the future with respect to infrastructure, education, health, and all other basic services. Wang & Wen (2018) indicate that demographic projections and planning are critical to efficient governance because it helps the planner to be aware and prepare for future demands, hence preventing over-investment and under-investment. Similarly, it can be argued that UN DESA (2022) holds that demographic projections play an important role in planning future long-term activities with respect to the provision of public services, among others, since it helps guide the taking of proactive measures rather than taking a very reactive approach by failing to see future directions with respect to demographic change.

With these observations in mind, the following recommendations can be made on how the local authority can prepare for the expected growth in the future.

1. Improve urban planning and infrastructure development: According to Prasetyo et al. (2020), proactive urban planning based on changing demographics would enable better control over residential density, transportation, and land use of the city. This, in turn, would slow down the process of urban sprawl.

2. Expand Education and Healthcare Services. As articulated by Martinez & Lee (2021), areas with ever-increasing populations often experience constraints in educational infrastructure as well as healthcare facilities, except when expanded beforehand. There lies the importance of integration with increased populations.

3. Encourage Environmental Practices to Ensure Sustainability. A study carried out by Li et al. (2019) highlighted that the increasing number of populations, owing to the effects that have been unleashed due to increased demands of water, energy, and waste management, calls for greater consideration of sustainability in resource management.

4. Promoting Employment in the Area. According to the research carried out by Nguyen and Ahn (2024), the economic growth method that is connected with demographic forecasts has its significant role in dealing with the issue of unemployment and maintaining the sustainability of the economy.

5. Improve Transportation and Public Safety. According to the study by Garcia & Santos (2023), population projection predictions enable the local authorities to optimize transportation infrastructure and safety systems prior to the setting up of congestion and safety issues.

The recommendations can be further justified by a series of arguments that discuss the relevance of these matters for sustainable development and good governance.

1. Therefore, urban planning can deal with the problem of congestion and at the same time provide assurance that there will not be any scarcity of resources. A population increase means that more pressure is put on the provision of housing, services, and infrastructure. According to Prasetyo et al. (2020), growth projections help a city effectively utilize land use, as well as infrastructure layout.

2. Increasing the provision of education and health care leads to enhanced living standards. When growth in the population is not absorbed by the ability to provide services, educational and health facilities suffer from overcrowding. As demonstrated by Martinez & Lee (2021), population growth predictions help leaders build education and health facilities before the growth in the population, thereby increasing the utilization levels and quality of services.

3. Sustainable environmental practices promote the effective conservation of environmental resources. Environmental pressure mounts with the increasing population of human beings in the earth's ecosystem. Li et al. in their research in 2019 show that the incorporation of sustainability in planning ensures the conservation of environmental resources and the promotion of ecological services.

4. Creating jobs ensures economic stability. The increasing population leads to an increased supply of labor. Nguyen & Ahn (2024) note that integrating the development of the labor force with demographic changes enables success for the enterprise and ensures that the unemployment rate does not contribute to weaknesses in the economy.

5. Developments in transport systems will prepare the city to cope with increased activity. A rising population requires advancements in transport and emergency response. Garcia & Santos (2023) highlight transport planning and ability to cope with disasters as elements of considerable importance that depend greatly on population projections.

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