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# Potential Prospects for Population and Infrastructure in 2045 on Supporting Development in Nduga Regency

**Charley M. Bisai[1], Pisi Bethania Titalessy[2], Marsi Adi Purwadi[3], Yundy Hafizrianda[4]**
Universitas Cenderawasih[1, 2, 3, 4]
Jayapura, Indonesia
Correspondence Email: bethaniapisi@yahoo.com
ORCID ID: 0000-0002-4102-6827

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## ABSTRACT

Adequate population and infrastructure are required for the growth of the economy. It is crucial for a country to have decent facilities since it is critical to home life as well as economic operations. The increase in population is a proportional enhancement of facilities and infrastructure. Nduga regency is one of the districts in the Papua Pegunungan province. It is an expansion area of Jayawijaya regency in 2008 which has the potential for abundant population and natural resources. However, there is still a lack of research in this district. Therefore, this study aims to determine potential prospects for population and theavailability of residential infrastructure in Nduga regency to support development in 2045. The method used is population projection analysis and the projection of facilities and infrastructure of education, health, economy, and road. The expected output is the availability of residential facilities and infrastructure in Nduga regency. In 2045, the population in Nduga regency has the potential to increase to 172,876 people and with such a population. Hence, it is necessary to provide school buildings, health facilities, as well as additional economic facilitiesand road.

**Keywords:** Development; Infrastructure; Projection; Population

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## INTRODUCTION

Population has a strategic role in the development of a country. Population is both the object and subject of development in a country. Population as an object of development means that the goal of development is to improve community welfare. As subjects of development, residents are the actors who will carry out development. A large population is a positive thing because a large population can be used as a subject for development, the economy will develop if the number of workers is large.

All nations or countries that are developed, prosperous and modern in the past, present and future are because they have superior, high-quality and highly competitive human resources. In this way, it will be able to innovate creatively and intelligently in managing high-value natural resources and even be able to create artificial resources with very high added value.

A large and high-quality population is the basic capital and the potential for increasing development in all fields. However, if the large population is not followed by the development of the quality of the population, it will turn into a burden on development and can reduce the development results. It is a fundamental demographic and sociological concept and is often used in various contexts, including government planning, economic analysis, healthcare, and social studies. Modern progress requires all parties, including the government, to compete in the face of intense competition. Regional governments as parties tasked with serving the community or population in various fields or aspects of life are required to provide services.

Population is the development capital for a region because it is a source of labor supply, especially for residents aged 15 years and over. The more population, this means the greater number of workers who can drive regional development. However, excessive population growth can also be a problem in development, especially in providing facilities and infrastructure.

The population of Nduga regency continues to increase over time. This population increase certainly has the consequence of providing adequate public facilities and employment opportunities that ensure the survival and welfare of the population. Means are things in the form of tools that are usually used to achieve a predetermined goal, while infrastructure is everything that is usually used as the main support for the implementation of production. The increase in population is proportional to the increase in the need for facilities and infrastructure.

In general, the provision of basic facilities and infrastructure for a city in Indonesia almost always lags the speed of population growth. Facilities and infrastructure are basic needs. It is important factors in increasing social stability, dynamics, and productivity of society. However, the government's ability to provide infrastructure is still limited. The construction of housing and its facilities and infrastructure needs attention because of the importance of housing as one of the basic needs that must be met.

Facilities and infrastructure in a region are an important aspect of human life. Apart from being a supporting factor for the progress of a region, facilities and infrastructure are also a factor that can help sustain people's lives. With the existence of facilities and infrastructure in an area, people can carry out their daily activities smoothly. Likewise for the government, facilities and infrastructure are the most important things for running the economy and government. If the condition of an area's facilities and infrastructure is good, then economic and transportation activities will also run smoothly.

Therefore, the government needs to record existing facilities and infrastructure in its government area. This is done to determine the condition of facilities and infrastructure along with attribute data related to these facilities and infrastructure.

The definition of infrastructure is anything that can be used as tools and materials to achieve the aims and objectives of a production process (Sagala & Mulyono, 2021). In other words, infrastructure is intended for immovable objects such as buildings, drainage networks, electricity networks and telephone networks. The purpose of facilities is to achieve a goal, namely welfare, such as schools, offices, health, and other means of supporting human activities.

The development of facilities and infrastructure has also been regulated in Law Number 1 of 2011 concerning Housing and Settlement Areas (Indonesia. The Audit Board, 2011). The population, population projections, and population growth movements have a big influence on the development of facilities and infrastructure, both urban and residential. The development of facilities and infrastructure that are inadequate and have not been completed in the development process in Papua province, especially the mountainous areas, is a challenge for the regional government because infrastructure itself is an asset in reaching investment in the Papua mountains region and increasing economic growth in Nduga regency. This study aims to analyze the potential prospects of population and the needs of facilities in education, health, economy, and housing to support development of Nduga regency in 2045.

## LITERATURE REVIEW

According to Todaro and Smith (2011), development has several goals. Firstly, to increase the standard of living (level of living) for each person, including income, level of consumption of food, clothing, housing, health services and education. Second, the creation of various conditions that enable the growth of self-esteem in each person through the establishment of social, political, and economic systems and institutions that promote human dignity and respect. Third, increasing the freedom (freedom/democracy) of each person in choosing various existing choice variables. For this reason, development is expected to create equality and justice (the absence of inequality in development, both between regions, subregions, and community members). Secondly, empowering the community and alleviating poverty. Third, create and increase employment opportunities. Fourth, increase the income and welfare of regional communities. Fifth, maintain or preserve natural resources so that they are beneficial for present and future generations (sustainable).

“Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World” by Nancy Birdsall, published in 1998, explores the intricate relationships between population dynamics, economic growth, and poverty in developing countries. The book delves into the following key points.

### Demographic Trends

Birdsall discusses the demographic transitions occurring in many developing countries. These transitions involve shifts from high birth and death rates to lower birth and death rates, ultimately leading to more stable population growth. This transition is influenced by factors such as improved healthcare and family planning.

**Demographic Dividend**
The book examines the concept of the demographic dividend, which occurs when there is a significant working-age population relative to dependents (children and the elderly). This demographic structure can potentially lead to increased economic productivity and growth.

**Economic Growth**
Birdsall explores the role of demographic changes in influencing economic growth. It was argued that countries experiencing the demographic dividend have the potential for accelerated economic development, provided they invest in education, healthcare, and job opportunities for the growing workforce.

**Poverty Reduction**
The book emphasizes the potential for demographic changes to reduce poverty in developing countries. A growing, educated workforce can contribute to higher income levels for families and reduce the overall poverty rate.

**Policy Implications**
Birdsall highlights the importance of targeted policies and investments to harness the demographic dividend. These policies include investments in education, health, and family planning to ensure that the working-age population is healthy, skilled, and employed.

Economic growth encompasses the augmentation of an economy's production capability, manifested through a rise in national income. It serves as a key indicator of economic prosperity and is a crucial yardstick for evaluating the success of economic development within a particular region. Growth in the economy is ascertained when the collective output of actual services, resulting from the application of production factors in a specific year, surpasses the real income of the populace from the preceding year. In essence, it reflects the positive trajectory and advancement of the economy (Runtunuwu & Kotib, 2021).

Strong and sustainable economic growth will be achieved if supported by adequate infrastructure. Todaro and Smith (2011) argued that infrastructure is a facility that enables economic and market activities, such as transportation networks, communications, distribution, water utilities, water channels, and energy supply systems. So, it can be concluded that infrastructure is a facility that will provide economic growth results from activities in the infrastructure sector, service sector and education sector.

Infrastructure is the basic physical equipment of an environment, region, city, or region (spatial space) so as to enable the space to function as it should. Infrastructure refers to the physical system that provides transportation, water, drainage, buildings, and other public facilities needed to meet basic human needs in the social and economic sphere (Grigg, 1988). Meanwhile, according to Polyzos and Tsiotas (2020), infrastructure is a very important potential factor in determining the direction and future development of a region, because development will not be successful and run well without adequate infrastructure support. The city is a public facility that is the main support for the implementation of a process or activity in the city which will ultimately determine the development of the city. Thus, city infrastructure is a public facility that is the main support for the implementation of a process or activity in the city, which will ultimately determine the development of the city.

Infrastructure performance through the Infrastructure Development Index has been studied by Patra and Acharya (2011). The research found that there is a positive relationship between the Infrastructure Development Index and the country's Net Domestic Product per capita. Empirical evidence shows that infrastructure has high potential to influence the growth of net domestic product per capita, which in turn can reduce poverty and ultimately help the economy. Further efforts need to be made to create more infrastructure facilities at the state level, to increase the country's domestic product and reduce the poverty level and ultimately the living standards of the people concerned.

Infrastructure development, which can encourage increased economic growth and reduce inequality, can be used as an instrument to reduce poverty, thus infrastructure development has become a top priority in policy in various countries (Calderón & Servén, 2014). On the other hand, infrastructure can also absorb most of the fiscal stimulus deployed amid the global crisis in 2007-2008. On average, 40 percent of government spending in several developing countries is for infrastructure spending, while for developed countries it is only 21 percent (International Labor Organization [ILO], 2011).

Procedures for planning housing environments in urban areas was prepared by the Construction and Building Engineering Committee (Pokja PPAS, 2019). This standard contains a detailed description of the principles of urban housing environmental planning, which was prepared as a revision of SNI 03-1733-1989 concerning procedures for urban housing environmental planning.

This standard was prepared through consensus in Bandung on June 17, 2003, which was attended by relevant stakeholders. If there are doubts regarding the application of this standard, it can be compared directly with the substance contained in the reference, or with the latest edition, except for matters that are adapted to Indonesian conditions.

Indonesian National Standards Procedures for urban housing environmental planning are guidelines (national documents) that function as a frame of reference for planning, designing, estimating costs and space requirements, as well as implementing housing and settlement development.

## RESEARCH METHOD

Data collection methods are used to support and strengthen the preparation of reports. At this stage is the stage of data collection - data that is very necessary to support this research, the data collection technique used only uses secondary data without using primary data. Secondary data is a survey conducted without going directly into the field but rather collecting data or information from several sources. Secondary data is usually arranged in the form of documents. The secondary data used the total population and existing conditions of health, education, economic, and housing infrastructure in Nduga regency taken from Nduga Regency Central Bureau of Statistics.

The analysis stage is an analysis of population projections to determine the need for infrastructure in 2045. To find out the availability of facilities and infrastructure in 2045 by comparing regulations and existing conditions.

Population projection is a way of depicting population numbers based on certain calculations which are based on assumptions about the components at work, including births, deaths, and migration. Projections play an important role in its purpose as a planning system for the future. In Indonesia, the National Development Planning System (SPPN) is a unified development planning procedure to produce long-term, medium-

term, and annual development plans implemented by state and community administrators at the central and regional levels. This is as mandated in Law no. 25 of 2004. In other words, population projections are useful as a database and target for determining policies for sectoral development.

Population projections are carried out to determine population growth each year with the aim of estimating the amount of infrastructure needed in the future. Population projections can be done using 3 methods, namely arithmetic, geometric, and exponential (Devina, 2022). The basis for selecting population projections is based on population growth tendencies and the characteristics of the planning city. The population calculation method in this research uses the geometric method. The geometric population growth rate uses the assumption that the population growth rate is the same every year.

The population in year 0, namely P0, and year n, namely Pn, always changes. Therefore, we need a number r which shows the rate of population growth in a certain period which can be obtained from several population growth model formulations.

To obtain the population growth rate (r) the equation is used as follows.

$$r = \frac{\left(\frac{Pn}{P0}\right)^{1/t}}{t} - 1$$

Where:
Pn is the population in year n;

P0 is the population in the base year;
r is the population growth rate;
t is the difference between the base year and year n.

A good projection is a projection that produces the smallest possible deviation between forecast results and reality. Population projection using the geometric method uses the assumption that the population will increase geometrically using the basis of compound calculations (Adioetomo & Samosir, 2010). The population growth rate (rate of growth) is considered the same for every year. The formula used in the geometric method is as follows.

$$Pn = P0(1+r)^t$$

Where:
Pn is the population for the year to be projected;
Po is the base year population;
r is population growth;
t is the period between the base year and year n.

## RESULTS

Nduga regency is included in the Papua Mountain province region with the district capital being in Kenyam district. Nduga regency has an area of 2,168 square kilometers with 32 districts and 248 villages. The following is the population of Nduga regency by district in 2022.

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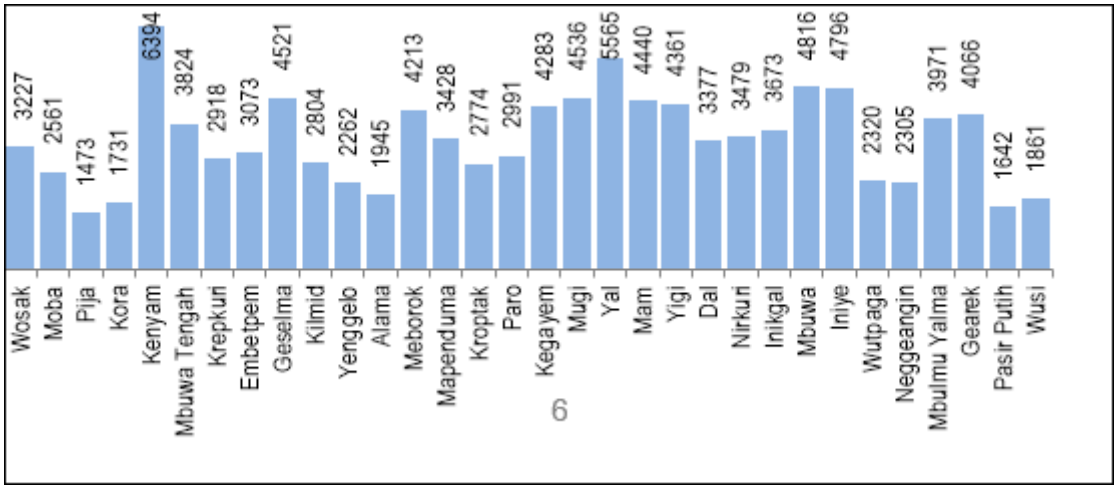
**Figure 1. Population by District in 2022**




*Source: Statistics Regency of Nduga (BPS Kabupaten Nduga, 2022).*

Based on BPS data, the population of Nduga regency in 2022 will be 109,630 people with the largest population being in Kenyam district, which is the capital of Nduga regency, namely 6,394 people and the smallest population in Pija district at 1,473 people. In the BPS Nduga regency report in figures for 2023, the population of Nduga in 2022 was recorded to have experienced growth of 1.58 percent from 2021.

To project infrastructure needs, population data is needed up to 2045. Therefore, population projections are prepared based on the results of the 2020 Population Census (SP). Population projections are needed by the government to improve the socio-economic conditions of the people through planned development. Projections play an important role in its purpose as a planning system for the future.

Population projections are carried out to determine population growth each year with the aim of estimating the amount of infrastructure needed in the future. Population projections can be done using 3 methods, namely arithmetic, geometric, and exponential (Devina, 2022). The basis for selecting population projections is based on population growth tendencies and the characteristics of the planning city. The following is the population number until 2045 using the geometric calculation method in Nduga regency by district. The geometric population growth rate uses the assumption that the population growth rate is the same every year.

**Table 1. Population Projections by District in 2045**

| District | 2045 |
|---|---|
| Wosak | 5089 |
| Moba | 4038 |
| Pija | 2323 |
| Kora | 2730 |
| Kenyam | 10083 |
| Mbuwa Tengah | 6030 |
| Krepkuri | 4601 |
| Embetpem | 4846 |
| Geselma | 7129 |

| | |
|---|---|
| Kilmid | 4422 |
| Yenggelo | 3567 |
| Alama | 3067 |
| Meborok | 6643 |
| Mapenduma | 5406 |
| Kroptak | 4374 |
| Paro | 4717 |
| Kegayem | 6754 |
| Mugi | 7153 |
| Yal | 8775 |
| Mam | 7001 |
| Yigi | 6877 |
| Dal | 5325 |
| Nirkuri | 5486 |
| Inikgal | 5792 |
| Mbuwa | 7594 |
| Iniye | 7563 |
| Wutpaga | 3658 |
| Neggeangin | 3635 |
| Mbulmu Yalma | 6262 |
| Gearek | 6412 |
| Pasir Putih | 2589 |
| Wusi | 2935 |
| Total | 172876 |

*Source: Author's Calculation (2023).*

The projection results show that the population of Nduga regency will be 172,876 people in 2045. The population of Nduga regency in 2022 is 109,630 people, population growth will continue throughout the projection period. One of the characteristics of the population of Nduga regency is the uneven distribution between districts. Most of the residents of Nduga regency live in Kenyam. However, the percentage of the population living in other districts is also projected to continue to increase.

The population, population projections, and population growth movements have a big influence on the development of facilities and infrastructure, both urban and residential. These facilities and infrastructure projections have been prepared as input to support development in Nduga regency.

## DISCUSSION

### Education

Infrastructure for education refers to the physical facilities, resources, and systems that support the delivery of educational services. It includes a wide range of elements necessary for the effective operation of schools, colleges, and other educational institutions. Educational infrastructure can be seen from Minister of National Education Regulation Number 24 of 2007 (Indonesia. The Audit Board, 2007a) and Permendikbud Number 40 of 2007 (Indonesia. The Audit Board, 2007b).

Based on the Minister of National Education Regulation, the implementation of national education must ensure equality and improvement in the quality of education amidst global changes so that Indonesian citizens become human beings who are devoted to God Almighty, have noble character, are intelligent, productive, and have high competitiveness in national and international relationships. To ensure the achievement of these educational goals, the government has mandated the preparation of eight national education standards as regulated in Government Regulation of the Republic of Indonesia Number 19, 2005 concerning National Education Standards (Indonesia. The Audit Baord, 2005). National education standards are minimum criteria regarding the education system in all jurisdictions of the Unitary State of the Republic of Indonesia.

Planning for educational facilities must be based on the educational goals to be achieved, where these educational and learning facilities will provide learning spaces that enable students to develop knowledge, skills, and attitudes optimally. With these educational projections, it is hoped that planning in the education sector can be implemented better and in accordance with needs.

To prepare projections for educational infrastructure at elementary to high school levels, the same assumptions are used, namely based on the targets to be achieved at the end of the projection. In the 2021/2022 academic year, in Nduga regency there are 31 elementary school units, 7 middle school units, 2 high school units, and 1 vocational school unit. Most of these schools are in the district capital, so the existence of educational facilities can be said to be not fully distributed. To determine the need for educational land in an area, it is necessary to know the Minimum Service Standards (SPM) for educational facilities in an area so that the amount of land use required can be determined by referring to educational service standards that are determined so that the need for educational facilities is spread evenly. SPM is a provision regarding the type and quality of basic services which is a mandatory government matter that every citizen has a minimum right to obtain. Basic services are a type of public service that is basic and absolute to meet people's needs in social, economic and government life. To find out the Minimum Service Standards for educational facilities, see the Decree of the Minister of Human Settlements and Regional Infrastructure No. 534/KPTS/M/2001.

For minimal educational facilities available are as follows: (1) 1 kindergarten (TK) unit for 1,000 residents. In 2045, 173 kindergarten units are needed; (2) 1 elementary school (SD) unit for every 6,000 residents, so for 2045, 29 units are needed (172,876/6,000 = 28,812 rounded to 29 units). It can be concluded that elementary school education facilities are still adequate because Nduga regency already has 31 elementary school units. However, it needs to pay attention to the distance between the population and the school building; (3) 1 junior high school (SMP) unit for every 25,000 residents, so for the next 20 years 7 units are needed (172,876/25,000 = 6,915 rounded to 7 units). There are 7 junior high school units available, so that junior high school education facilities willstill be sufficient; (4) 1 high school (SMA/SMK) unit for every 30,000 population, 1 unit is needed (172,876/30,000=5,762 rounded to 6 units). With only 3 SMA/SMK available in Nduga regency, it is necessary to add 3 SMA/SMK units by 2045; and (5) 1 University unit for 70,000 residents. With there being no tertiary institutions in Nduga regency, by 2045 there will be a need for at least two (2) tertiary institutions for the 172,876 population.

**Table 2. Educational Building Facilities Needs**

| Year | Kindergarten | Elementary School | Junior High School | Senior High School |
|---|---|---|---|---|
| 2022* | 1 | 31 | 7 | 3 |
| 2029 | 126 | 21 | 5 | 4 |
| 2034 | 139 | 23 | 6 | 5 |
| 2039 | 154 | 26 | 6 | 5 |
| 2045 | 173 | 29 | 7 | 6 |

*Source: Projection Results, 2023 (Processed Data).*

**Health**

The healthcare system must be designed to meet the needs of the population, including hospitals, clinics, and healthcare professionals. Changes in population size and age distribution can affect healthcare demand. Health Facilities function to provide health services to the community, have a very strategic role in accelerating the increase in the level of public health as well as controlling population growth. The basis for providing this facility is based on the number of residents served by the facility.

Health facilities are one of the government's efforts to improve the quality of public health, and it is the government's obligation to provide adequate health service facilities and public service facilities for every citizen. The number of health facilities in Nduga regency is still limited and only includes hospitals, Posyandu, polyclinics, health centers, and Pustu. In 2020, there were 1 hospital, 8 Posyandu, 3 polyclinics, 13 community health centers, and 10 Supporting Community Health Centers (Pustu).

Based on "Guidelines for Minimum Service Standards, Guidelines for Determining Minimum Service Standards in the Field of Spatial Planning, Housing and Settlements and Public Works (Decree of the Minister of Housing and Settlements and Regional Infrastructure No. 534/KPTS/M/2001)". For health service facilities, there is a minimum of 1 treatment center unit available for every 3,000 people. In 2045, with a population of 172,876, 58 units will be needed.

1 maternity hospital unit for every 10,000-30,000 people, so 17 maternity hospitals are needed in 2045. 1 Puskesmas unit for every 120,000 people, so 1 Puskesmas unit is needed. 1 hospital unit for every 240,000 people, then 1 hospital unit is needed. Where there is already 1 general hospital unit in Nduga regency, namely the Pratama Elvrida Sara Hospital which is a hospital belonging to the Nduga regency government with class D type where in this type at least 2 basic specialist medical services are available, with facilities and service capabilities that include general medical services, emergency services, basic specialist medical services, nursing, and midwifery, as well as clinical and non-clinical support services.

**Economy**

The size and composition of the population can influence economic factors such as labor supply, consumer demand, and overall economic growth. A growing population can lead to economic expansion, while a declining population may pose economic challenges. Infrastructure for the economy refers to the physical and organizational structures, facilities, and systems that support economic activities and facilitate economic growth.

Based on the Minimum Service Standards Guidelines for Determining Minimum Service Standards in the Field of Spatial Planning, Housing and Settlements and Public Works (Decree of the Minister of Housing and Settlements and Regional Infrastructure No. 534/KPTS/M/2001), the coverage for each sub-district is a minimum of 1 market for each

30,000 residents. Thus, if we look at population projections in 2045, each district in Nduga regency does not reach 30,000 residents. However, if we calculate the total district for Nduga regency in 2045 which is projected to reach 172,876 people, it is necessary to have 6 markets (172,876/30,000=5,762) rounded to 6 units). This number is sufficient for the total number of existing residents and exceeds the number of markets that already exist in Nduga regency. However, it is necessary to pay attention to the distance or radius to reach the market so that it needs to be evenly distributed so that each resident of the district can reach the existing markets.

According to the scale of service, the classification of types of trade and commerce facilities are (1) Shop/stall (RT unit service scale = 250 residents), which sells daily necessities; (2) Shops (service scale 6,000 residents), which sell more complete daily necessities and services such as telephone kiosks, photocopying, and so on; shopping centers and/or neighborhood markets (subdistrict unit service scale = 30,000 residents), which sell daily necessities including vegetables, meat, fish, fruit, rice, flour, clothing materials, clothes, grocery items, tools. educational tools, household tools, as well as services such as internet cafes, kiosks and so on; and (3) Shopping and commercial centers (sub-district unit service scale = 120,000 residents), which apart from selling daily necessities, clothing, grocery items, electronics, also provide workshops, repairs, non-polluting production units, entertainment venues as well as other commercial activities such as offices, banks, small industries, and others.

**Road**

Road infrastructure is essential for economic development, trade, and the mobility of people and goods. Investment in road infrastructure can lead to increased connectivity, reduced travel times, and improved road safety. Governments and transportation authorities are responsible for planning, building, maintaining, and upgrading road infrastructure to ensure that it meets the needs of the population and the economy.

The relationship between population and road infrastructure is significant and interconnected. The size and growth of a population can have a profound impact on the development, maintenance, and expansion of road networks. Proper planning and investment are crucial to ensure that road networks can support the economic and social activities of a growing population while maintaining safety and sustainability.

The ratio of road length to population is a measure that provides insights into the accessibility and transportation infrastructure in each area. The ratio of road length to population is obtained by dividing the population of an area by the road length (km). This ratio means 1 km of road in the area compared to access to serve a number of residents. The higher the ratio value, the higher the number of people served.

The total length of roads according to authority level in Nduga regency is 554.2 kilometers, which is only the length of provincial roads and the length of district/city roads because there are no national roads. The ratio of road length to population is 192, which means that every 1 km of road serves 192 residents. The following is the ratio of population to road length in 2045.

**Table 3. The Ratio of Population to Road Length in 2045**

| Proportion of Road Length | 2020 | 2029 | 2039 | 2045 |
|---|---|---|---|---|
| Total Road | 554,2 | | | |
| Ratio of population to road length (Population/Km) | 192 | 227 | 251 | 312 |

*Source: Statistics of Papua Province (BPS Provinsi Papua, 2023).*

In planning the road network, it must refer to the technical provisions regarding the development of residential road infrastructure, road networks and applicable road geometry, especially regarding procedures for general planning of road networks for vehicle and human movement, and rescue access in emergency drainage situations in residential areas in urban areas. One of the technical guidelines for road networks is regulated in the Technical Guidelines for Residential Road Infrastructure (Road Network Systems and Geometry).

## CONCLUSION

Population projections require the government to project populations in accordance with its responsibility to improve the socio-economic conditions of the people through planned development. Population projections can be used for planning whose aim is to provide services in response to the projected population and to change population trends towards social and economic demographic development. Projecting population numbers in the future over a relatively short period of time can be done using either mathematical methods or component methods because the total results have almost no difference.

Population and infrastructure projections are fundamental to the long-term success of regions and nations. Accurate projections are crucial for efficient resource allocation and sustainable development. As technology advances and demographics change, it is essential to employ data-driven models and flexible planning approaches that can adapt to evolving trends. Successful integration of population and infrastructure projections contributes to the creation of vibrant and sustainable communities.

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## DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interest.

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