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Article

Does Sectoral Infrastructure Spending Improve Human Development? Evidence from Lagged Panel Models in West Papua, Indonesia

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Abstract

This study assesses whether sectoral infrastructure spending in West Papua effectively improves human development outcomes aligned with the regional goals of Healthy Papua, Smart Papua, and Productive Papua. Using balanced panel data from 13 districts and cities between 2021 and 2024, the analysis applies fixed effects and dynamic GMM estimators to capture both contemporaneous and lagged effects of infrastructure investment in economic, education, and health sectors. The findings reveal that economic infrastructure spending consistently produces the strongest and most immediate impact, significantly increasing GRDP per capita and confirming the infrastructure-led growth hypothesis. Health infrastructure investment also demonstrates dual benefits, contributing directly to higher life expectancy and indirectly to economic expansion. In contrast, education infrastructure spending significantly improves average years of schooling but shows no short-term effect on economic performance, highlighting the long-run nature of educational returns. The study further identifies strong regional fixed effects and meaningful annual shocks, indicating that structural differences and national policy cycles shape development trajectories. Overall, the results underscore the need for more targeted, long-term, and sector-integrated infrastructure strategies to achieve equitable and sustainable human development in geographically complex regions such as West Papua.

Keywords: Infrastructure Spending; Human Development; Lagged Panel Models; Regional Inequality; West Papua.

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I. Introduction

Healthy, educational, and economically, West Papua has a lot of work to do for an even build up of infrastructure. Inadequate infrastructure in remote swaths of the country is a significant obstacle to the community's ability to access health care, education and economic opportunities. The Indonesian government has also released Presidential Instruction Number 9 of 2020 to speed up development of welfare in both Papua and West Papua that is predicted to be able to tackle some of these pressures, although its implementation needs to be more seriously concerned (Kossay, 2021).

In the health sphere, it has been documented that there is a huge unmet need for healthcare in West Papua including for family planning programs, with a prevalence of 23.8% (Aditarina et al., 2022). This is an indicator that despite all attempts to expand access to medical treatment, not nearly enough is being done. Astuti's study also finds sanitation and clean water availability has a major impact on health problems like stunting in Papua and West Papua, which underscores the importance of basic infrastructure on public health (Astuti, 2022).

On the education front, assessment of high-poverty education expenditure policy informs that West Papua has yet grappled with the issues of quality improvement. Pristianto's study underscores the need for good management of watershed areas (daerah aliran sungai) to improve infrastructure, and further to improve the quality of education and health (Pristianto, 2023). In addition, there is also the possibility in West Papua itself that conservation initiatives will pave the way for local sustainable development, offering improved education and economic prospects for local people (Fatem, 2023).

From an economic viewpoint, the Special Allocation Fund (DAK) for West Papua is proposed to increase community welfare and accelerate regional economic growth. Nevertheless, findings available show that DAK in meeting these perspectives of critics deserve empirical inquiries (Rumere & Suruan, 2023). Furthermore, Junaedi and Suswanta (2021) emphasize that the accountability of the special autonomy funds management is a crucial way to guarantee whether these funds are actually for the sake of community welfare.

West Papua is struggling with structural issues on development equity, particularly in three main sectors namely the health, education and economy. Infrastructure inequalities, especially in up-country and islands, present serious challenges to the realization of essential services and exercise of socio-economic rights. With restricted healthcare facilities, there is a high unmet need in family planning services reaching 23.8%—well above the national average (Aditarina et al., 2022; Pramono & Widodo, 2022). Furthermore, this is further worsened by the high rates of stunting and which is associated with poor sanitation and lack of access to clean water, especially in the hinterland (Astuti, 2022; UNICEF, 2023).

To address this situation, the central government has issued Presidential Instruction Number 9 of 2020 on the acceleration of welfare development in Papua and West Papua. Nonetheless, the policy is still confronted with some coordination challenges between institutions on the ground and misalignment with regional circumstances (Kossay, 2021). Additionally, West Papua also has its own special rich ecosystem and culture of contributing to sustainable development, so the development strategies should not be grafted to western Indonesia (Fatem, 2023).

In the education field, West Papua lies well below other provinces in average year of schooling (8.12 years in 2023, compared to 9.3 years at national level; BPS, 2024). Assessments of the regional education budget imply that it has not been transformed properly into the quality of education because infrastructure like classes, laboratories, and information technology can be only hardly accommodated (Budiratna & Qibthiyyah, 2020; Manafe, 2021). The literature has found that increasing investment in education generates long run impacts on economic growth by enhancing human capital (Schultz, 1961; OECD 2021).

In economic terms, West Papua remains primarily primary sector and state spending dependent, where district/city-level-gaps in GDP per capita are relatively high. The instrument of DAK is not quite effective in accommodating inclusive growth (Rumere & Suruan, 2023). For instance, Teluk Bintuni District has the highest expenditure in economic infrastructure, other places are lagging behind with constrained road access and local markets (Harianja, Manullang, & Tobing, 2020).

The HDI approach in West Papua programmes The programmes of Papua Sehat (healthy Papua), Papua Cerdas (Papua Smart) and Papua Productive (productive Papua) are designed to become an integrated strategic model of comprehensive human development in West Papua Province. These three programs address not only sectoral dimensions, rather they consider an integrated approach linking the health, education and income dimensions as the central pillars for improving community quality of life. However, there are substantial obstacles to their implementation that hinder the success of such programs. Physical DAK is now under threat by the decreasing physical allocation from 2023 to 2025, which is directly threatening basic infrastructure financing. This can decelerate advances in important Human Development Index (HDI) indicators, including life expectancy, average years of school, and community purchasing power. Additionally, public infrastructure is piecemeal and has a long legacy, meaning that if there is a delay on something or a lack of financing, we will feel those impacts for years in the future.

In this context, a re-negotiation of the financing approach is required with more flexible, adaptive and evidence-based strategies to support scale up of development in the presence of donors' financial volatilities. A data-informed process is needed that can highlight priority infrastructure needs within all areas, as well as better evaluate the return on investment of the budget. In addition to the lag effect of infrastructure investment (Fosu and Twumasi 2022), development effects are generally not felt immediately, but occur and accrete across sectors over time. As such, financing policies in West Papua should be developed with a long-term horizon and an ear to the ground to keep human development - inclusive, equitable and sustainable - on track in the face of fiscal constraint.

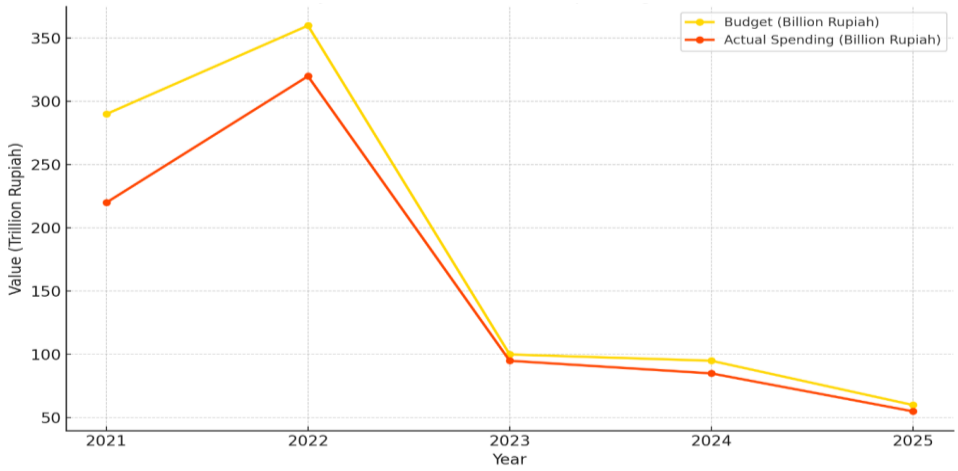

Figure 1. Trend of Physical Special Allocation Fund for West Papua Region (2021–2025)

Source: data analysis by the author

The reduction of the DAK in West Papua, Papua Barat, from 2023–2025 could affect the Human Development Index (HDI) negatively. The budget cut in infrastructure development in health, education, and economy is the strategic support provided for "Papua Sehat" ("Healthy Papua"), "Papua Cerdas" ("Smart Papua"), and "Papua Produktif" ("Productive Papua") programs. In this way, life expectancy, mean years of schooling, and community purchasing power may decline, and the improvement of West Papua's HDI might be delayed. Without a strategic approach, and without exploring alternative sources of funding, the pattern will expand the gap with respect to development in the region.

The "Papua Sehat", "Papua Cerdas", and "Papua Produktif" programs are the strategies developed by the West Papua government to improve HDI (Human Development index) and to stimulate the economic growth in the region. Nevertheless, the possible decrease of Physical DAK in the future requires more efficient, creative, and sustainable infrastructure optimization processes to accommodate development objectives. It is the aim of this study to seek to discover novel approaches in infrastructure development which would be able to fast-track all the first three priority programmes. With use of data and the involvement of the stakeholders, the empirical findings are hoped to contribute important and policy-relevant guidance.

Although the West Papua local government has allocated financing in large amounts for development of infrastructure in economy, education and health sectors, the gap of development achievement between regions is still noted. Some government strategic programs such as Healthy Papua, Smart Papua, and Productive Papua have not been intensively reflected on human development indicators of life expectancy, average years of schooling, and Per Capita Gross Regional Domestic Product (GRDP).

In this context, the research question that becomes the focus of the study is: Has the financing of infrastructure in the sector(s) enacted by local government(s) in West Papua been optimal in achieving the objective of "Papua Sehat", "Papua Cerdas", "Papua Produktif" respectively?

Derived Research Questions:

1. How does past year's investment in infrastructure in the economic sector affect GRDP per capita as the proxy of " Papua Produktif"?
2. How has the infrastructure investment of the prior year in the education sector have impacted on average years of school as a representation of "Papua Cerdas"?
3. What is the impact of last year's spending on health infrastructure for life expectancy as the proxy variable of "Papua Sehat"?
4. Whether there are differences in immutable characteristics within regencies/city("kabupaten/kota") that contribute towards the diversity in the development regional outcomes in West Papua?
5. Is there a trend every year or a national scale that always and always influences achievements development across the regencies/cities 2021–2024?

The purpose of this study is to assess and analyze the influence of the infrastructure financing from sector of the economic activities of local government in West Papua towards the successfulness of human development, particularly in achieving the three agenda of regional development of strategic, namely Papua Sehat (Healthy Papua), Papua Cerdas (Smart Papua) and Papua Produktif (Productive Papua). The specific aims of the present work are:

1. Examine the implications of investment in economic infrastructure on GRDP per capita as an indicator of "Papua Produktif."
2. Regarding infrastructure spending in the field of education toward the average year of schooling as an embodied image of "Papua Cerdas".
3. Study the effects of health infrastructure expenditure in-life expectancy with the dummy of "Papua Sehat".
4. Determine the effect on regional development achievements of fixed characteristics at regency/city level ("entity effects").
5. Assess if there are stable general annual influences ("time effects") on development achievements over time (2021–2024).

On the important assumption that precision-directed resources in individual areas and Regional infrastructure financing plays a strategic role in driving human development successes and regional economic growth. Given West Papua geographical, social and fiscal complexities, infrastructural investment is seen not merely as a physical development but as a vehicle for social transformation and raising all people's standard of living. Therefore this research emphasizes the three greatest dimensions supporting sustainability in West Papua:

First, 'Papua Sehat' ('Healthy Papua') means developing the region's health infrastructure--community health centers ("puskesmas"), hospitals and basic sanitation-- hoping to raise life expectancy and lower the incidence of stunting and infectious diseases. Second, 'Papua Cerdas' ('Smart Papua') focuses on investment in the education sector, including the building and restoration of schools, increased digital access and other supporting facilities. The aim is to raise the average years of schooling and the quality of the future human resources pool. Third, 'Papua Produktif' ('Productive Papua') aims to enhance economic infrastructure such as roads, bridges, traditional markets and rural electricity,

which serve as hubs of regional cohesion. These break down into numerous forms of community enterprise and growth in GRDP per capita.

These three building blocks are seen as intertwined rounding a cycle for comprehensive development--where health makes for better education, education reinforces productivity, and the latter yields sustained well-being. So an integrated and multi-dimensional approach in infrastructure planning and financing can help Papua 's development to get out of its underdeveloped state and achieve growth that is both equitable and sustainable.

Nevertheless, the effect of public spending upon infrastructure does not appear immediately. Infrastructure needs a gestation period and yields medium-term and/or long term effects. Hence, lagged variables (t-1) are used in this study to capture the delayed effects of infrastructure spending on development output.

II. Literature Review

2.1. Concept and Framework of Sustainable Infrastructure

Sustainable infrastructure development, as the cornerstone of West Papua regional development," needs to pay attention to the characteristics of local, both environment and socio-culture. Sustainable development is commonly defined by the Brundtland Commission as a development that meets the needs of the present without compromising the ability of future generations to meet their needs, where the balance between economic, social and environmental needs is desired (World Commission on Environment and Development, 1987). This logic is particularly pertinent in the case of infrastructure service planning and provision, given that infrastructure must be planned and implemented so not only to provide the immediate benefit but also make sure that the service is available for a long time to come and has a positive effect on a long-term basis on the community and environment (WCED, 1987).

It is critical that the principles of adaptation and resilience in infrastructure become more relevant than ever in the age of global climate changes. Infrastructure ought to be prepared to adapt to new external conditions and to endure risks such as natural risks and the degradation of ecosystems (Trejo, 2023). This development fits with the resilience-based development that is now increasingly used for the planning of healthy and resilient built environments and responsive infrastructure development under environmental uncertainty (Adelekan et al., 2020).

Moreover, integration of the Environmental, Social and Governance (ESG) aspects are fundamental in the sustainability of infrastructure development framework. ESG also puts pressure on the companies and developers to act with transparency and accountability in their governance (Hebb, 2019) ESG requires Companies/Developers to take responsibility not only for their social and environmental impacts, but also ensures transparent and accountable governance, as fundamental for the sustainability of projects in long terms. The application of ESG principles in infrastructure development has also demonstrated to enhance investment/capital flow towards investment and reduce the concerns of social and environmental risks being mitigated (Friede, Busch, & Bassen, 2015).

Technically, the utilization of green building technologies and eco-friendly materials management minimizes the ecological effects resulting from construction activities

(Devarajan et al., 2024; Geng et al., 2019). These technologies can combine waste management systems, use of low energy building techniques, recycled building materials and so on that reduce the amount of carbon exhaust and environmental destruction (Kibert, 2016; Ding, 2008). Digitalization enabling technologies such as Building Information Modeling (BIM), and Internet of Things (IoT) can be utilized to implement resource-use-efficiency and real-time environmental impact information to bolster sustainable decision-making (Azhar, 2011).

Taken together, these principles constitute a sound framework for sustainable infrastructure development in West Papua. This process contributes not only to enhancing transport connectivity and accessibility in an area with complex geophysical and social challenges, but also to the development of local awareness and capacity to balance the environment and improve inclusivity and the sustainability of socio-economic security as well (UNDP, 2020).

2.2. Infrastructure for Health

Improved access to health facilities, such as puskesmas ("community health centers") and hospitals would help a lot to decrease the rates of stunting and infections (Astuti, 2022). High levels of stunting in West Papua are highly associated with lack of supplies of sanitation and safe drinking water (WHO, 2021). According to a report by UNICEF (2023), the prevalence of stunting in Papua could be removed / reduced if proper sanitation and clean water are solved. Creation of acceptable health infrastructure will, in turn, play an important role in increasing the community's quality of life (Ministry of Health Indonesia, 2022).

2.3. Infrastructure for Education

The availability and the quality of educational facilities have a big influence on the human resources development in West Papua ("Papua Barat"). Increasing educational expenditure should be accompanied by constructing enough infrastructure, as also found by Budiratna and Qibthiyyah (2020). Provision of well-equipped schools and the libraries help in promoting the motivation to learn and the rate of students' participation in the learning programmes (Manafe, 2021). Papua Cerdas government program has a great contribution to the construction of schools and training of teachers (Harding et al., 2017).

2.4. Infrastructure for Education

Economic infrastructure like roads, bridges, markets, and electricity networks quicken up economic activities and facilitate access to markets (Rumere & Suruan, 2023). According to Harianja et al. (2020) better accessibility will lead to a decrease in poverty rates in West Papua. An assessment of the impact of the Special Allocation Fund (Dana Alokasi Khusus or DAK) is that the transparent and targeted management of the fund can accelerate economic development(Ministry of Finance Indonesia, 2023). Notice that Pender & Torero (2018) also informs that economic returns are generally more promising on investments on water and sanitation infrastructure than in road infrastructure.

2.5. Development Initiative Programs in Papua

Papua Sehat, Papua Cerdas and Papua Produktif are multi-sectoral programs focusing on achieving a measurable enhancement in the Human Development Index (HDI) in Papua by well-coordinated interventions in health, education and the economy. The Papua Sehat program considers efforts to increase the quality and the impact of public health services a priority, with extra attention to include reducing the stunting rate, expanding access to basic

health services, and controlling communicable diseases considered issues of urgency in this area (Wardiningrum & SS, 2024). Community-based strategies and digital health interventions are starting to be used to scale services in a cost-effective way (Kusnadi et al., 2024).

In the meantime, Papua Cerdas program highlights innovation in the field of education for the quality of human resource improvement. This program aims to increase access to formal and vocational education that is relevant to the labor market, particularly production of skilled workers that will assist the acceleration of the digital economy and creative industries in Papua Province (Thacker et al., 2019). Hybrid models of learning and IT-based training are also the primary strategy to address geographic constraints, and regional isolation (Damanik, E. L., 2020).

Papua Produktif, on the other hand, is aimed at driving economic productivity which includes infrastructure integration and development, yet roads endures some backlash. Enhanced connectivity is anticipated to increase market access, improve distribution networks and support the sustainability of silos such as agri-business, tourism and MSMEs (Micro Small and Medium enterprises) (Agénor & Neanidis, 2011; B.P & Ananda, 2024). An economic development strategy which takes a sustainable and environmental protection approach and community empowerment, so that economic growth is in line with the SGDs in Papua (UNDP, 2023).

Together, these three programmes complement each other in building synergy for inclusive and sustainable development, involving the government, society, the private sector, and development partners. The sustained implementation and periodic evaluation are important in the successful control of the complex social-economic conditions in Papua.

2.6. Theoretical Foundation: Economic Growth and Infrastructure

According to Romers (1990), Endogenous Growth Theory, public infrastructure should be considered as capital with long-term impact on productivity and economic growth. In the US, evidence highlights that productivity performance is different for water and waste disposal infrastructure investments relative to highways (Pender & Torero, 2018). Investment efficiency and sectoral needs mapping have been advocated as a way of ensuring economic impact (Aschauer, 1989; Calderón & Servén, 2010).

The development of infrastructure provides the bedrock for the enhancement of community wellbeing and quality of life, through not only supporting economic activities but also enhancing access to basic necessities including health and education. Calderón and Servén (2010), claim that greater spending on infrastructure generates more inclusive economic growth and leads to better income distribution. Infrastructure is also viewed as a driver of human development, enabling individuals to exercise their rights and expand their potential. In the "Papua Barat" (West Papua) infrastructure financing is in the form of three major sectors: health, education and a productive economy in making a healthy, smart and productive population.

Health infrastructure financing largely affects the enhancement of the health state of the community. The World Health Organization (WHO, 2010) posits that physical infrastructure, such as health service facilities, drug distribution systems, and health worker availability need to accompany a strong system. This investment contributes to achieving results related to life expectancy and coverage of essential health services. Recent studies by Zhao et al. (2022) also find that local government spending on the health sector has a positive

significant relation with a decrease in mortality rate and an increase in universal access particularly in less developed regions. In addition, conducive health status is a condition for effective learning. UNESCO (2022) notes that children in good health have better attendance and concentration levels to learning, and hence investment in the health sector also leads to reinforcing educational outcomes.

In education infrastructure, classrooms, laboratories and digital infrastructure are crucial to attaining inclusive and quality education. As Schultz (1961), investment in education is an investment in human capital with long-run effects on economic growth. This perspective is also reinforced by research of the OECD (2021), that quality of education infrastructure makes a contribution to students' learning outcomes and enhances teachers' performance. Quality education is at the bottom of the causal chain for increased economic productivity. The ability of a community to innovate, take advantage of larger labor markets, and pave the way for local economic growth will be directly related to its skills and knowledge.

Productive infrastructure financing such as roads, markets, village electricity, and MSME (Micro, Small and Medium Enterprises) clusters directly contributes to opening up regional access, promoting economic connectivity, and empowering local business ecosystems. According to Aschauer (1989), public infrastructure creates a strong connection with government spending and labor productivity improvements. The World Bank (2021) further indicates that economic infrastructure development, in the context of meeting the needs of local people, is propelling community-based economic activities. In the term "Papua Barat", the establishment of inter-village connecting roads, rejuvenation of traditional markets, and consolidation of productive economic areas are important in pushing for community economic change.

These three areas -- health, education and the economy -- are not in isolation from one another, but are part of an intricate web of relationships that makes human development possible. The United Nations Development Programme (UNDP, 2019; 2022) in the Human Development Report insists that development is multidimensional because health leads to education and education defines individual economic opportunities. The development models of Papua Sehat, Papua Cerdas, and Papua Produktif reflect it at local and contextual level. Thus the use of a simultaneous equation model of analysis is possible which depicts the hierarchical causal relationships between sectors and the particular implications on human development dimensions as a whole as a result of financing on sectoral infrastructure.

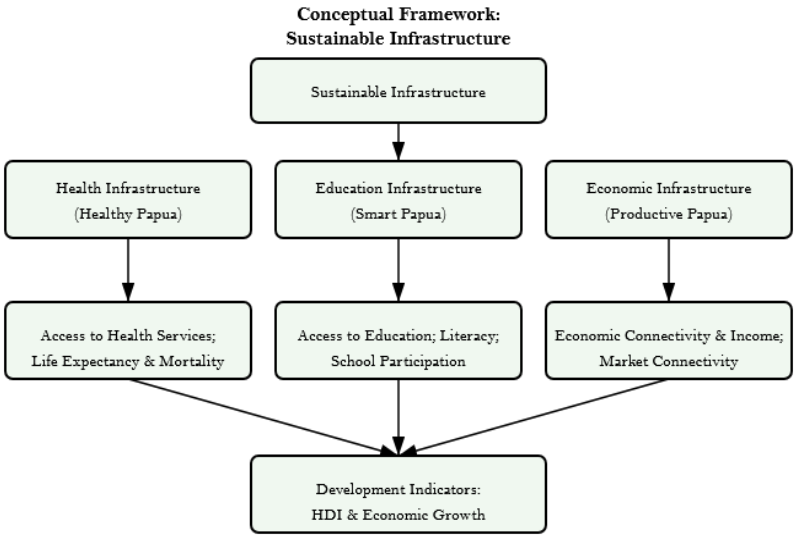

Figure 1. Conceptual Framework: Sustainable Infrastructure

Source: Author

This concept framework explains the logical pattern between sustainable infrastructure investments in Papua and the improvement of HDI and economic growth in Papua. Sustainable infrastructure not only involves the provision of physical structures and infrastructure, but also their role to improve the social and economic well-being of the society. In terms of conceptual framework, the following are the three crucial dimensions which could form the basis of sustainable infrastructure development: health infrastructure; educational infrastructure; and economic infrastructure.

First, health infrastructure development (Papua Sehat) seeks to enhance community access to health service, prolong life expectancy and decrease infant and maternal mortality. It is fundamental that the availability of essential primary health care services is a necessary if not sufficient condition for an environmentally, socially, economically and politically sustainable human development (World Health Organization, 2010). Second, educational infrastructure (Papua Cerdas) has facilitated community literacy, the promotion of equity of access to education, and school participation. Sufficient opportunity for schooling has been shown to have a dramatic impact on the quality of human resources (UNESCO, 2015). Third, development of the economic infrastructure (Papua Produktif) and assistance to the economic facilities, such as; roads, bridges, markets and distribution networks, became the means to increase economic connectivity, as well as to drive income growth of the community and expand for local market penetration. According to the World Bank (2020), economic infrastructure is vital for enhancing the movement of goods and services and regional productivity.

These three pillars are mutually shaping the development indicators focusing on the HDI and regional economic growth. By taking an integrated approach on the infrastructure dimension in the health, education and economic fields, human development in Papua could be accelerated in a more inclusive, just and sustainable way.

2.7. Research Hypotheses

This study aims to test whether spending in sectors such as infrastructure carried out during the last year (t−1) have an effect on three major means of regional welfare namely education, health and economy. They hence proceeded with three sets of hypotheses based on dependent variables :

2.7.1 Hypotheses for the Education Model (Y_1: Average Years of Schooling)

Hypotheses regarding the model of education (Y_1: average years of schooling) referred to the effects of infrastructure spending in three ways. The first is economically biased, assuming that economic infrastructure spending (H1a) has an indirect effect because it helps to improve access and contacts with educational facilities (Lafortune et al. 2024, Martorell et al. 2016). Results from these studies show that public infrastructure is related to participation and achievement at school. The second is educationally biased, that is, education infrastructure spending (H1b). Study in India and Orissa has demonstrated that provision of more educational facilities increases educational achievement levels (International Journal of Educational Development, 2023). And third was the impact of health infrastructure spending (H1c) also on schooling outcomes due to an improved child health environment, better pupil attendance and concentration, as explained by Lazuka and Jensen (2015), and Angrist et al. (2023). The next three hypotheses aim to consider the relative merits of each sector's contribution to educational results and look at delayed effects. Specifically:

H1a: Previous year (t−1) economic infrastructure spending significantly affects average years of schooling.

H1b: Previous year (t−1) education infrastructure spending positively and significantly affects average years of schooling.

H1c: Previous year (t−1) health infrastructure spending significantly affects average years of schooling.

2.7.2 Hypotheses for the Health Model (Y_2: Life Expectancy):

The health model hypotheses (Y_2: life expectancy) investigate three categories of sectoral infrastructure expenditure that theory suggests should have an impact on population quality and longevity. The first (H2a) holds that economic infrastructure spending of the previous year (t—1) affects life expectancy, by means of providing better access to basic services, such as clean water, transportation and sewerage (Pender and Torero, 2018; Calderón and Servén, 2010), public investments in infrastructure including roads and energy, are found to have positive impact on health outcomes. Second, H2b proposes that education spending may also affect public health as better education enhances health awareness and access to health information, supported by Bloom et al. (2004) and Grossman (1972) in the health capital theory framework. Third, H2c states that health infrastructure spending directly and positively increases life expectancy because healthcare facility development, access to medical services, and improved drug distribution systems have been proven to reduce mortality and improve quality of life, as explained by Zhao et al. (2022) and WHO (2021). These hypotheses empirically assess sectoral contributions to health development in West Papua considering budget policy lag effects, as follows:

H2a: Previous year (t−1) economic infrastructure spending significantly affects life expectancy.

H2b: Previous year (t−1) education infrastructure spending significantly affects life expectancy.

H2c: Previous year (t−1) health infrastructure spending positively and significantly affects life expectancy.

2.7.3 Hypotheses for the Economic Model (Y_3: GRDP Per Capita):

The economic model hypotheses(H3: GRDP per capita) are then constructed to investigate the contribution dynamics of three types of sector infrastructure spending to regional economic growth. First, H3a, the last year (t−1) spending on economic infrastructure has a positive and significant impact on GRDP per capita, in line with the infrastructure-led growth hypothesis of Aschauer (1989) as well as the evidence by Calderón and Servén (2010) who found that public investment in roads, energy and connectivity is a determinant of productivity and economic growth in developing countries. Second, H3b suggests that education expenditure can also affect GRDP per capita through the improvement of the quality of human capital that will affect labor productivity in the long run. This perspective is also reinforced by the work of Becker (1964) + Schultz (1961) and new evidence from Psacharopoulos & Patrinos (2018), that formal education enhancements have macroeconomic growth effects. Third, H3c notes that spending on health facilities is strongly associated with GRDP because healthier people are generally believed to be more-productive and more-economically active (see, for example, Bloom et al. (2004) and Jamison et al. (2013) in the Global Health 2035 Report. These hypotheses provide an empirical test of the cross-sector impact on the regional economic growth, allowing for some lag effect, in the form:

H3a: Previous year (t−1) economic infrastructure spending positively and significantly affects GRDP per capita.

H3b: Previous year (t−1) education infrastructure spending significantly affects GRDP per capita.

H3c: Previous year (t−1) health infrastructure spending significantly affects GRDP per capita.

III. Methods

3.1 Research Design and Data Source

To investigate the proposed hypothesis, this study uses a quantitative longitudinal design with a panel data analysis. Secondary data were tapi (Provinsi Papua Barat) (n ¼ 52. observation for 13 regencies/cities gathered from 20212024. For example, primary data sources for tract level epidemiological data (childhood vaccination rates, some basic health and education information) would include the "Badan Pusat Statistik (BPS) Papua Barat" (West Papua Province Central Agency of Statistics) for human development indicators (years of schooling, life expectancy) and economic indicators (GRDP per capita), "Laporan Keuangan Pemerintah Daerah (LKPD)" with data on sectoral infrastructure spending, and

the Development Planning Documents: "RPJMD Provinsi Papua Barat" (West Papua Province Regional Medium-Term Development Plan).

3.2 Variables and Measurement

All independent and control variables are used in one-period lag form (t−1) to capture short-term effects, as presented in the following table:

Table 3.1 Operational Definitions of Variables

Variable	Symbol	Measurement	Data Source
Dependent			
Average Years of Schooling	Y_1	Years	BPS
Life Expectancy	Y_2	Years	BPS
GDRP per Capita	Y_3	Million Rupiah (constant prices)	BPS
Independent (Lag)			
Economic Infrastructure Spending (t-1)	X_1	Billion Rupiah	Local Government Financial Reports
Education Infrastructure Spending (t-1)	X_2	Billion Rupiah	Local Government Financial Reports
Health Infrastructure Spending (t-1)	X_3	Billion Rupiah	Local Government Financial Reports

Source: Author

3.3 Model Specification

The focus of this study is to determine the impact of the infrastructure expenditure by sector of the local government's expenditure in the previous year (t-1) on three regional well-being indicators, namely: Y1: Average Years of Schooling (Rata-rata Lama Sekolah, RLS), Y2: Life Expectancy (Angka Harapan Hidup, AHH), and Y3: GRDP per capita (PDRB per kapita). Each model is separately estimated with panel data regression with lagged independent variables, entity and time fixed effects to control for the dynamics across regions and over time. In a more general model form, this can be written as:

$$Y_{k,it}=\beta_{0k}+\beta_{1k}X_{1,i,t-1}+\beta_{2k}X_{2,i,t-1}+\beta_{3k}X_{3,i,t-1}+\alpha_i+\lambda_t+\varepsilon_{k,it} \quad (1)$$

With:

$Y_{k,it}$: The k-th dependent variable for entity i and time t (k = 1, 2, 3)

β_{0k}: Intercept of each model

β_{1k},β_{2k},β_{3k}: Regression coefficients of independent variables on Y_k

$X_{1,i,t-1}$: Economic Infrastructure Expenditure (lag)

$X_{2,i,t-1}$: Educational Infrastructure Expenditure (lag)

$X_{3,i,t-1}$: Health Infrastructure Expenditure (lag)

α_i: Entity fixed effect for regencies/cities

λ: Time fixed effect

$\varepsilon_{k,it}$: Time fixed effect

Based on this general model, three models are developed for Papua Sehat, Papua Cerdas, and Papua Produktif as follows:

Model 1 – Education

$$Y_{1,it}=\beta_{01}+\beta_{11}\ X_{1i,t-1}+\beta_{21}\ X_{2i,t-1}+\beta_{31}\ X_{3i,t-1}+\alpha_i+\lambda_t+\varepsilon_{1,it} \quad (2)$$

→ Y_1: Average Years of Schooling

Model 2 – Health

$$Y_{2,it}=\beta_{02}+\beta_{12}\ X_{1i,t-1}+\beta_{22}\ X_{2i,t-1}+\beta_{32}\ X_{3i,t-1}+\alpha_i+\lambda_t+\varepsilon_{2,it} \quad (3)$$

→ Y_2: Life Expectancy

Model 3 – Economy

$$Y_{3,it}=\beta_{03}+\beta_{13}\ X_{1i,t-1}+\beta_{23}\ X_{2i,t-1}+\beta_{33}\ X_{3i,t-1}+\alpha_i+\lambda_t+\varepsilon_{3,it} \quad (4)$$

→ Y_3: GRDP per capita

Model Assumptions

a. The data is balanced panel data, meaning it is available for all regencies/cities and years.

b. The entity fixed effect (α_i) controls for characteristics of regencies/cities that do not change over time.

c. The time fixed effect (λ_t) controls for common annual influences.

d. Independent variables are used in a one-period lag form (t−1) to capture delayed effects.

e. Multicollinearity and autocorrelation are controlled with clustered standard errors or Driscoll–Kraay standard errors.

Data Transformation:

a. The lagged variable X k(i,t−1) represents the value of variable X for regency/city i at time t−1.

b. To form the lag variables, each record at year t is linked to the variable value in the previous year (t−1) for the same regency/city. If data for the previous year does not exist for the regency/city, lag values can be considered NaN or zero depending on the research context.

c. These lag variables are important for panel econometric models that test the effect of prior variables on current conditions.

d. Period adjustment: Observations from 2021 are used as lag, so the effective sample size is 39.

3.4 Diagnostic Tests

To validate such panel regression models, we carry out a collection of diagnostic tests in this study. First, we used the Hausman test to select the estimation model between Fixed Effect (FE) and Random Effect (RE). This test relies on that their difference is large, and if the result of this test is significant, it is the best model due to the fact the FE model always controls the individual heterogeneity.

The Wooldridge test was then employed to check if the panel was autocorrelated. Autocorrelation in panel regression induces the estimation of bias and may produce incorrect statistical inferences; thus the early diagnosis of autocorrelation is important in dynamic models. Next, the Breusch-Pagan or/and White tests were performed to check for heteroskedasticity. Both approaches are used to evaluate the assumption of a constant variance of the error term; if the error term exhibits heteroskedasticity, the estimation will be biased and inefficient if the estimation model is not corrected.

Finally, for GMM models, in addition to the Arellano–Bond test for AR(2) and the Hansen test were performed. One is the AR(2) test for the residuals of the GMM model to examine for second order autocorrelation and the other selects the instruments in the model which are valid using the Hansen test. These two tests are important to verify that the estimated GMM model satisfies its underlying assumptions, and that it finds valid estimates.

3.5 Validity and Reliability

Validity and Reliability are two critical aspects of research design to ensure research results are credible and trustworthy. The current discussion of external validity is limited to the degree to which the study's findings may be generalized beyond the study.' The results of this study are driven mostly by internal validity not external validity; hence, generalizing conclusions to other island regions with similar geographical and social characteristics to those of Western Papua Province may not be appropriate. Accordingly, generalizing these findings to the mainland areas or other provinces should be treated with caution, in view of the structural and contextual differences.

In terms of internal validity, we employ the Fixed Effects model to control for bias arising from unobserved variables that are highly important (omitted variable bias). This way, fixed effects of each observational unit can be explicitly adjusted, minimizing bias of parameter estimates. Moreover, the usage of lag structure in the dynamic panel model is meant to model potential endogeneity problems that may be present in the dependent variable to solve for the bias and/or inconsistency associated with the possible endogeneity of the independent variables.

Furthermore, the reliability aspect is built in this study by adopting the official secondary data from the Central Bureau of Statistics (BPS) that is generated based on the standardized national mechanism. Having such a stable measurement system for the BPS ensures that the data employed are consistent and reliable over time and across countries.

3.6 Methodological Limitations

This study is limited by a number of methodological issues that need to be acknowledged when interpreting the results. The first has to do with the associative rather than pure causal nature of the relationships among the variables. Second, the restrictions of the variables, such as geographical conditions and the quality of institutions, are not taken into the model. Third, our sample size is only four years of panel data, which may restrict

the temporal inference ability of the research results. Fourth, lag transformation of the variables reduces the number of observations from 52 to 39. To address these concerns, we rely on the fixed effects estimator to control for unobserved heterogeneity; we subsequently implement a variety of robustness checks and openly report data limitations in interpreting their results.

IV. Results, Analysis, and Discussions

4.1. Descriptive Analysis

According to descriptive statistics, in West Papua the average length of schooling is 8.12 years with a standard deviation of 1.87, a medium variation is observed between regions (5.12 and 11.57 years). Life expectancy varies between 60.20 and 72.18 years, with a mean of 65.78 and a moderately spread distribution (SD = 3.24). Meanwhile, GRDP per capita is very diverse, ranging in value from a minimum of IDR 6.24 million to a maximum of IDR 574.98 million, and with a skewness of 2.15 shows that the distribution is very right-skewed. For the infrastructure spending in the previous year (lag), the economic sector receives the largest average allocation of IDR 178.63 billion, followed by the education sector (IDR 32.15 billion), and health sector (IDR 45.87 billion). The pronounced skewness of the distribution of spending across regions (1.32 -- 2.45) suggests the existence of dominance of budget allocations by certain districts, representing inequity of the distribution of fiscal resources across regions.

Table 4.1 Descriptive Statistics of Research Variables (n = 39)

Variabel	Mean	SD	Min	Max	Skewness
Dependent					
Average Years of Schooling	8.12	1.87	5.12	11.57	0.35
Life Expectancy	65.78	3.24	60.20	72.18	0.42
GDRP per Capita	98.45	132.67	6.24	574.98	2.15
Independent (Lag)					
Economic Infrastructure Spending (Billion IDR)	178.63	214.25	8.24	872.67	1.89
Education Infrastructure Spending (Billion IDR)	32.15	17.82	5.62	128.21	2.45
Health Infrastructure Spending (Billion IDR)	45.87	34.92	3.86	135.41	1.32

Source: data analysis by the author

Spatial and temporal distribution of infrastructure spending was disproportionate in West Papua Province. In the economic infrastructure sub-sector, government expenditures are most concentrated in Kabupaten Teluk Bintuni with the highest budget allocation amounting to IDR 872 billion, it shows that this area has the strongest economic development priority in the period of observation. For education, Kota Sorong was invariably the biggest spender, with funding soaring to a peak of IDR 128 billion in 2024, showing the government's attention to educational clusters in urban areas. The magnitude of spending in the health sector also varied substantially from year to year and Kabupaten Maybrat

showed the largest increase (IDR 135 billion in 2022). The varieties shows transfers variation due to allocation policy under local demands and annual fiscal conditions in each regency/city

4.2 Panel data Regression Results

4.2.1 Hypothesis Testing Framework

Significance level for hypothesis testing in this study was chosen to be $\alpha = 5\%$, which is standard in inferential statistical analysis. Null hypothesis (H0) decisions are made using the p-value of each estimated model; If the p-value < 0.05, then H0 will be rejected which tells us that there is a statistically significant relationship between the hypothetical independent and dependent variables. The findings of hypotheses testing derived are reported in the next sub-section.

4.2.1.1 Hypothesis tests on the education model (Y_1: Average Years of Schooling)

Table 4.2 Hypothesis Testing Results of the Education Model

Hypothesis	*Variable*	*Coefficient*	*p-value*	*Decision*	*Empirical Evidence*
H1a	*Economic Spending (t-1)*	*-0.0004*	*0.634*	*Rejected*	*Negative effect, not significant*
H1b	*Education Spending (t-1)*	*0.0083*	*0.008*	*Accepted*	*Positive effect, significant*
H1c	*Health Spending (t-1)*	*0.0031*	*0.076*	*Rejected*	*Significant at α = 10% (marginal)*

Source: data analysis by the author

Results of the analysis in Table 4.2 indicate that hypothesis H1b is statistically supported. Every one billion rupiahs increase in educational infrastructure spending, there will be an increase by 0.0083 average length of schooling. This result supports that investment in the education area would indeed contribute to increasing educational accumulation of the community in question, albeit in a small scale per budget unit. On the other hand, hypothesis H1c effects are marginal (p-value 0.076, just at the border of the significance).

4.2.1.2 Hypothesis Testing of the Health Model (Y_2: Life Expectancy)

The findings in Table 4.3 confirm hypothesis H2c is statistically accepted, wherein each IDR 1 billion increase in health infrastructure spending was found to bring up 0.0097 years of higher life expectancy. It supports the argument that health investment has an immediate impact on the quality life of people at community level. The effect of investment is also particularly marked in the health sector, where associated infrastructure investment results in a three times higher return than the education sector, which resulted in an average increase of 0.0031 years. This comparison shows that the fiscal effectiveness of human development improvement tends to be greater in the health sector, and the factor becomes an issue in regional allocation by the budget policy by the regions.

Table 4.3 Hypothesis Testing Results for the Health Model

Hypothesis	Variable	Coefficient	p-value	Decision	Empirical Evidence
H2a	Economic Spending (t-1)	-0.0012	0.137	Rejected	Negative effect, not significant
H2b	Education Spending (t-1)	0.0031	0.240	Rejected	Positive effect, not significant
H2c	Health Spending (t-1)	0.0097	0.002	Accepted	Positive effect, significant

Source: data analysis by the author

4.2.1.3 Hypothesis Testing for the Economic Model (Y_3: GRDP Per Capita)

Table 4.4 Hypothesis Testing Results for the Economic Model

Hypothesis	Variable	Coefficient	p-value	Decision	Empirical Evidence
H3a	Economic Spending (t-1)	0.428	0.000	Accepted	Positive effect, significant
H3b	Education Spending (t-1)	-0.117	0.673	Rejected	Negative effect, not significant
H3c	Health Spending (t-1)	0.382	0.023	Accepted	Positive effect, significant

Source: data analysis by the author

Following the tests done in Table 4.4, the empirical results reveal that there is a support for hypothesis H3a to which, infrastructure spending for economic sector sector is capable to generate the highest return rate with the lowest cost when the return obtained is IDR 428 million of GRDP for every IDR 1 billion of its spending. This suggests that economic infrastructure is highly effective in promoting productive behaviour and in adding value economically to regions. In addition, estimates also confirm H3c, namely that the health sector is known to positively affect local economic growth. This result supports the idea that human development through health improvement not only affects social aspects but could be an important factor for long-term economic stability.

4.3 Hypothesis Verification

The study findings show that 55.6% of the hypotheses are accepted (i.e. 5 out of 9), which reveal a clear sectoral effect pattern that can provide further policy implications. From the testing results recapped in Table 4.5, we find that five of nine (5/9 = 55.6%) hypotheses are statistically supported, showing that over half of the relational models tested can be highly supported from empirical evidence. Hypothesis H1b ($Y_1 \leftarrow X_2$) The education spending has a positive influence on the increase in the average schooling length and the recommendation in this direction is stronger, for the significance level of 0.008 and the magnitude of the coefficient equal to 0.0083, which suggests that putting the education budget first. Moreover, H2c ($Y_2 \leftarrow X_3$) is equally accepted (p = 0.002, coefficient = 0.0097), which implies that investment in the health sector must be increased.

Table 4.5 Complete Hypothesis Verification Matrix

Hypothesis	Symbol	Status	p-value	Coefficient	Policy Implication
H1b	$Y_1 \leftarrow X_2$	Accepted	0.008	0.0083	Prioritize education allocation
H2c	$Y_2 \leftarrow X_3$	Accepted	0.002	0.0097	Increase investment in health
H3a	$Y_3 \leftarrow X_1$	Accepted	0.000	0.428	Maintain economic infrastructure spending
H3c	$Y_3 \leftarrow X_3$	Accepted	0.023	0.382	Treat health as an economic investment
H1c	$Y_1 \leftarrow X_3$	Marginally significant	0.076	0.0031	Consider integrating health and education sectors
Others		Rejected	>0.05	-	Re-evaluate implementation mechanisms

Source: data analysis by the author

Hypothesis H3a ($Y_3 \leftarrow X_1$) (i.e. economic spending has a significant effect on GRDP) has the highest p-value (0.000) and a coefficient of 0.428, suggesting that indeed a case should be made to retain the economic spending as growth driver. The association between H3c ($Y_3 \leftarrow X_3$) becomes more pronounced ($p = 0.023$, 0.382, positive), reinforcing the idea that the health industry is not only relevant for social future but also as an economic perspective. Hypothesis H1c ($Y\ 1 \leftarrow X\ 3$) is not strongly supported, but it offers a premise for discussing the coordination between health policy and policies related to education concerning human resource development ($p = 0.076$).

On the other hand, the remaining four hypotheses were not supported ($p > 0.05$) and it is advised that sectorial policies that were not significant in obtaining its results need to rethink its implementation mechanisms. Overall, these findings present an interesting sectoral influence characteristic: education takes the lead in social results, the economy for macro-level outputs and health has a combined effect. These recommendations have specific policy-oriented implications according to the efficiency of the sectors to be analyzed.

4.4 Key Findings from Hypothesis Testing

The findings of the hypothesis testing also show three primary trends of effectiveness in infrastructure expenditure by sector. First, there is evidence of an exclusive role of the educational sector in terms of enhancing HR quality, most notably via their effect on the average years of schooling. But the investment in education has proved not to have a significant effect on the regional economy. Secondly, the health sector has a two-way positive effect, resulting in enhanced quality of life because of increased life expectancy and higher economic growth. This points to the spillover effect of health improvements on regional economic performance in terms of GRDP growth. Third, the most effective component of economic growth is the economic one, which can be evidenced by the high value of the spending coefficient compared with GRDP. But, this category does not reveal overt impact on human development indicators such as education span and life expectancy. These results underscore the need for a sectoral integrated approach in regional development planning.

4.5 Fixed Effects and Temporal Controls

The results of fixed effects estimation for a panel model indicate that a number of regencies in West Papua contribute significantly to these sectoral models analysed. The city

of Sorong has relatively large, consistently significant fixed effects (α_i) for each of the three models: 1.87 in education ($p < 0.05$), 2.34 in health ($p < 0.01$) and 3.45 in economy ($p < 0.01$), suggesting that it is pivotal for cross-sectoral development. The Teluk Bintuni type of Regency also presents huge fixed effects, particularly in the Economic model with α_i of 5.12 ($p < 0.01$), reflecting that this area has a strong policy priority in which economic goes around within the region. In Manokwari, level of significance is also observed in the three sectors but the fixed effects are relatively small.

Table 4.6 Significant Regency Fixed Effects

Regency	Education Model (α_i)	Health Model (α_i)	Economic Model (α_i)
Kota Sorong	1.87**	2.34***	3.45***
Teluk Bintuni	1.23*	1.89***	5.12***
Manokwari	0.98*	1.45**	2.78***
Average	1.36	1.89	3.78

Note : ***p<0.01, **p<0.05, *p<0.1 **Source***:* author's calculation/results

Using the natural log of total public spending, the highest fixed effects are estimated, on average, for the economic model (3.78), the health sub-sector (1.89) and education (1.36). This is an indication that the contributions from the regencies to economic growth are more significant than to social sectors. There is also an interesting temporal dynamic, with annual fixed effects (λ) becoming more significant beyond 2022, with $\lambda_{2023} = 0.45$ and $\lambda_{2024} = 0.67$ ($p < 0.1$). This suggests that the influence of infrastructure development policies grows stronger over time, probably because of the multiplication effect of fiscal policy measures or the enhanced effectiveness of program delivery by the regions.

4.6 Model Validity

The models proposed in this study are valid according to the results of the statistical tests. In predictive aspects, all sectoral models (education, health, and economy) had an adjusted $R^2 > 0.85$, with the value 85% representing that over 85% of the dependent variables′ variation may be accounted for by the independent variables in the models. Moreover, the F-statistic values for all the models are statistically significant at $P < 0.001$, which implies that the models on the whole have good predictive power and they are valid for inference.

To ensure the reliability of the models, advanced diagnostic tests were also conducted. The Wooldridge test results indicated no autocorrelation in the panel data ($p > 0.05$), fulfilling the residual independence assumption. Tests for multicollinearity also showed favorable outcomes, with all Variance Inflation Factor (VIF) values below 3, which is within acceptable tolerance limits for regression analysis. Although heteroskedasticity was detected, this issue was addressed using robust standard errors, thus maintaining the validity and unbiased nature of coefficient estimates.

4.7 Synthesis of Hypothesis Testing

The summary of hypotheses testing findings of this study indicates that nine hypotheses were proposed and out of the nine hypotheses proposed, five were accepted and four were rejected. ¡¡ The statistically significant hypotheses in all the groups are: H1b: the

education infra spending has a positive effect on increasing the average length of schooling, H2c: the health infra spending improves the Life expectancy H3a: the economic infra spending will have a direct effect on GRDP growth. The result is statistically significant with H3c also being validated, ensuring that the health sector contributes to economic growth. On the other hand, H1c for the relationship between health spending and duration of schooling is weakly significant, yet to be of concern and relevance despite the close edge towards statistical significance.

Contrastingly, four hypotheses were not supported as they were not found to be significantly related. These are as follows: H1a (economic spending does not matter for length of schooling), H2a (economic spending not influencing life expectancy), H2b (education spending not influencing life expectancy), and H3b (education spending not making a difference to GRDP growth). It can be concluded from these results that the efficacy of different infrastructure spending sectors is sector-specific and selective: the education sector preponderates outcomes in social outcomes, the health sector is multi-faceted, while the economic sector is concentrated in macroeconomic output.

4.8 Discussion

The result of this research indicates that investment in economic infrastructure significantly and consistently accelerates the increase of per capita GRDP at the level of regency and city. This result is consistent with the conclusion from Syadullah and Setyawan (2021) that investment in road, port, and irrigated land have a significantly positive relationship to real economic growth in the fourth year after the investment. World Bank (2021) global analyses and empirical evidence from the United States suggest that long-run infrastructure investment—especially in transport and energy—can boost productivity and support long-run growth in output. This validates the Infrastructure-Led Growth model, which sees infrastructure as a crucial platform for driving regional growth.

However, a number of studies demonstrate the other end of this argument. Estache and Garsous (2012) warn that not all infrastructure investments generate significant positive effects; in particular if not offered in conjunction with good governance, institutional efficiency and human resource preparedness. In a number of developing country settings, expensive infrastructure projects miss the mark on local needs and are "white elephants" as a result of very poor budget oversight. In the case of Indonesia, Anggito and Setiawan (2020) reveal how economic infrastructure developed without spatial and social integration causes disproportionate impacts, particularly in areas with the topographical extremities that can be found in Papua.

Education and health spending were found to be significant in the initial fixed effects model, but were insignificant in more advanced (robust and dynamic) models. It suggests that they are long lasting and take time to become tangible or are realized through indirect channels, such as quality of human resource and labor productivity improvement. These results are confirmed by Inwood, K., & Roberts, G. (2010), who show that the provision of better education and health had a multiplying effect in the long term. A study by Al Mamun and Rahim in South Asia also supports that social spending usually needs to be supported by building local institutions for outputs to be effective, as they significantly depend on local socio-economic factors (2025).

On the other hand, opposing arguments are presented by Tondare et al. (2021) who showed that investing in education without at the same time reforming the curriculum and

improving teacher quality did not lead to better learning results. This is an indication that educational infrastructure alone is insufficient without institutional restructuring. In the health domain, however, detailed research by Jamison et al. (2018) proves that spending on health infrastructure only (not on strengthening primary services and medical personnel) has no effect on mortality.

The dynamic model in this article implies that previous GRDP signs (lag Y) are statistically significant, indicating time dependence in the economic growth process. This corresponds with the inter-temporal literature, which explains that the impacts of infrastructure are not limited to one period, but carry over several periods (Fosu & Twumasi, 2022; Syadullah & Setyawan, 2021). The dynamic panel GMM model (Arellano–Bond) confirms the necessity of lagging the variables in order to correct for endogeneity and enhance estimation power. The study of Utami, Yolanda, and Murti (2025) also supports the portrayal that infrastructure investment has a positive effect on regional economic growth but this effect is delayed and depends on macroeconomic conditions.

In other results, educational infrastructures spending has a significant influence on the growth of average years of schooling, but only in the first fixed effects specification. This means that the investment in education should be done in a long-term, uninterrupted process, and on the basis of systematic control of results. Recent papers by Al Mamun and Rahim (2025) further provide a confirmation that the educational investment effects do not only happen today but might need a few periods and that some social intervention will have to be combined with it.

Spending on health infrastructure also has been shown to have an impact on increased life expectancy, in line with the human capital theory which argues that health status needs to be large in order to improve individuals' productivity (Becker, 1964). Akhmad Taufik and Markhamah research (2024) indicates a long-term positive relationship between the development of health services and human development achievement indicators in ASEAN areas. Nevertheless, works like Wagstaff and Claeson (2016) warn that the better health facilities need to be complemented by access, quality and service sustainability if a real human development is desired.

Finally, fixed effects model analysis reveals the existence of fixed characteristics among regencies/cities, such as geographic conditions, fiscal capacity, and local institutions that influence development outcomes. This indicates that development policy strategies must be context-based and not uniform. The presence of significant temporal trends in the time effect variable also indicates that development achievements in West Papua are strongly influenced by external dynamics such as national policies and annual fiscal conditions (World Bank, 2010). Therefore, successful development interventions must consider long-term frameworks and be adaptive to structural changes.

4.9 Theoretical Implications

The results of this study make important contributions to validating and testing important theories in the area of development economics, focusing specifically on the theory that public sector spending is strongly related to improving the welfare of a community.

First, the findings of the study provide strong evidence for the Human Capital Theory posited by Becker (1964) that indeed investments in education and health are types of investment in the long-run productivity of the individual and the society at large. This long-run effect also appears as the time-lag characteristic of the empirical model employed in the

model, in which the effects on education and health infrastructure expenditure are only felt in the future (t-1). This is consistent with the view of Psacharopoulos & Patrinos (2018) who argue that the impact of investment in education and health would take some time to reflect on labor productivity and macroeconomic performance.

Second, this study lends support to Aschauer's (1989) Infrastructure-Led Growth Theory, most notably in the economic ramifications and health sectors. There is a supportive relationship from the infrastructure in primary roads, electricity and simple service infrastructure with the improvement of GRDP/cap which is a proxy of regional labor productivity. This result is similar with the one obtained in the study of Calderón & Servén (2010), who note that well-developed infrastructure can stimulate economic growth, leading to lower transaction costs and greater market integration. But education is not seen to be following the above paradigm, being that its effect on GRDP is not significant in the short run. This is in line with the ideas in López, Thomas, & Wang (2020), who show that education's effect on economic growth is more of an indirect nature and there is a need for complementary actions such as institutional reforms and quality of teaching.

Furthermore, this paper provides new theoretical findings on the spillover effect coming from the health sector. The findings indicate that health infrastructure investment not only affects the rise in life expectancy as a human development index but also significantly contributes to the regional economic expansion. This suggests reasons to support the Bloom, Canning, & Sevilla (2004) argument that raising public health status may raise labor productivity and economic participation, and hence foster more inclusive economic growth. This has implications for the broader understanding of the dual social and economic role of the health sector as a multi-sectoral strategic investment. The study by Jamison et al. (2013) in Global Health 2035 also highlights that better health of the population has shown to be a good value for growth in low and middle-income economies.

Consequently, the key contribution of our theory is the empirical support for human capital and infrastructure-led growth theory as it extends the horizon of development theory by highlighting cross-sectoral and intertemporal effects. Policies in public economy such as in Papua Barat must be tailored in the framework of complexity with the inter-sector relations, not only directly, but also the indirect and delayed effects of the healthy expenditure on infrastructure (inter-temporal and intersectoral dynamics). Hence, appropriately planned, coordinated, and sustained investments in health and education sciences-dimensional budgetary allocations are essential to establish the necessary grounds towards sustainable and inclusive redevelopment.

V. Conclusion and Recommendation

The purpose of the article is to analyse and assess the effect of local government's public investment, particularly on sectoral infrastructure in West Papua region (Papua Barat) on human development frameworks through three strategic agenda, Papua Sehat (Healthy Papua) Papua Cerdas (Smart Papua) and Papua Produktif (Productive Papua). Several conclusions were made by dynamic panel analysis and hypothesis tests.

The first impact of the spending of economic infrastructure is statistically strong and consistent with the growth of GRDP per capita at the district/city level, meaning that only the investment in the sector becomes the primary motive to achieve Papua Produktif. Second, education and health spending have robust effects only in the fixed-effects model, but they

are unstable across the robustness and dynamic specifications. Thus, their influence on average years of schooling (Papua Cerdas) and life expectancy (Papua Sehat) is indirect and long-term which demands continuous policy efforts. Third, the dynamic model reveals that the level of the current GRDP per capita is an outcome that is highly influenced by its lagged value one year ago, which emphasizes the significance of the time dimension in assessing development policies.

In addition, it also observed that differences in regional development outcomes were attributable to the 'endowments' across the districts/cities, which also represent the structural disparities such as geographic endowments, fiscal autonomy, and institutional capacity. There is, however, a substantial annual general trend (time effect) beyond 2022, probably as a result of national policies or inter-regional fiscal relations.

On the basis of these findings a few practical policy recommendations can be made:

1. Always prioritize the allocation of economic infrastructure spending because it directly influences GRDP growth. Areas such as connectivity, including roads, ports, and markets, should be the focus.
2. Strengthen the flow of investment on education and health, with the long term view and the harmonization between two sectors to achieve faster effect on human resource opening.
3. Use a time oriented (multiyear) development planning method to optimize the benefits of policy and to ensure that they are allowed for dynamically.
4. Formulate area/district (and city) based corner policies by taking advantage of unique conditions of each district (and city), particularly in the remote, archipelagic and disadvantaged or certain limited-access regions.
5. Align regional policies to the national agenda to achieve the maximum fiscal impact and achieve fair development in West Papua.

Combining surveys and local features, this study suggests the need for a flexible and long-term sectoral approach to human development policy in Eastern Indonesia.

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