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Exploring the Relationship Between Industrial Zones and Integrated Ports in Promoting Regional Development Sustainability in Sorong Regency, Indonesia

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ABSTRACT

In assessing regional development, changes in land use, particularly when land is utilized more productively, offer key insights into their impact on the local economy. Industrial development has emerged as a significant driver of regional economic growth, especially in archipelagic nations such as Indonesia, where maritime potential, the fisheries sector, and marine resources can catalyze industrial advancement, particularly through port activities. Sorong serves as a prime example of this transformation, thriving due to its abundant marine resources and functioning as a hub for industrial and port activities. This study seeks to examine the relationship between industrial zones and integrated ports in fostering the sustainability of regional development, specifically in Sorong Regency. By analyzing the factors influencing port development, economic indicators, and environmental considerations, through the use of structural equation modeling (SEM) and interviews with stakeholders, this research demonstrates that the development of industrial zones and integrated ports plays a crucial role in shaping regional development in Sorong Regency.

1. INTRODUCTION

The dynamics of development are among the most visible indicators of regional progress. A particularly significant issue arises from the phenomenon of land use change, which becomes critical when the demand for land exceeds the available resources. This is especially evident in the growing demand for built-up land, which often leads to a reduction in the area allocated for agricultural purposes [1]. Land availability remains static, while demand across various sectors continues to rise, resulting in increased competition among land users. Land uses that are economically less viable may be converted into more profitable alternatives, reflecting a shift in land allocation towards higher-value purposes [2]. One critical form of land use change that contributes to economic growth is industrial development. Even a modest increase of one percent in economic growth can lead to the creation of approximately one hundred thousand jobs, highlighting the significant role of industry in driving employment and economic advancement [3]. Industry plays a fundamental role in regional development, particularly as a leading sector that drives the growth of other sectors, including trade, agriculture, and services. Its development serves as a catalyst for broader economic advancement, fostering the expansion and diversification of related industries [4]. The issue of increasing population, besides escalating land needs, the rising population in an area contributes to higher temperatures, directly impacting the environment [5].

The success of sustainable industrial management depends on five variables: human resources, product quality management, corporate social responsibility implementation, leadership, and green innovation strategy [6]. Another crucial factor driving industrialization's impact on regional development is the increase in international access and capacity [7]. Seaports are essential components facilitating trade, with over 90% of international trade moving through the seas, making seaports and their hinterland areas vital components of global trade [8]. The sustainability of port cities in terms of economic, social, and environmental aspects [9]. Economic aspects include GDP indicators, primary, secondary, and tertiary industry scales, port scale, cargo throughput, and the amount of foreign capital used. Social aspects consist of government policy indicators, infrastructure, security, and the improvement of city quality in terms of education and technology. Environmental aspects include air quality indicators, centralized waste management, and green open spaces. In 2018, an estimated 70% of global trade volume was conducted through maritime transportation [10, 11]. Ports in Guangdong, Hong Kong, and Macao, factors driving port development include transportation infrastructure, port market

development level, GDP, secondary industry development, port development strategy, and business environment [12]. The level of port transportation infrastructure is a fundamental factor in port development, influencing business processes in port activities and affecting the level of industrial agglomeration [13]. At a broader regional development level, in the compilation of the Regional Development Index (IPR) to depict development ratings, areas have a more comprehensive measurement dimension, including economic, social, infrastructure, environmental, and information factors [14].

Geographically, Indonesia is a maritime and archipelagic nation with a coastline stretching over 99,123 km, making it the second-longest coastline in the world after Canada [15]. This condition provides Indonesia with abundant marine resources due to its vast ocean expanse. The presence of ports in Sorong Regency signifies one of the potentials for regional growth, serving as the gateway for maritime transportation in West Papua and Papua provinces, catering to the flow of passengers and goods from various cities in Indonesia [16]. The Ministry of Investment / BKPM (2020) states that the potential of Sorong Port as a hub for Sea Toll Sorong is one of the main gateways for maritime transportation in West Papua and Papua, serving the flow of passengers and goods from various cities in Indonesia. The role of Sorong Port has a significant contribution to supporting export activities and as a supporter of economic growth in Sorong and West Papua Province. Coastal areas are transition zones marking the transition between land and sea [17].

The existing conditions, such as industrial zones and ports in Sorong Regency, serve as the embryo in driving the emergence of other activities. This study will investigate the significance of the development of integrated industrial and port areas for the sustainability of regional development in Sorong Regency.

2. METHODOLOGY

2.1 Study area

The research area is located in the Integrated Industrial and Port Development Area in Sorong Regency, which includes Aimas District, Mariat District, Mayamuk District, Salawati District, Mosigin District, and Seget District as listed in Table 1. The study's location map can be seen in Figure 1.

Table 1. Study area

District	Wide (km^2)	Percentage of Main District Area (%)	Number of Villages / Subdistricts
Aimas	690,06	5,27	14
Mariat	542,19	4,14	11
Mayamuk	542,19	4,14	11
Salawati	345,03	2,63	7
Mosigin	443,61	3,39	9
Seget	443,61	3,39	9

2.2 Sample and data collection

The data collection methods encompass both primary and secondary approaches. Primary data is acquired through observations and interviews with respondents. Interviews serve as a valuable means to obtain firsthand data, particularly through in-depth conversations with knowledgeable stakeholders well-versed in the investigated issues. Collaborative engagement and the involvement of stakeholders are pivotal components in achieving participatory spatial planning [18]. The research employs two forms of data collection methods.

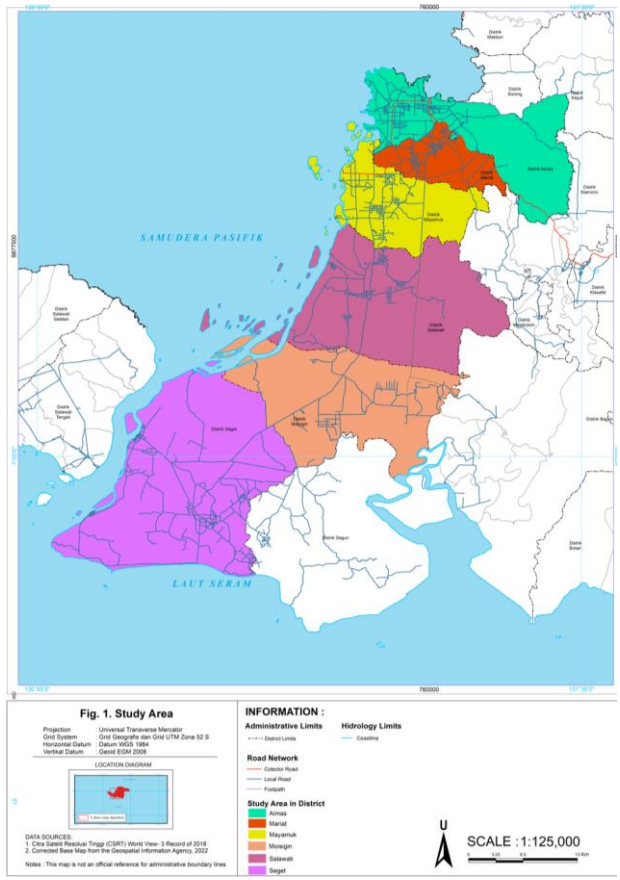

Figure 1. Study location map

2.2.1 Primary data collection

Observations: Observation or field surveys were conducted with the aim of systematically assessing and documenting observable indicators that could provide insights into the prevailing environmental conditions within the research area.

Interviews: In-depth interviews were conducted with industry and port experts to gain a deeper understanding of stakeholders' perspectives on regional development, with a specific focus on the unique characteristics of industrial and port activities in Sorong Regency. This approach aimed to collect valuable insights, informed opinions, and expert knowledge, thereby contributing to a more comprehensive understanding of the complex dynamics that shape the region's economic and developmental landscape.

Questionnaire Completion: The data collection process involved the administration of a meticulously designed questionnaire aimed at gathering information on the interconnection between industry and ports in Sorong Regency. The questionnaire incorporated variables and indicators derived from an extensive literature review. The responses collected were then carefully measured using an ordinal scale, with scoring numbers assigned to quantify and analyze the results. This methodological approach ensured a systematic and structured evaluation of the data, enabling a nuanced understanding of the complex interrelationships between the industrial sector and port activities in Sorong

Regency.

2.2.2 Secondary data collection

Secondary data collection involves sourcing information from the Regional Planning and Development Agency of Sorong Regency, specifically focusing on spatial planning, industry, and port planning. Additionally, data concerning regional development conditions is obtained from the Sorong Regency Statistics Agency. The collected datasets will undergo a thorough review in preparation for comprehensive analysis, ensuring that the information gleaned contributes substantively to the broader understanding of the regional dynamics encompassing spatial planning, industrial activities, and port development in Sorong Regency. Sampling is proceeded in two stages as picture in Figure 2.

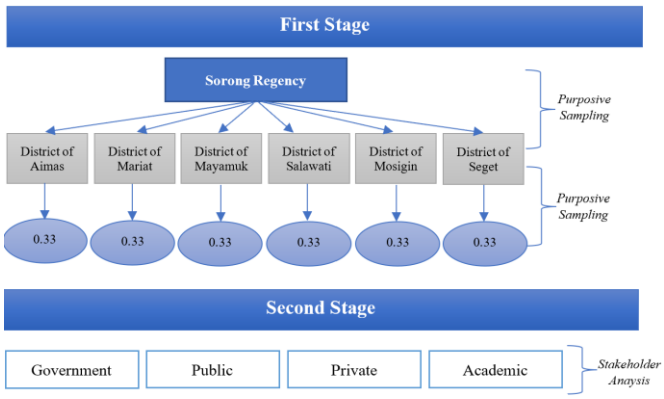

Figure 2. Sample collecting plot

In the first phase, six districts in Sorong Regency were selected using purposive sampling. The selection of these six districts was based on their proximity to the Industrial Development and Integrated Port Area of Sorong Regency. This study involved a total of 200 respondents. Therefore, the sample size was calculated based on the assumption of equal size, meaning that 33.3% of the sample was taken from each district. In the second phase, the selection of the sampling units, which are the objects or respondents to be studied, was carried out. The objects of this research were chosen based on the stakeholder analysis. The selected sectors included the government sector (33%), the community sector (30%), the private sector (26%), and the academic sector (11%). Each sector was selected based on the level of importance and influence of the stakeholders regarding the issues raised in the study.

2.3 Variables

The overarching goal of this research is to scrutinize the multidimensionality of the impact resulting from integrated industrial and port area development on regional progress. This examination is structured around four latent variables, namely, industrial zones, integrated ports, regional development, and sustainable development.

Variables and Indicators:
(IA) Industrial Areas
X1.1: Regional Economic Value
X1.2: Social Politics
X1.3: Labors
X1.4: Policy Support
X1.5: Spatial & Infrastructure Development
(IP) Integrated Port
X2.1: Economy
X2.2: Labors
X2.3: Spatial Developments
(RD) Regional Development
Y1.1: Economy development
Y1.2: Social and demography
Y1.3: Regional Infrastructure Support
(KP) Sustainable Development
Y2.1: Environmental Quality Level
Y2.2: Social
Y2.3: Production Process
Y2.4: Waste and Emission Management
Y2.5: Strategic Area Infrastructure
Y2.6: Port Throughput Value
Y2.7: Government Policy Support

2.4 Analyzing of data

SEM is a sophisticated multivariate statistical analysis technique employed to assess relationships among measured variables and test theoretical models elucidating these relationships. This approach empowers researchers to model the intricate relationships between latent variables, which are not directly measured, and measured variables. Furthermore, SEM facilitates the examination of causal relationships between these variables, offering a comprehensive framework for investigating complex interdependencies within the proposed theoretical model [19].

2.4.1 Components of SEM

1) Variables in SEM

Within the framework of SEM, two types of variables are distinguished: latent variables and observed variables. Latent variables, also known as unobserved or hidden variables, cannot be directly observed but are estimated or measured through related variables that are observable. The term "latent" emphasizes the underlying and unobservable nature of these variables [20]. On the other hand, observed variables, also referred to as measurement variables, are empirically observable through survey or census activities, providing tangible data for analysis [21]. This differentiation allows for a comprehensive examination of both the manifest and underlying aspects of the variables within the SEM framework.

2) Models in SEM

In SEM, two fundamental models are employed: the structural model (inner model) and the measurement model (outer model). The structural model delineates the causal relationships among latent variables within the overarching model. Comprising latent variables and parameters, the structural model encapsulates the dynamics of relationships between these variables. Conversely, the measurement model is concerned with the connections between measured variables and latent variables. This model aids in the interpretation of latent variables by scrutinizing the relationship between these latent constructs and their observable indicators, elucidating the complex interplay between the conceptual and empirical facets of the model [20].

3) Errors in SEM

Similar to the division of models, errors in SEM are categorized into two types: structural errors and measurement errors. Structural errors pertain to inaccuracies within the structural model, indicating instances where the exogenous

latent variable (predictor) fails to perfectly predict the endogenous latent variable (response). These errors underscore the inherent challenges in capturing and modeling the intricate causal relationships between variables, acknowledging the inherent complexity and uncertainties within the structural components of the SEM framework (Figure 3).

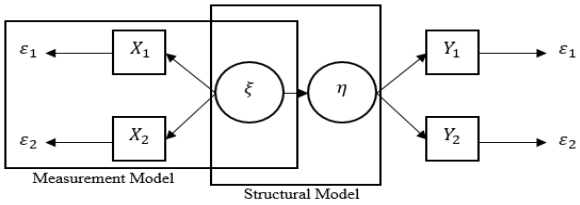

Figure 3. SEM's components illustration

4) The Structural Error is Denoted by ζ (zeta)

On the other hand, measurement error within SEM pertains to inaccuracies in the measurement model, signifying instances where observed variables cannot perfectly measure the corresponding latent variables. This type of error is further distinguished based on exogenous indicator variables, denoted by δ (delta), and endogenous indicator variables, denoted by ε (epsilon). Recognizing and addressing measurement errors are crucial aspects of SEM, as they highlight the challenges in precisely capturing latent constructs through observable indicators and contribute to refining the model for more accurate and reliable analyses.

2.4.2 Structural equation model partial least square (SEM-PLS)

SEM-PLS, a multivariate data analysis method widely applied in social research, business, and various scientific disciplines, provides a robust framework for modeling relationships between constructs (variables) and assessing the influence of each variable on others [21]. Several advantages distinguish SEM with a PLS approach: Firstly, it excels at handling high-dimensional data, particularly beneficial for datasets with numerous variables, as PLS effectively reduces dimensionality, simplifying interpretation. Secondly, SEM-PLS exhibits a high tolerance for multicollinearity, addressing issues commonly encountered in multivariate data analysis with highly correlated variables. Lastly, SEM-PLS uniquely enables the simultaneous analysis of constructs comprising both reflexive and formative indicators, a capability not feasible in the SEM method with the Covariance-Based approach (CB-SEM) due to the risk of model identification issues. The use of the Ordinary Least Square series analysis algorithm in PLS avoids problems related to model identification in recursive models and does not assume a specific distribution form for variable measurements [22].

3. DISCUSSION

Table 2 show significant value about the correlation between variables. The correlation between variables as pictured in Figure 4. For the evaluation of the structural model in PLS SEM analysis, there are several stages, namely testing direct effect hypotheses, testing indirect effect hypotheses, and determining the coefficients of determination or R-Square (R^2).

Table 2. Measurement of reliability in second order indicators

Correlation Between Variables	Signification Value
X1 -> Y1	0.438
X2 -> Y1	0.420
Y1 -> Y2	0.656

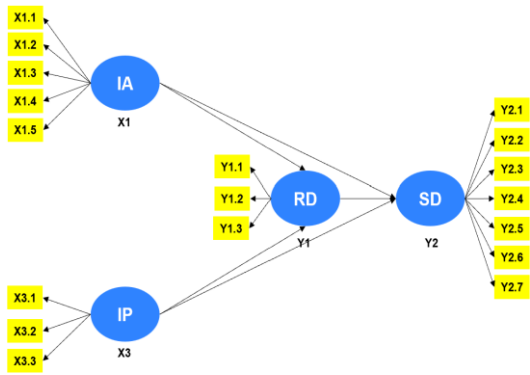

Figure 4. Conceptualization of SEM Analysis on research variables

3.1 Relationship between the influence of industrial area variables on regional development variables

Industrial cluster policies serve as a primary and widely used tool for economic development in the context of regional economic planning [23]. Based on SEM analysis results, it is shown that the industrial area variable has a quite significant influence on the regional development variable with a value of 0.438. This indicates that industrial activities in Sorong Regency have a considerable impact on the patterns of activities, urban spatial structure, and spatial planning in the region. According to the Gross Regional Domestic Product (GRDP) data of Sorong Regency for the years 2021-2022, the processing industry sector has the largest contribution to the economic structure in Sorong Regency [24, 25].

In a study conducted by Rustan [26] titled "Study of The Impact of Establishing a Special Economic Zone Policy for Sorong, Southwest Papua," it is mentioned that the existence of the Sorong Special Economic Zone (SEZ) has the potential to create many opportunities, including in logistics and industrial areas [26]. Within the industrial zone, the main opportunities for the development of the palm oil industry include derivative products such as cooking oil, margarine, butter, vanaspati (vegetable ghee), ice cream, bread fat, instant noodles, soap, detergent, cocoa butter extender, chocolate and its coating, special fat, dry soup mix, snack sugar, biscuit fat, filled milk, lubricants, textile oil, and biodiesel. This aligns with the research conducted by Syali et al. [27], which states that the Special Economic Zone has a positive impact on the economic growth of West Papua Province.

Supporting these studies, this research conducted within the scope of Sorong Regency indicates that the industrial area variable has a quite significant influence on the regional development variable. The development in various industrial sectors ultimately leads to the formation of an industrial zone. The substantial growth of activities in the industrial zone in Sorong Regency has the potential to influence the emergence of infrastructure development plans that support these industrial activities. Thus, gradually forming a regional character in the process of regional development.

3.2 Relationship of the influence of integrated port variables on regional development variables

Previously, in a study conducted by Lugo and Martinez-Mekler [28], concerning the correlation between the presence and quantity of ports on the development/scale of a city, it is mentioned that the presence and quantity of ports influence the growth of a city [28]. In another study conducted by Vroomans et al. [29], it shows the relationship between ports and cities in three cities: Hamburg, Antwerp, and Rotterdam. In that research, the strongest relationship between the port and the city is in Hamburg, based on a strong culture that strengthens the integration between the port and the city, where the dominant role of the community's character is also prominent [29]. In Antwerp, political constellations are responsible for the continuity of conflicts in the city, affecting the development of the city and the port. In Rotterdam, it has a more business-oriented culture that influences the relationship between the port and the city. This study concludes that these three cases have a commonality that variations in shared values (uniqueness) in a region play a crucial role in changing the relationship between ports and cities. In another study, it is mentioned that local wisdom in maritime regions can have a positive impact on regional planning and management, especially in the field of maritime spatial planning [30].

Based on the results of SEM analysis in this research, it is shown that the integrated port variable has a quite significant influence on the regional development variable with a value of 0.420. This indicates that the existing conditions in Sorong Regency, which are largely dominated by the presence of influential ports, have a significant impact on the development of Sorong Regency. Ports are one of the main gateways for trade, both locally, nationally, and internationally, involving value-added services such as cargo handling, warehousing, and packaging functions, and serving as a hub for land transportation arrangements in Sorong Regency. The presence of cargo ports, passenger ports, fishing ports, and the like becomes the embryo of the emergence of other activities as a result of these port activities (multiplier effect). Over time, this condition will shape an arrangement or structure of interconnected activities. The activities or actions of the population in a region will certainly have implications for spatial allocation patterns and the development of a region. This condition is in line with the planned development of the Sorong Special Economic Zone (SEZ), which involves the role of ports in Sorong Regency to become the driving sector for economic activities.

3.3 The relationship between regional development variables and sustainable development variables

Based on the SEM analysis results presented in Table 2, this study indicates that the regional development variable has a significant impact on the sustainable development variable, with a value of 0.656. This suggests that regional development in Sorong Regency, which includes elements of economic, social, and environmental development, influences the future sustainability of development in Sorong Regency. Regional development is closely linked to economic growth in Sorong Regency. If the development sectors in Sorong can proceed while addressing the needs of the population, economic requirements, and environmental carrying capacity, then regional development that impacts sustainable development is not an unachievable goal.

3.4 The influence of indicators on the main variable

3.4.1 The influences of indicators within the industrial zone variable

The influence of indicators within a variable is used to analyze the relationship between an indicator and its corresponding variable. The greater the influence of the indicator, the greater its significance value. The following are the values of the influences of indicators within the industrial zone variable.

Table 3. The values of the influences of indicators within the industrial zone variable

Variable / Indicators	X1
X1.1 (Regional Economic Value)	0.183
X1.2 (Social Politics)	0.146
X1.3 (Labors)	0.164
X1.4 (Policy Support)	0.320
X1.5 (Spatial & Infrastructure Development)	0.318

Based on the Table 3, it is gathered that the indicators significantly influencing the formation of the industrial zone variable are the policy support indicator and spatial development and infrastructure indicator. This is highly correlated because both in the development plan policies and spatial planning in Sorong Regency, spatial programs and activities are mainly designed to support the operation of industrial activities that shape an industrial zone. These programs and activities include plans for the development of road networks, plans for the development of land and sea transportation infrastructure, plans for the development of energy networks, and so forth.

3.4.2 The influences of indicators within the integrated ports variable

The influence of indicators within a variable is used to analyze the relationship between an indicator and its related variable. The greater the influence of the indicator, the greater its significance value. The following are the values of the influences of indicators within the integrated port variable.

Table 4. The values of the influences of indicators within the integrated ports variable

Variable / Indicators	X2
X2.1 (Economy)	0.314
X2.2 (Labors)	0.304
X2.3 (Spatial Development)	0.432

Based on Table 4, it is found that the indicators in the integrated port variable have relatively equal influence in shaping the integrated port variable. However, the spatial development indicator has the highest influence in forming the integrated port variable in Sorong Regency. This spatial development indicator can be observed from the creation of integrated transportation to support port activities, even though the development of integrated transportation in Sorong Regency is still in progress. Additionally, the spatial development shaping the integrated port can be seen in the construction of docks, as well as other supporting infrastructure and facilities for the port, the clustering of ports, the proximity of ports to the city center, and so forth.

3.5 Analysis result of direct effect test

The results of testing the direct effect hypothesis are as follows. Based on the observations of the P-values presented in Table 5, which are below the significance level of 0.05, it can be concluded that there is a significant direct influence of the industrial and integrated port areas on regional development in Sorong Regency. As for the other hypotheses, based on the P-values, it is stated that there is a direct influence of the regional development variable on the sustainable development variable in Sorong Regency.

Table 5. Analysis result of direct effect test

Hypothesis	T Statistics	P Values
The influence of industrial areas on regional development	4.162	0.000
The influence of integrated ports on regional development	3.376	0.001
The influence of regional development on development sustainability	9.918	0.000

The significant impact of the industrial and integrated port areas in Sorong Regency indicates that regional development, which encompasses economic, social, and environmental development elements, influences the future sustainability of development in Sorong Regency, as conceptualized in the three pillars of sustainable development. In the economic aspect, this relationship is demonstrated through the level of economic productivity in the industrial zone as well as port-related activities. In the social aspect, it can be shown through socio-political activities, employment, and policy support for each variable, both in the industrial area and the integrated port. From an environmental perspective, spatial development, including the planning of industrial and port areas that adhere to green industry principles, plays a crucial role in forming the significant influence of these two variables on regional development.

Consequently, regional development is intricately connected to the economic, social, and environmental advancements taking place in Sorong Regency. Moreover, if the development sectors in Sorong are able to progress while considering the population's needs, economic demands, and the environmental carrying capacity, regional development that fosters sustainability can indeed be realized.

4. CONCLUSION

The significant impact of the development of industrial and integrated port areas on regional development in Sorong Regency indicates that the industrial area variable has a substantial influence on the regional development variable. An analysis of the Gross Regional Domestic Product (GRDP) of Sorong Regency for 2021-2022 reveals that the processing industry sector makes the largest contribution to the economic structure of Sorong Regency. Simultaneously, the integrated port variable also shows a significant impact on regional development. This suggests that the conditions in Sorong Regency, which are largely dominated by ports and industry, have a substantial effect on the region's development. This is aligned with the development plan for the Sorong Special Economic Zone (KEK), where the involvement of ports in Sorong plays a crucial role as a driving force for economic activities, while still considering social elements and environmental sustainability principles. Under these conditions, the presence and productivity of the industrial and integrated port areas, when viewed in a broader context encompassing economic, social, and environmental aspects, can support the concept of sustainable development. This indicates that the progress or development of the region, supported by these two key elements, can contribute to the realization of sustainable development.

5. RECOMMENDATIONS

To enhance the progress of this study, it is essential to amalgamate a broader range of factors that suit the unique features of the research site across various locations. Additionally, expanding the sources of data by integrating insights from current secondary data pertaining to economic advancement alongside multiple variables believed to exert influence could be beneficial. On the policy aspect, the suggestion proposes that the significant outcomes derived from the variables examined in this study can play crucial roles in devising strategies aimed at ameliorating the disadvantaged condition of Sorong Regency.

6. LIMITATIONS

In this research, the categorization of industrial areas and port zones according to their hierarchy or classification has not been carried out. Hence, if the typology or categories of current industries and ports are determined in advance, important factors influencing them can be systematically categorized.

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