Journal of Ecohumanism
2024
Volume: 3, No: 7, pp. 4535 – 4547
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
https://ecohumanism.co.uk/joe/ecohumanism
DOI: https://doi.org/10.62754/joe.v3i7.4562

The Effect of Cities and Ports on Economic Growth in Indonesia: The Mediating Role of Containerization

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Abstract

Containerization, Containerization, a developing method for transporting goods, is revolutionizing thetransportation system and industry on a global scale. This study examines the effect of containerization on economic growth and its role in mediating the impact of cities and ports on economic development in Indonesia. The study, which employed a quantitative descriptive approach, collected panel data from 50 cities and ports involved in container loading and unloading activities in Indonesia and analyzed the data using Structural Equation Modeling (PLS-SEM). The research findings demonstrate that containerization has a positive and significant effect on economic growth and mediates the impact of cities and ports on economic development in Indonesia. These results provide an empirical basis for formulating policies and developing more effective economic strategies for archipelagic countries based on interrelated variables. Investment in thoughtful infrastructure and collaborative and comprehensive stakeholder strategies can provide substantial economic benefits for sustainable development goals (SDGs), contributing to the global impact of containerization.

Keywords: *Containerization, Cities and Ports, Economic Growth, Archipelagic Country.*

Introduction

Containerization enables fast and reliable transportation of raw materials, components, and semi-finished products to areas with production facilities and distribution of consumer goods worldwide[1]. Containerization causes a major reduction in costs and complications in the transportation of goods so containers have changed the shape of the world economy[2]. Containerization creates the need for innovative practices for handling container cargo, modification, and integration of transportation systems[3]. Containerization is growing rapidly which enlarges and integrates the global economy[4]. A major paradigm shift (or revolution) has occurred in the container cargo distribution system, leading to an increasing level of integration between modes[5]. The development of containers in Indonesia began in the 1960s and in 1973 the first container shipment used a semi-container ship.

The development of containers in Indonesia began in the 1960s and in 1973 the first container shipment used a semi-container ship. The first container port operation in Indonesia was Tanjung Priok Port in 1980. Containerization as a form of logistics modernization plays an important role in trade efficiency. Containerization starts from production and consumption activities in the city, and logistics activities in the transportation system. The added value of increasing containerization can reduce logistics costs and encourage economic growth. The growth trend graph of indicators related to Indonesia's economic growth for the period 2019-2022 as shown in Figure 1 shows the same growth trend, including cargo and container traffic.

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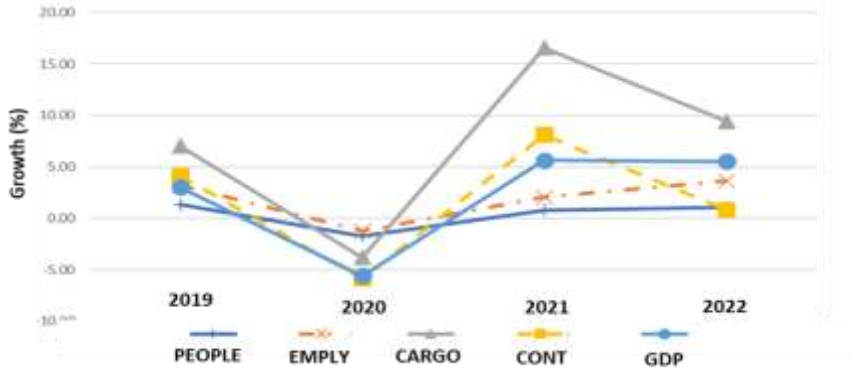

Figure 1. Growth of Indonesia's Economic Indicators in the Period 2019-2022.

Furthermore, Indonesia as an archipelagic country with disparities in city and port conditions. One illustration of the disparity in containerization in Indonesia can be seen from the intensity of container traffic as in Figure 2.

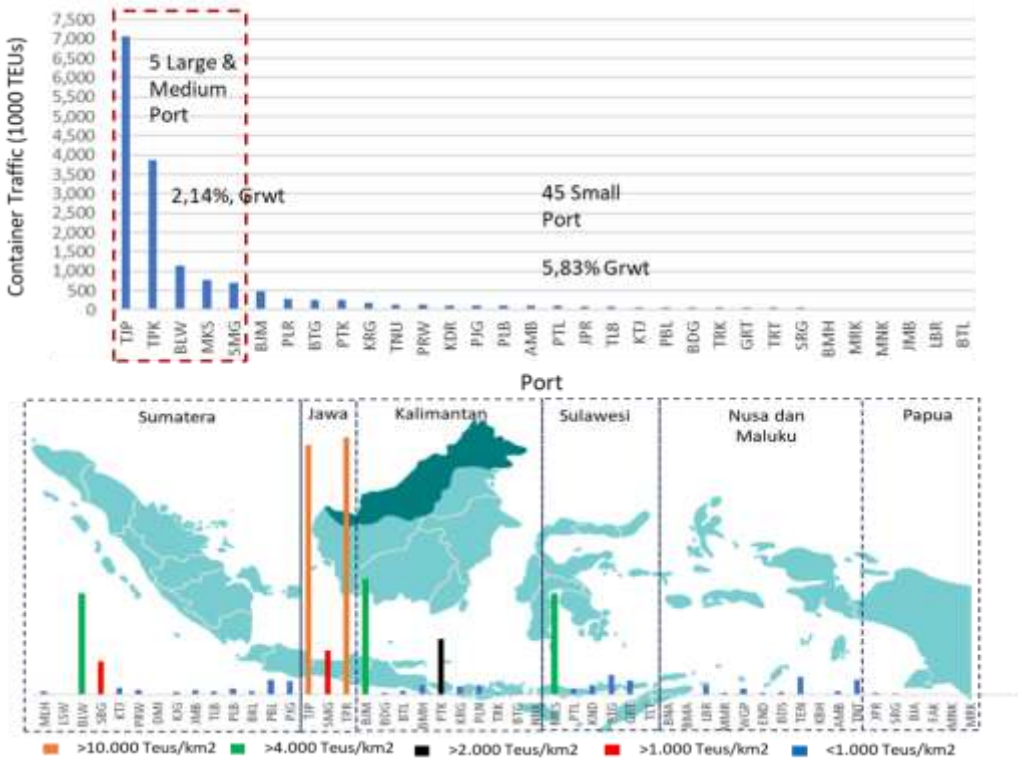

Figure 2. Container Traffic (Teus) And Intensity (Teus/Km2) In 2022.

Previous research states that containerization is influenced by port development where the port is part of the urban area, there is a significant relationship between the city and the port so further research on the influence of cities and ports on economic growth through containerization provides valuable insights for the development of more effective policies and strategies.

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Literature Review

The Effect of Cities on Containerization

The results of a study conducted on 41 port cities in Indonesia, showed that the population of large, medium, and small cities has a positive effect on container traffic[6], as well as research in the United States stated that the population in container port cities grows about twice as fast as other coastal port cities due to containerization[7]. Other elements of the city that effect containerization are (1) City economic activity, (2) Large cities as centers of trade, (3) Infrastructure and connectivity, (4) Innovation and technology, (5) Employment and labor, and (6) Regulatory environment.

Cities also play a vital role in the global logistics network, influencing how goods are transported, handled and distributed via container shipping. The relationship between cities and containerization can be analyzed based on the city typology matrix, namely the relationship between city size based on population and terminal size based on the amount of terminal traffic per year referring to the city and port typology matrix in Figure 3[8],[9]. The position of cities and container traffic helps in the planning, development and management of ports and cities that are more efficient and in accordance with the role they play in the economy.

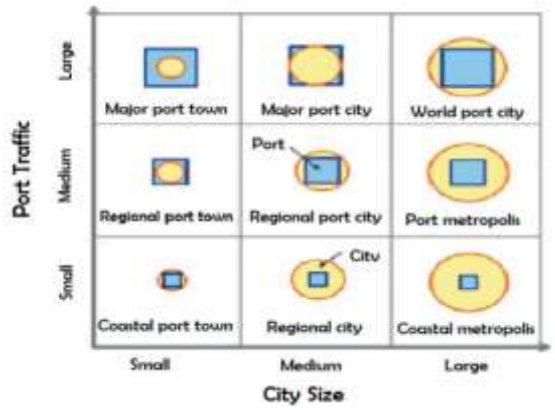

Figure 3. City And Port Typology Matrix

The Effect of Containerization on Economic Growth

The importance of the role of maritime transportation and port development, is consistent with previous findings in the literature, but few studies have investigated whether there is a two-way relationship between economic growth and port throughput/traffic in port cities in East Asia[10]. Furthermore, research conducted by[11] in South Korea stated that container port activities have a positive effect on regional economic growth.

Containerization has a major effect on economic growth, affecting various aspects of global trade, industrialization, and economic development. Containerization drives economic growth through (1) Reducing transportation costs, (2) Increasing trade volume (3) Expanding global markets, (4) Increasing supply chain efficiency (5) Urban and regional development (6) Technological and infrastructure advances.

Previous Research on The Effect of City Port and Containerization on Economic Growth

Several previous studies in the last ten years related to the relationship between variables in several countries using several analysis methods have produced findings that show a positive and significant influence as in Table 1., from several kinds of literature, it can be concluded that City resources are described as area, population, workforce, and city infrastructure[12],[13], [14][15],[16],[17],[18]. Port indicators include port facilities and port traffic[19],[20],[21]. Containerization can be seen from the growth of traffic, infrastructure, and system and terminal performance[22],[23],[24],[25]. Economic growth is an increase in

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output per capita from the main business fields (primary, secondary, and tertiary)[26]and [27], and business fields that are closely related to containerization are[28],[29],[30], [31],[32].

Table 1. Summary of Studies on the Effect of City Port and Containerization on Economic Growth.

Author (Year)	Country	Var./Indicator	Method	Findings
Deng at. al (2013)	China	AV, Port demand, regional economic	SEM	Added Value of Port activity has a positive and significant effect on the development of the regional economy
Essoh, N.P.S. (2013)	Korea	Traffic, GDP	Solow Model	Port activity and activity generated have contributed and can accelerate the economic growth
Goncalves (2016)	Brazil	AV, Port demand, regional economic	SEM	Value added port activity effects the regional economy, playing a mediating role between the demands of the port and the regional economy
Rahmawati, et.al (2016)	Indonesia	GDP, Impor,t and General Cargo Containerized	Regression	GDP and imports have an effect to general cargo Containerized in INA.
Park, JS & Seo, Y-J (2016)	Cote d'Ivoire	Area, Population, GDP, Cargo Port, Container Port	Solow Model	Container port activities positively effect and investment indirectly leads to regional economic growth
Prakoso,A, et.al (2017)	Indonesia	GDRP, Teus, Road	Dynamic Approach	Tj.Priok Port Development has a positive effect on economic growth in Jakarta
Munim and Schramm (2018)	World	Infrastructure, LPI, Sea Borne Trade, Economic Growth	SEM	Port infrastructure and logistics performance affect economic growth and mediating by seaborne trade
Mudronza at.al (2020)	Europian Union	GDP, Population, HC, un employ, Population	Method of moments	The operation of seaports has a positive effect on the economic growth
Fratila at. al (2021)	Europian Union	GDP, Investment, Traffic, unemployment, GINI, NOx, SO2	Panel Regression	Reducing the impact of the intensity of maritime economic activities through green investments in port infrastructure and ship ecology..
Sun and R. Kauzen (2023)	Tanzania	Port infra, International trade, economic growth	SEM	International trade has a significant effect on economic growth in Tanzania.

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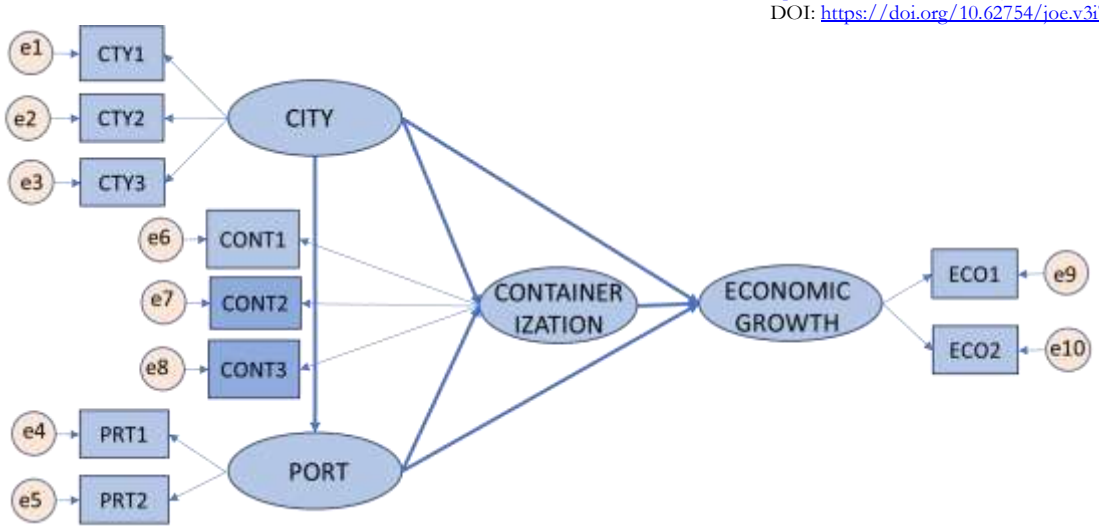

Figure 4. Structural Model

Table 2. Variables and Description.

Construct	Indicator	Abrev.	Description	Source	Units
City(CTY)	Population	CTY1	Number of city port population	IBS	People
	Employment	CTY2	Number of city port employment	IBS	Person
	Roads Length	CTY3	Total roads length in city port	IBS	Km
Port (PRT)	Berth Lenght	PRT1	Total berth length at port	IPC	M
	Cargo Troughput	PRT2	Total number of cargo handled at port	IBS	Tons
Containerization (CONT)	CT Traffic	CONT1	Total number of container loaded/unloaded in terminal	IPC	TEUs
	CT Performance	CONT2	Average number of container handled per ship per hour	IPC	Box/Ship/Hrs
	CT Berth Lenght	CONT3	Total berth length at terminal	IPC	M
Economic Growth (ECO)	GDP Industry	ECO1	GDP from industry and manfactr sector at CMP	IBS	IDR Bi
	GDP Transportation	ECO2	GDP from transportation and warehouse sector at CMP	IBS	IDR Bi

Notes: IBS= Indonesia Beareu of Statistic, IPC=Indonesian Port Corp., CMP=cosntant market price

Research Hypotesis

From the conceptual model diagram as shown in Figure 4. several Hypotheses are drawn 1) H1: there is a significant and positive direct effect of the Containerization variable on the Economic Growth variable can be accepted 2) H2: there is a significant and positive indirect effect of the City variable on the Economic Growth variable through the City and Containerization.

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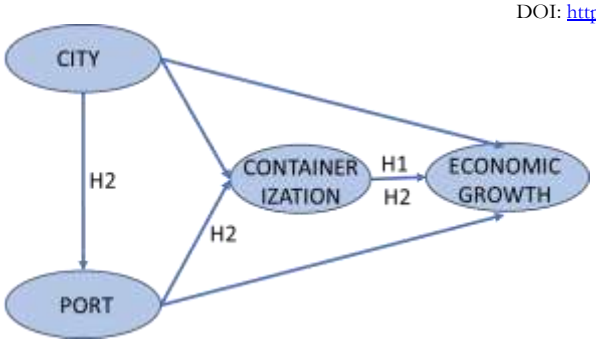

Figure 5. Conceptual Model Diagram and Hypotesis

Methodology

The study uses quantitative descriptive. The research method used is survey research, namely research whose data is collected from a sample of the population to represent the entire population. The type of research used is explanatory research the sampling technique used was purposive sampling with a homogeneous sample category (homogenous sampling), namely a sampling technique based on certain considerations according to the research objectives and the sample has characteristics that are by the characteristics of the population[33].

Data analysis using secondary data from sample size with quantitative techniques is determined using the Slovin formula[34] sample of 50 cities and ports serving containers managed by PT. Pelabuhan Indonesia II (Persero). The following Figure 6. is a map of the location of cities and container ports, the size and hierarchy of the ports that are samples in this research.

Figure 6. Location Map of Container Ports in Indonesia Managed By IPC

The data collected is secondary data in the form of statistical data obtained from IBS publications, MoT dan IPC. Data is panel data, combining time series and cross-section data in 50 districts/cities and ports. The data analysis technique is analysis to obtain an overview of the characteristics of the sample. Data analysis and processing using SmartPLS 4.0 software. Table 3. below shows the descriptive statistics data for variables.

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Table 3. Descriptive Statistics for Variables

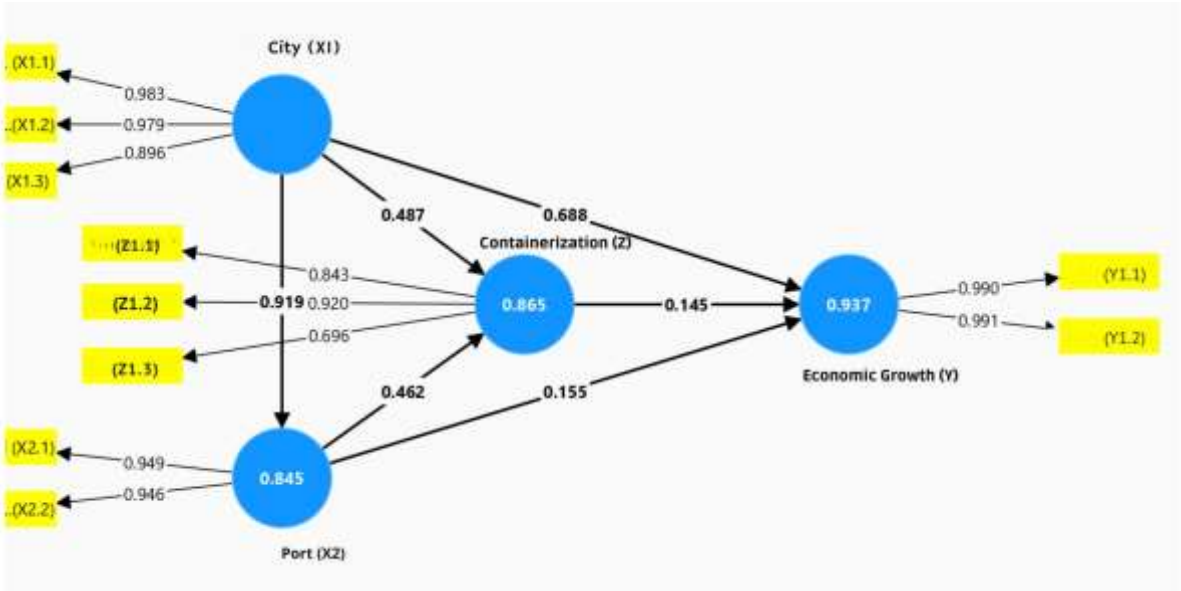
Construct	Variable	N	Mean	Min	Max	Std.Dev
City (CTY)	Population (peo.)	250	758.901	54.7	10,679.95	1,514.10
	Employment (pers.)	250	341.238	21.12	4,875.27	689.079
	Roads Length (Km)	250	985.709	51.98	6,432.00	1,023.36
Port (PRT)	Berth Lenght (m)	250	1,288.05	60	13,018.00	2,331.60
	Cargo Throughput (Tons)	250	4,809.39	54.43	86,586.73	9,638.08
Containerization (CONT)	CT Traffic (TEUs)	250	324,835.28	1,146.00	7,076,478.25	1,067,627.19
	CT Performance (BSH)	250	23.221	5.33	57.47	12.189
	CT Berth Lenght (m)	250	673.772	60	11,097.00	2,009.50
Economic Growth (ECO)	GDP Industry (IDR.Bi)	250	13,356.78	27.06	228,741.59	34,803.27
	GDP Transportation (IDR.Bi)	250	3,626.10	-2.56	74,214.76	10,008.66

Notes: CT= Container Terminal, IDR.Bi=in Billion Rupiah

Result

Validity and Reliability Model

Based on the validity of outer loading, it is stated that all items or indicators are valid using convergent validity (Table 4.), another method for assessing validity is discriminant validity. The AVE value (Table 5.) above 0.5 means that all latent variables used in this study are valid because they have met the recommended AVE value indicating that the constructs used in the model have good convergent validity and can explain most of the variance of the related indicators. Another method in assessing Discriminant Validity.



Fiure 7. Outer Model Analysis

Based on the Fornell-Larcker Criterion Table 6., all the roots of the AVE of each construct are greater than its correlation with other variables, the latent construct is truly different from other constructs, so the discriminant validity requirements in this model have been met.

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Table 4. Convergent Validity

Variable	Containerization (CONT)	City (CTY)	Port (PRT)	Economic Growth (ECO)
CTY2			0,946	
CONT3	0,843			
PRT1			0,949	
ECO1				0,990
ECO3		0,896		
CTY2	0,696			
CONT1	0,920			
CTY2		0,979		
CTY1		0,983		
ECO2				0,991

Table 5. Discriminant Validity

Variable	AVE
CONT	0.680
ECO	0.981
CTY	0.909
PRT	0.897

Table 6. Fornell-Larcker Criterion, The Roots of AVE

	CONT	CTY	PRT	ECO
CONT	0,825			
CTY	0,912	0,953		
PRT	0,910	0,919	0,947	
ECO	0,914	0,963	0,919	0,990

Internal Consistency Reliability measures how well an indicator can measure its latent construct[35]. Based on Table 7, it can be seen that all constructs have Cronbach's Alpha values> 0.6, so it can be said that all these constructs are reliable.

Table 7. Result of Reliability Analysis

	Cronbach's Alpha	rho_A	Composite Reliability	AVE
CONT	0,763	0,836	0,863	0,680
CTY	0,949	0,963	0,968	0,909
PRT	0,886	0,886	0,946	0,897
ECO	0,980	0,981	0,990	0,891

Model Fit Measurement

Model Fit indicates how well the model fits the data obtained. The results of the model fit test, some of the model fit measures used are as in the following Table 8:

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Tabel 8. Result of Model Fit

Result	Saturated Model	Estimated Model
SRMR	0,076	0,076
d_ULS	0,316	0,316
d_G	1,321	1,321
Chi-Square	1169,454	1169,454
NFI	0,756	0,756
rms Theta	0,364	

In the model results, the SRMR value of 0.076, which is below the threshold of 0.08, indicates that this model has a good fit with the existing data. Containerization mediates the effect of cities on economic growth but is complementary [36], with or without containerization the effect of cities on economic growth remains significant and positive as shown in Table 9.

Table 9. Mediation Effect

Indirect Effect	Original Sample			t Statistic	P Values	Mediation Type
CTY (a) -> ECO (b)	0,688			13,971	0,000	*Complementary, partial mediation*
CTY (a) -> PRT (c) -> CONT (d) -> ECO (b)	0,062			3,433	0,001	

Statistical Hypothesis Test

Direct effect of CONT on ECO with a p value of 0.001 where <0.05 so accept H1 meaning there is a significant and positive effect of CONT on ECO, with the equation ECO=0.145·CONT+ϵ5. Indirect effect of the CTY on ECO through PRT and CONT with a coefficient of 0.062 and a p-value of 0.001, thus accepting H2, meaning that there is a significant and positive effect of the CTY on ECO through PRT and CONT, with the equation: PRT→PORT→CONT→ECO: βPRT→PRT→CONT→ECO=0.062, t=3.433, p=0.001, the details of which are explained in Table 10.

Table 10. Hypothesis Test Result

Hypotesis	Original Sample	Sample Mean	Standar Deviation	t Statistik	P Values	Decision
H1	0,145	0,152	0,043	3,402	0,001	Accepted (Significant)
H2	0,062	0,066	0,018	3,433	0,001	Accepted (Significant)
t table = 1,65 (df =246, α=0,05, one tail						

Discussion

City Port Typology

From the data on city size and container traffic with data from 2022, the city and port typology can be determined as shown in Figure 7.

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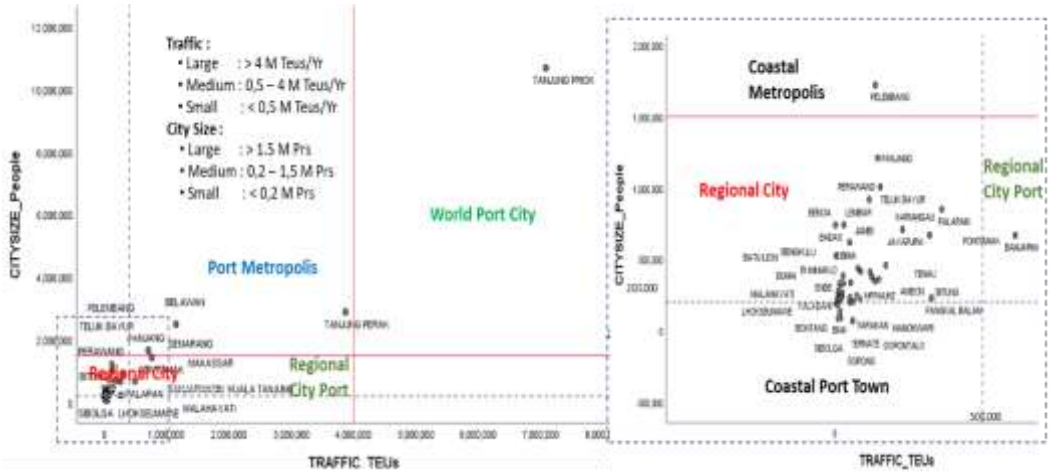

Figure 8. City Ports Typology

There are 5 types of Port Cities in the analyzed sample, namely (1) Tanjung Priok Port as World Port City, (2) Tanjung Perak, Semarang and Belawan Ports as Port Metropolis, (3) Makasar, Banjarmasin, Pontianak Ports, as Regional City Ports, (4) Bengkulu, Jambi, Palembang, Kuala Tanjung Ports and others as Regional Cities and (5) Sibolga, Gorontalo and Sorong Ports as Coastal Port Towns. The dominant port groups are Regional Cities and Coastal Port Cities, with small container traffic positions and medium and small city sizes that show low trade connectivity only within the regional scope (same origin and destination), which are characteristics of an archipelagic country that requires effective strategies in developing regional infrastructure and connectivity for sustainability.

The Effect of Containerization on Economic Growth

Containerization has a direct, positive, and significant effect on economic growth through increased efficiency, reduced costs, and increased scale of global trade. An efficient containerization process is an important factor in driving economic growth. Process efficiency can be achieved by improving facilities (Nyema, 2014), stimulating container traffic with infrastructure and superstructure readiness, and improving loading and unloading performance or container handling at the port. Efficiency from improving terminal performance can provide added value for the industrial/manufacturing business sector and the transportation and warehousing business sector that affect the economy[37],[38]. The data of the port city shows that for large container terminals (Tanjung Priok) the average container growth in the last 5 years is 1.77% and the average GDP growth is 2.2%, for medium terminals the average container growth in the last 5 years is 2.2% and the average GDP growth is 2.8% and small terminals the average container growth in the last 5 years is 1.28% and the average GDP growth is 2.16%. There is the same pattern and direction of growth and medium-sized container terminals show greater growth.

The readiness of facilities and terminal performance can stimulate growth in consumption volume, production and distribution of goods and terminal activities have a positive effect on regional economic growth, and port development investment indirectly leads to economic growth[11]. The data of 50 ports/container terminals, shows that the terminal facility capacity is still utilized at 479 TEUs/m' (<50% of the terminal standard) and has the potential to be improved, as well as the loading and unloading performance is still 25.71 TEUs/Ship/Hour from the minimum standard of 20-56 TEUs/Ship/Hour (depending on the availability of equipment)[39].

The utilization indicator shows that the capacity that is still available is quite large and can still be improved to increase revenue in the sector. The performance indicator compared to the standard that is still small shows the room for improving performance that can be done by managers to accelerate the process and increase efficiency, including by modernizing equipment, implementing technology and digitalization,

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managing ship time and schedules, improving the quality of Human Resources (HR), and simplifying administrative procedures.

From the container terminal performance data, it can be seen that large terminals have a performance (BSH) of 55.03 which is higher than medium-sized terminals with an average BSH = 37.17 and small-sized terminals with an average BSH = 25.04. This shows that the performance between terminals is very different, which is greatly affected by the readiness of infrastructure, superstructure, and information systems as well as available human resources.

The performance of this terminal is in line with the average GDP of the city and the port (large: IDR 281,758.9 billion, medium: IDR 71,606.01 billion, and small: IDR 14,199.83 billion). For a terminal to be effective, the port must be efficient – namely, it must be efficient in terms of costs, which in turn requires that it must be technically efficient. For example, if a terminal is effective because its operational objectives are to maximize profits and is efficient in costs, then greater profits can be obtained for the same level of throughput service by reducing its costs to be cost-effective.

The Effect of Cities and Ports on Economic Growth Through Containerization

Cities indirectly have a positive, and significant effect on economic growth through containerization, indicating that the containerization process on the hinterland (city) side provides added value to city resources in the production/consumption and distribution (logistics) processes which will certainly increase the city's economy, but has not had a strong effect because it is related to the complexity of the multiple effects (multiplier effect) of city resources on the economy.

Likewise with the indirect effect of cities on economic growth through ports and containerization. This emphasizes the importance of integration between city resources, ports, and the containerization process and is optimized for driving the economy.

Ports indirectly have a significant effect on economic growth through containerization, indicating that efficient ports increase containerization which ultimately drives economic growth. Container terminals are part of the spatial, system, and services of the Port, and the development of container terminals is part of the development of the Port.

Container ports are critical nodes in the global supply chain and play an essential role in the growth strategies of many developing countries. Similarly, sustainable tourism initiatives contribute to economic growth by enhancing community welfare and aligning with Sustainable Development Goals (SDGs) aimed at eradicating extreme poverty by 2030 (Satia Negara Lubis & Arga Abdi Rafiud Darajat Lubis, 2024). In many cases, establishing efficient, high-quality container port infrastructure has become a prerequisite for a successful export-driven growth strategy, boosting the economic resilience of nations. Countries that focus on both container port development and sustainable tourism enjoy a compounded impact, as these investments facilitate production, expand logistics, create jobs, and increase income levels in local communities. Together, these efforts form a complementary approach to economic development, aligning national goals with global sustainability objectives to promote robust, inclusive growth across sectors [40,41]

Conclusion and Recommendation

The conclusion that can be stated from this study is that containerization has a significant and positive effect on economic growth which shows that traffic and terminal performance support economic growth and investment in container terminal facilities will directly improve the Indonesian economy and cities have a significant effect on economic growth through containerization, emphasizing the importance of cities in driving efficiency in the containerization process with investment in the right infrastructure and collaborative and comprehensive stakeholder strategies can produce significant economic benefits and sustainable development goals (SDGs). Containerization as a mediating variable, plays an important role in

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strengthening the relationship between city and port resources with economic growth for an archipelagic country like Indonesia.

Further research can be conducted by adding other dynamic indicators from independent/exogenous variables or economic growth indicators from the expenditure approach to enrich comparison with the results of this study and how the collaboration strategy should be carried out by local governments and port managers to further encourage the benefits of containerization for economic growth.

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Journal of Ecohumanism
2024
Volume: 3, No: 7, pp. 4535 – 4547
ISSN: 2752-6798 (Print) | ISSN 2752-6801 (Online)
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