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Analysis of Port Facilities and Container Flow Growth for the Development of Makassar Port, Indonesia

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Abstract

Purpose: The aim of this research is to determine the effect of port facilities and container flow growth mediated by spatial regulation on the development of Makassar Port in South Sulawesi Province.
Research Methodology: This study uses path analysis with a sample of 133 respondents from the Makassar Main Port Authority Office, Local Government of Makassar City, Pelabuhan Indonesia IV, Makassar Container Terminal, and the Directorate General of Sea Transportation.
Results: The findings show that spatial regulation does not significantly mediate the relationship between port facilities and port development. It neither strengthens nor weakens the influence of port facilities on port development. Limited land availability and poor integration with transport systems remain key constraints affecting port performance.
Conclusions: The development of Makassar Port is driven by port facilities and container flow growth, indicating the need for continuous infrastructure expansion, including Makassar New Port development. Operational readiness, especially cargo handling equipment such as gantry cranes, is essential to improve efficiency and reduce dwelling time.
Limitations: This study is limited to Makassar Port and may not be fully generalizable. It relies on questionnaire data that may contain subjective bias. It also focuses only on three variable port facilities, container flow growth, and spatial regulation without considering other factors such as economic conditions, technology, and policy changes.
Contributions: This study contributes by analyzing the mediating role of spatial regulation in port development and provides practical implications for policymakers regarding the alignment of spatial planning with port infrastructure development for sustainability.

Keywords: *Container Flow Growth, Port Development, Port Facilities, Regional Spatial Plan, Spatial Regulation*

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1. Introduction

Makassar Port in the province of South Sulawesi since then until now has a very important role in supporting domestic/national as well as international trade because of its strategic position in the midst of islands of the Unitary State of the Republic of Indonesia. Having a hierarchy as a Main Port, it is supported by the regulator with the establishment of the Makassar Main Port Office and Makassar Main Port Authority Office and operated by the expertised Pelabuhan Indonesia IV (Wahyuni et al., 2020;

Witte et al., 2020; Zuhdi, 2018). The Port of Makassar consists of four General Terminals: Soekarno, Hatta, Hasanuddin, and Paotere. Pelabuhan Indonesia IV built the Container Terminal of Makassar New Port stage I starting in 2015 as a new terminal in the Port of Makassar.

Based on the loading-unloading flow in Soekarno Terminal, it is seen that the pattern of cargo movement in the period of 2013-2017 experienced a decrease with an average decrease of 7.8 percent over five years, where the biggest decrease can be seen in 2014 at 14 percent (Munaf et al., 2018; Nuraeni et al., 2022). From the table of loading-unloading flow in the Hatta Terminal, it is seen that the pattern of container movement in the period of 2013-2017 experienced a decrease with an average increase of 3.1 percent over five years, where the biggest increase can be seen in 2016 as many as 9.5 percent (Hernawan et al., 2022; Mahmoudi & Mollaei, 2014).

Based on the performance indicators of the operational services of Makassar Port, it can be stated that they still fulfill the performance standard established by the Ministry of Transportation, except for the value of approach time in the Hatta Terminal. However, regarding the Berth Occupancy Ratio and the stacking yard occupation in the Hatta Terminal it is seen to have approached the predetermined limit of berthing performance (Abidin et al., 2022; Barasa et al., 2019). The increase in the global trend over the last ten years in the change of cargo delivery pattern from using conventional packaging to container is predicted to constantly increase the trend of container growth from year to year, including at the Port of Makassar. Therefore, the predicted increase in container flow in the future requires the port to consistently adjust its capacity (Ruslin, 2021; Shu et al., 2012).

Regional Spatial Plan is made as a direction of development in Makassar City implemented by taking advantage of territory space in effective, efficient, harmonious, aligned, balanced, and sustainable ways to improve society's welfare and security defense, and it is simultaneously the direction for investment in location development to be implemented by the government, society, and business circles (Pemerintah Kota Makassar, 2015). Port zoning is established by considering space utilization for port operation and development in the future, provision for the prohibition of activities in the free air space above the water body, which can affect and disrupt the sea transportation line, as well as the limitation of port space utilization in the work area or Daerah Lingkungan Kerja (DLKr) and interest area or Daerah Lingkungan Kepentingan (DLKp) of the port.

From the spatial regulation, based on the results of research in Makassar City, South Sulawesi, it can be concluded that the rapid city development takes up space in Makassar City so that the supply of space cannot fulfill the demand, causing the development to penetrate areas that should not be used as built areas, which impacts the increasing disorder of Makassar City. The procurement and operation of port service facilities begin with a plan designed based on the data of the need for infrastructure and superstructures (Lasse, 2016; Lumi & Yosef, 2022).

The 2017 Master Plan of national Port states that the growth of national cargo loading-unloading volume in the period of 2009-2014 is significant enough. The growth of container volume is driven by the pattern of cargo movement, with containerization growing up to 19.2 percent a year (from the growth of containers in the period of 2004-2009 which was only 7.9 percent a year). The rate of container growth seems to fluctuate significantly with a prominent difference between the cargo weight and TEUs, which is probably due to the movement of empty containers, although the average container weight per TEU does not change much, i.e. around 11.5-12.8 tons/TEU (Garrido et al., 2020; Ge et al., 2021; Notteboom et al., 2019).

The high growth of loading-unloading volume indicates that sea transportation remains the main backbone of transportation. The change in cargo movement pattern from conventional packaging to containers requires planning of port facilities that can serve containers (Gou & Lam, 2019; Hosseini & Al Khaled, 2021; Peng et al., 2019). Container depots are essential because, if not prepared, they will cause the container yard to be filled with empty containers (Gharehgozli et al., 2020; Gusah et al., 2019; Parmenas, 2022). Based on the 2015 Sea Highway Concept Implementation Report from the Transportation Directorate of Bappenas, it is stated that commercial ports in Indonesia have a limited depth of approximately 6-10 meters so that they can only serve container vessels around 700-1600 TEUs. In addition, the utilization of modern equipment for loading and unloading, such as container cranes, lifting cranes, and JIB cranes, has been implemented in only a small number of ports.

2. Literature Review & Hypothesis Development

2.1 Port Facilities

Port is a place consisting of land and/or water with certain boundaries as a place for government and business activities used as a place for ship berthing, passengers getting on and off, and/or cargo loading and unloading, in the form of terminals and ship berths Republik Indonesia (2008). Some previous research on the research variables has been conducted. Siahaan (2015) studied the Container Terminal in Makassar to increase wharf productivity through an approach to the quality of ship service and the speed of ship loading and unloading. In the study of Port Facilities, Abali and Echeonwu (2022) and Sinaga and Daud (2014) say that the facilities in the Port of Sibolga exceed the maximum value of the predetermined Berth Occupancy Ratio. In the Port of Tegalsari, Tegal, according to (Nurdyana et al., 2013), an agressive port development has been done by immediately adding

The basic, functional, and supporting facilities that have not yet been fulfilled; increasing the number of fleets and developing basic, functional, and supporting facilities. The cargo loading-unloading services in the Port of Bungkutoko, Kendari, according to Musyaqqat and Pradjoko (2020) and Putra and Djalante (2016), are still poor because the ratio between waiting time and service time is still very high.

2.2 Growth of Container Flow

The result of another study by Ruslin (2021) in the Soekarno-Hatta Container Terminal in the Port of Makassar indicates that the performance of the container terminal wharf in the existing condition is good because it is under the standard suggested by UNCTAD with an achieved Berth Occupancy Ratio of 56.4 percent. The same occurs in the stacking yard, where the value of YOR is 34.7 percent. In the research of Container Terminal in Makassar New Port, the results Kasba and Paotonan (2020) and Wahida et al. (2019) indicate that there are many variables determining the Berth Occupancy Ratio, one of which is the duration of unutilized in the loading-unloading, which significantly affects the wharf occupancy ratio. In addition, an imbalance of cargo flow occurs in wide-scale small ports in Malaysia; therefore, decision makers and policy makers should identify the key factors that determine business operations (Othman et al., 2020). In addition, Solossa et al. (2013) found that the Port of Sorong, West Papua, needs improvements in cargo loading-unloading service, passenger getting on and off, ship's call, and container ship's call, which have a direct impact on the performance of port facilities for up to the next 15 years.

2.2.1 Port Development

According to Jansen et al. (2018), port development in Indonesia is to drive inclusive growth, where partnership is the missing chain between the business strategies at the micro and macro levels as the effect of the port area and economy in general. Concerning the ports in Indonesia and Austrarch of the industry investinvint more on the importance of environmental sustainability and ensure tharegulations on the the ns on environment are understood and well implemented. Dry ports have emerged as an integral part of commercial facilities in China in the last decade and have played an important role in regional and economic development (Beresford et al., 2012). The emergence of offshore ports is partly driven by their proximity to the main population center or industrial area and partly by the need to support the fast-growing container flow (Sdoukopoulos & Boile, 2020; Yan et al., 2021). Another study on port development Taneja et al. (2020) shows that in many port projects being planned in Indonesia, technical feasibility and mangroves as wave breakers can improve the nature of environmental added value. Kartohardjono and Buwono (2012) explains it is expected that the determination of the area of Sedau

The terminal, as an extension of Singkawang Port, West Kalimantan, can enhance port activities because of the strategic role of the port in area development. The result of study in the Port of Sabang, Aceh, Arahman et al. (2018) indicates that the main factor determining the selection of alternative location for the port development isEnvironmental conditions. In contrast, in the Port of Sibolga, North Sumatera, the long-term development plan is prepared by zoning and layout through physical and operational separation between the general cargo terminal, conventional container terminal, and passenger terminal (Arianto, 2017).

The aim of this research is to know the justification for the development of Makassar Port by developing Container Terminal of Makassar New Port and determining the need for port facilities and container flow growth against the development of Makassar Port by considering regional spatial suitability. The projected target in the port master plan with the realization indicates a negative gap, meaning that the realization is under the projected port development plan, and it is predicted to have an impact on the change in the container handling plan in the Port of Makassar.

2.3 Hypothesis Development

Therefore, the following hypotheses are proposed:

- H_1: The determination of Port Facilities (X1) toward Port Development (Y).
- H_2: The determination of Container Flow Growth (X2) toward Port Development (Y).
- H_3: The determination of Port Facilities (X1) toward Container Flow Growth (X2).
- H_4: The determination of Port Facilities (X1) toward Port Development (Y) mediated by Spatial Regulation (X3).

The determination of Port Facilities and Container Flow Growth in the Hatta Terminal through the Moderator of Spatial Regulation toward the Development of Makassar Port, systematically illustrates the relationship between independent and dependent variables that can be depicted in a model of structural relationships among variables (Figure 1).

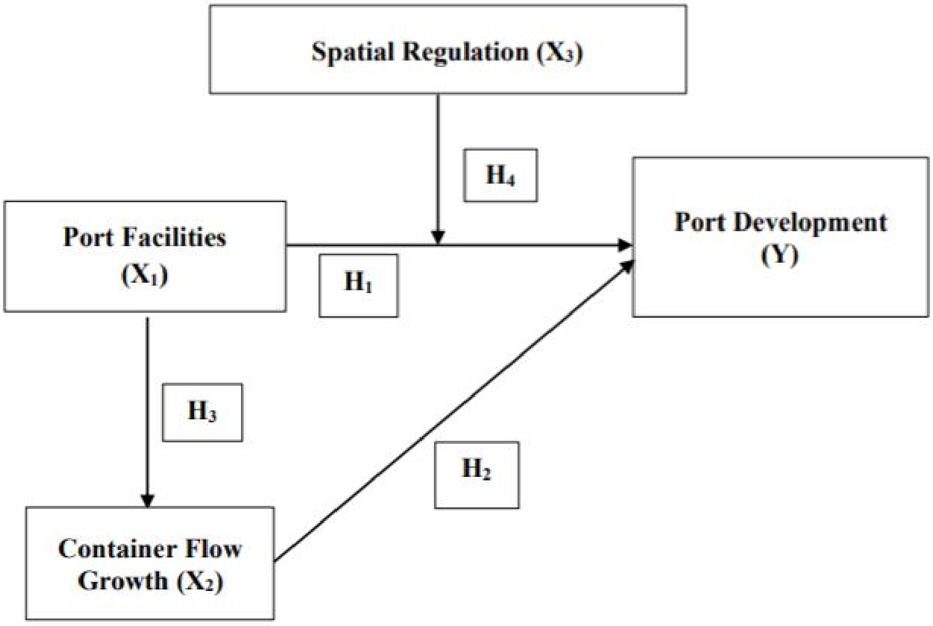

Figure 1. Research Model

3. Methodology

3.1 Research Design

This study employs a quantitative research design using path analysis to examine the causal relationships among variables. A moderating variable (spatial regulation) is included to assess its role in strengthening or weakening the relationship between independent and dependent variables. The study also applies Moderated Regression Analysis (MRA) as an extension of multiple linear regression to test interaction effects among variables.

3.2 Data Collection

The population consists of all stakeholders involved in the operation of Hatta Terminal, totaling 199 individuals from institutions such as the Makassar Main Port Authority Office, Local Government of Makassar City, Pelabuhan Indonesia IV (Persero), Makassar Container Terminal, Port Directorate, and the Directorate General of Sea Transportation. A sample of 133 respondents was selected using stratified random sampling, including directors, structural officials, and relevant employees. Data were collected primarily through questionnaires. Additional secondary data related to spatial regulation were obtained from the Regional Spatial Plan of Makassar City and South Sulawesi Province, as well as the Makassar Port Master Plan for validation and cross-checking.

3.3 Data Analysis

Data analysis began with assumption testing, including validity and reliability tests. After meeting the required assumptions, path analysis was conducted to estimate causal relationships among variables. Moderated Regression Analysis (MRA) was applied to examine the interaction effects of the moderating variable. Hypothesis testing was carried out using t-tests and F-tests. Path analysis, as an extension of multiple regression, was used to evaluate both direct and indirect effects among variables based on the proposed theoretical model.

4. Results and Discussion

4.1 Results

4.1.1 Path Analysis Testing

The result of the ANOVA test or F-test shows that the value of Fstatistic is 18.033; therefore, the regression model is stated to be significant and can be used to predict among variables, which all together have a determination toward Port Development (Y). In the significance test of the Partial Model or t-test, it indicates that Variable X_3, that is Spatial Regulation, gives a coefficient value as many as negative 0.207 at the significance level $0.812 > 0.05$. Thus, it can be interpreted that the Moderating Variable of Spatial Regulation (X_3) is not significant in determining Port Development (Y). The negative value indicates that the effect of moderation tends to weaken the determination of Port Facilities toward Port Development. The insignificance of the Spatial Regulation coefficient with sig 0.812 indicates that the variable of Spatial Regulation (X_3) is a genuine moderating variable and cannot be placed as an independent variable.

The interpretation is strengthened by the coefficient value of determination (R^2) from the calculation in the second regression equation after the Moderating Variable X_3, namely spatial regulation, with the value of R^2 is 0.295, then the variable of spatial regulation (X_3) as the moderating variable does not determine whether strengthening or weakening. Therefore, it can be stated that H_0 is accepted, so that the variable of Spatial Regulation does not have a determination for the variable of Port Facilities (X_1) toward Port Development (Y).

The calculation of correlation coefficient has resulted in the correlation value among variables as follows (Table 1).

Table 1. Matrix of Correlation Coefficient among Variables Correlations

		Port Development	**Port Facilities**	**Container Flow Growth**	**Spatial regulation**
Port Development	Pearson Correlation	1	.543**	.383**	.044
	Sig. (2-tailed)		.000	.000	.617
	N	133	133	133	133
Port Facilities	Pearson Correlation	.543**	1	.444**	.103
	Sig. (2-tailed)	.000		.000	.236
	N	133	133	133	133
Container Flow Growth	Pearson Correlation	.383**	.444**	1	.103
	Sig. (2-tailed)	.000	.000		.137
	N	133	133	133	133
Spatial Regulation	Pearson Correlation	.044	.103	.130	1
	Sig. (2-tailed)	.617	.236	.137	
	N	133	133	133	133

**. *Correlation is significant at the 0.01 level (2-tailed).*

From Table 1 it can be seen that there is a medium correlation, with the value of Pearson Correlation between 0.41 to 0.60 in all the variables tested.

4.1.2 Calculation of Path Coefficient in Sub Structure 1

The causal relationship between the variables in sub structure 1 consists of one endogenous variable, namely Port Development (Y), and two exogenous variables, namely Port Facilities (X_1) and Container Flow Growth (X_2). The equation for Substructure 1 with a causal relationship between the variables is shown in Figure 2.

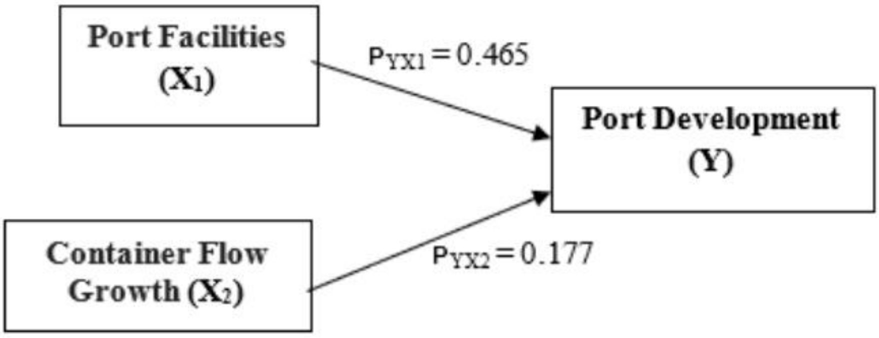

Figure 2. The Path Diagram of Sub Structure 1

4.1.3 Determination of Port Facilities (X1) toward Port Development (Y)

Based on the calculation that has been done, it can be known that the value of path coefficient P_{YX_2} is 0.177 with tstatistic 2.192 and ttable 1.657. Therefore, the value of tstatistic is 2.192 > 1.657. The value of the determination coefficient (R^2) is 0.147, which means that the determination contribution of container flow growth to port development is 14.7 percent, meaning that H_0 is rejected and the path coefficient is significant. Based on this result, it can be interpreted that Container Flow Growth (X_2) has a significant direct effect on Port Development (Y).

4.1.4 Determination of Container Flow Growth (X_2) toward Port Development (Y)

Based on the calculation that has been done, it can be known that the value of path coefficient P_{YX_2} is 0.177 with tstatistic 2.192 and ttable 1.657. Therefore, the value of tstatistic is 2.192 > 1.657. The value of the determination coefficient (R^2) is 0.147, which means that the determination contribution of container flow growth to port development is 14.7 percent, meaning that H_0 is rejected and the path coefficient is significant. Based on this result, it can be interpreted that Container Flow Growth (X_2) has a significant direct effect on Port Development (Y).

The causal relationship between variables in substructure 1 consists of one endogenous variable, namely Y (Port Development), and two exogenous variables, namely X_1 (Port Facilities) and X_2 (Container Flow Growth). The value of path coefficient X_1 toward Y as big as P_{YX_1} is 0.465, and X_2 toward Y as big as P_{YX_2} is 0.177. The calculation of the residual coefficient obtained a value of 0.825. The data processing result of the causal relationship in substructure 1 shows that the value of the Determination Coefficient (R^2) of the Port Facilities variable (X_1) for Port Development (Y) is 0.295.

4.1.5 Calculation of Path Coefficient in Sub Structure 2

The causal relationship happening between variables in sub structure 2 consists of one endogenous variable, namely X_2 (Container FlowGrowtht),) and one exogenous variable, namely X_1 (Port Facilities). The causal relationship between the variables in Substructure 2 is depicted inb Figure 2.

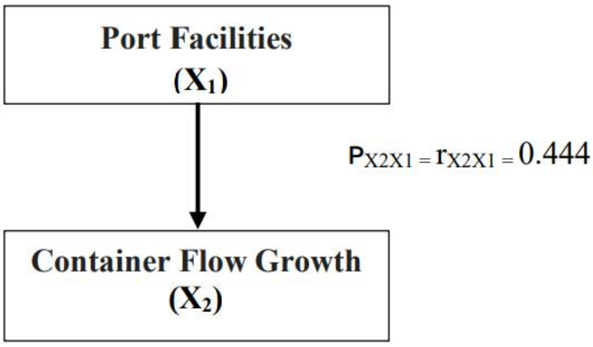

Figure 3. The Path Diagram of Sub Structure 2

The causal relationship between variables in substructure 2 consists of one endogenous variable, namely X_2 (Container Flow Growth), and one exogenous variable, namely X_1 (Port Facilities).

4.1.6 Determination of Port Facilities (X_1) toward Container Flow Growth (X_2)

Based on the calculation that has been done, it can be known that the value of path coefficient X_1 to X_2 as big as $P_{X_2X_1}$ is 0.444 with tstatistic 5.671 and ttable 1.657. The value of the determination coefficient (R^2) is 0.197, which means that the determination contribution of port facilities to container flow growth is 19.7 percent, meaning that H_0 is rejected and the path coefficient is significant. Based on this result, it can be interpreted that Port Facilities (X_1) have a significant direct effect on Container Flow Growth (X_2).

4.1.7 Calculation of Path Interaction Test on the Variable of Spatial Regulation

Variable X_3 (Spatial Regulation) is predicted to determine the relationship between Variable X_1 (Port Facilities) and Variable Y (Port Development), where the variable will strengthen or even weaken the determination between the variables moderated. Two steps of analysis are required to determine this relationship. First, the determination of Variable X_1 (Port Facilities) to Variable Y (Port Development) is analyzed to determine the strength of their relationship. Further analysis is conducted by adding variable X_3 (Spatial Regulation) as a moderating variable to the steps of analysis to determine whether Variable X_3 (Spatial Regulation) strengthens or weakens the relationship between Variable X_1 (Port Facilities) and Y (Port Development).

Based on the path calculation in sub structure 1, sub structure 2, and the calculation of path interaction test of moderating variable X_3, the whole path diagram of variables X_1, X_2, and X_3 toward Y can be depicted as in Figure 4.

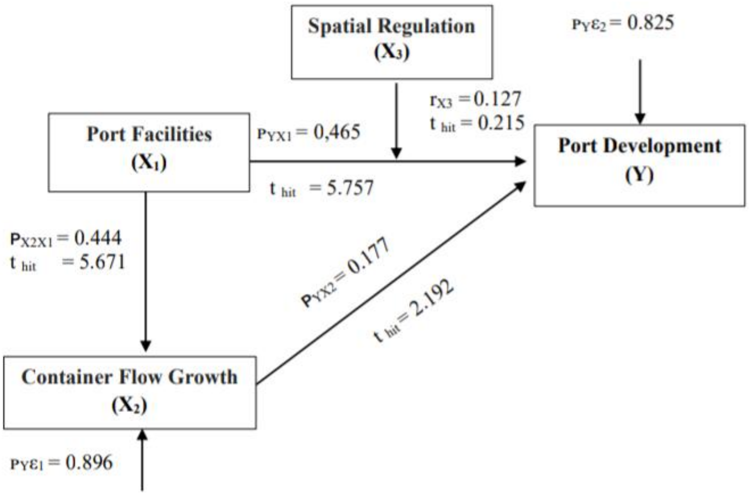

Figure 4. Path Diagram of Variables X_1, X_2, and X_3 toward Y

4.1.8 Determination of Port Facilities (X_1) toward Port Development (Y) mediated by Spatial Regulation (Y)

Based on the tests and analyses that have been conducted, the findings of this research indicate that spatial regulation is one of the variables that has no determination, neither strengthening nor weakening the relationship between port facilities and port development, so that the research hypothesis H_0 is accepted, with the coefficient value negative 0.207 at the significance level $0.812 > 0.05$. A negative value indicates that the moderating effect tends to weaken the determination of port facilities for port development. The insignificant coefficient of Spatial Regulation (the sig is 0.812) indicates that the variable of Spatial Regulation (X_3) is a genuine moderating variable and cannot be placed as an independent variable. The interpretation is strengthened by the coefficient value of determination (R^2) that has been calculated in the second regression equation after the

The moderating Variable of Spatial Regulation is included in the equation, with the value of R^2 being 0.295, so that the value is the same as the value of R^2 before the moderating variable is included. To help determine a hypothesis, a test is carried out by comparing the calculation statistic and the table statistic, in which to determine the value of t table in this research, distribution table of t is used to set the level of significance.

The calculation of the path coefficient is summarized in Table **??**.

Table 2. Summary of Path Coefficient Calculations

Path	Path Coef	t-statistic	t-table alpha = 0.05	alpha = 0.01
P_{YX_1}	0.465	5.757	1.657	2.356
P_{YX_2}	0.177	2.192	1.657	2.356
$P_{X_2X_1}$	0.444	5.671	1.657	2.356
r_{X_3}	0.127	0.215	1.657	2.356

4.1.9 Hypothethical Test

Table 3. Summary of Path Coefficient Calculations

No	Hypothesis	Sig.	Conclusion
1	Port Facilities toward Port Development	0.000	Having a direct determination (positive)
2	Container Flow Growth toward Port Development	0.000	Having a direct determination (positive)
3	Port Facilities toward Container Flow Growth Port	0.000	Having a direct determination (positive)
4	Port Facilities toward Port Development mediated by Spatial Regulation	0.812	Having no direct determination

4.2 Discussion

4.2.1 Port Facilities and Port Development

Based on the hypothetical tests, Port Facilities have a significant direct determination toward Port Development. Port facilities are a factor that has a positive direct determination toward port development, so that both the port administrator and port operator should pay attention to the availability, adequacy, and readiness of port facilities according to the level of operation that must be provided by the port as mentioned in the port development plan. The hypothesis in this research concerning Port Facilities and Port Development is in line with the study Nurdyana et al. (2013) in the Port of Sunda Kelapa, North Jakarta, and the Port of Tegal, Central Java, stating that some of the port facilities are in good conditions and satisfying but there are several service factors that must be improved such as the arrangement and condition of the temporary parking area, in-out access, wharf, warehouse, stacking yard. The result of another research Farikin et al. (2015) mentions that the condition of the facilities of Nusantara Fishing Port of Prigi is good enough because the facilities are well maintained and still in good conditions. Thus, the result of research based on this theory supports the result of the previous research. It means that Port Facilities have a significant direct determination toward Port Development.

4.2.2 Container Flow Growth and Port Development

Based on the hypothetical test, Container Flow Growth has a significant direct effect on Port Development. Container Flow Growth is a factor that has a positive direct effect on port development. It would be better if the rate of container flow growth becomes a factor to be considered in calculating the estimated sea transport services in the port development plan.

Related to the hypothesis in this research concerning Container Flow Growth and Port Development, an evaluation was conducted by projecting the growth of ship and container flows from 2018 to 2030 in the Container Terminal of Boom Baru Port, Palembang. According to Situmorang and Buchari (2015), the utilization of a wharf is high enough, and ships must wait for berthing at the wharf because the stacking yard can no longer accommodate the flow of all containers. The result of another research in the Port of Biak, according to Arianto (2014), indicates that between 2030 and 2035, it will need an additional unit of new dock mooring as long as 130 m, based on the predicted volume of container loading and unloading. Thus, the result of research based on this theory supports the result of the previous research. This means that Container Flow Growth has a significant direct effect on Port Development.

4.2.3 Port Facilities and Container Flow Growth

Based on the hypothetical test, Port facilities have a significant direct determination toward Container Flow Growth. Port facilities are a factor that has a positive direct determination toward container flow growth; therefore, the researchers recommend that the change in the global trend in cargo movement using containers must be supported and anticipated by providing port facilities that can serve the growth of container flow in accordance with the capacity to be served.

The hypothesis in this research concerning port facilities and container flow growth supports the research conducted at the Container Terminal of Makassar New Port. According to Arahman et al. (2018), additional loading and unloading equipment is needed for long-term use, in line with the need for container handling facilities. This hypothesis is also in line with another study at the wharf of the Container Terminal of Makassar New Port Wahida et al. (2019), which calculates the occupation rate of the container yard and wharf and determines the facility planning in line with the need up to 2039. Thus, the results of this study based on this theory support the results of previous research. This means that Port Facilities have a significant direct effect on Container Flow Growth.

4.2.4 Port Facilities, Port Development and Spatial Regulation

The hypothetical test gives port facilities a weakening determination toward port development. Spatial regulation in this study does not prove to have a determination for port facilities toward port development, which is neither strengthening nor weakening and tends to have a negative determination. It would be better if the development of the Regional Spatial Plan considers the need for a space to build port facilities by providing a space for port development. The unavailability of space will force the optimization of port facilities in the existing port and become a negative determinant of the need for port development. Coordination with the Local Government is required to ensure that spatial regulations support port development.

The hypothesis in this research concerning Port Facilities, Port Development, and Spatial Regulation is in line with the result of previous research by Putra and Djalante (2016), which states that based on the condition of wharf facilities and the stacking yard in the Port of Bungkutoko, Kendari, South-East Sulawesi, it needs a development strategy of extending the infrastructure development, that is, developing one more unit of wharf. Thus, the results of research based on this theory support the results of previous research. This means that port facilities have a negative direct effect on Port Development because port development does not always follow spatial regulations.

5. Conclusions

Based on the Makassar Port Master Plan, the Hatta Terminal currently has a container wharf that is 850 m long, which is intended to serve vessels with a maximum capacity of 3000 TEUs. It has a container yard as wide as 11.4 ha, with a maximum loading-unloading capacity of 800 thousand TEUs per year. This value is one of the parameters indicating the need for additional port facilities as a form of port development. The development of Makassar Port in the Makassar New Port by building port facilities is to anticipate the need for port facilities in the middle and long term. Such an anticipation has been taken by building the container wharf in the Hatta Terminal, and based on the data from Pelabuhan Indonesia IV, the facilities can directly increase the growth of container flow in 1998 by as many as 102 thousand TEUs at a growth rate of more than 20 percent in the first two years and more than 10 percent in the following years, reaching ± 600 thousand TEUs in 2019. Meanwhile, in order to improve the performance and operation of Makassar Container Terminal, the readiness of discharging equipment, especially Gantry Cranes, becomes a key factor in the speed of cargo movement from and onto the ship and reduces the Dwelling Time. Considering these thoughts, further efforts are needed to reveal several aspects related to this research. For example, a further study is expected to show the unrevealed things as new findings and can accomplish the results of this research.

5.1 Research Limitations

This study has several limitations that should be acknowledged. First, the research is limited to Makassar Port, which may restrict the generalizability of the findings to other ports with different characteristics and operational conditions. Second, the study relies primarily on questionnaire-based data, which may introduce subjectivity due to respondents' perceptions and judgments. Third, the analysis focuses on selected variables, namely port facilities, container flow growth, and spatial regulation, without incorporating other potentially influential factors such as economic conditions, technological advancements, and policy changes. Finally, the use of path analysis provides insight into causal relationships but may not fully capture dynamic and long-term interactions among variables

5.2 Suggestions and Directions for Future Research

Future research is recommended to expand the scope by including multiple ports across different regions to enhance the generalizability of the findings. Further studies should also incorporate additional variables such as logistics performance, digitalization, environmental sustainability, and government policy to provide a more comprehensive analysis of port development. Moreover, longitudinal studies are suggested to better understand the long-term impact of container flow growth and infrastructure development. The use of advanced analytical methods, such as Structural Equation Modeling (SEM) or system dynamics, is also encouraged to capture more complex relationships among variables. In addition, future research should explore the integration of spatial planning with port development strategies to ensure sustainable and coordinated infrastructure expansion.

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Author Contributions

DEP and MT contributed to conceptualization and data collection. DEP and YP contributed to methodology. YP and PR contributed to formal analysis. MT and YP contributed to investigation. DEP contributed to writing—original draft preparation. PR and MT contributed to writing—review and editing. PR contributed to supervision. MT and YP contributed to validation.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this study. This research was conducted independently, and no financial or personal relationships influenced the results or interpretation of the findings.

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