Just-In-Time Analysis of Port Operation in Manila

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ABSTRACT. Ports and harbors are vital transportation hubs in the Philippines, connecting the country to global markets and driving economic growth. Manila South Harbour faces issues like delays, increased taxes, shipping costs, and congestion, which arise due to its large operations. Being one of the world's busiest, it manages a significant amount of cargo daily, and effective and timely cargo movement is crucial for economic growth and competitiveness. Implementing the Just-In-Time (JIT) strategy can improve overall efficiency and customer satisfaction while reducing costs. This study simulates JIT in Matrix Laboratory utilizing Yard Utilization, Daily Truck Movement, and Container Traffic. The study focuses on the optimization capacity and efficiency of the JIT policy on the Yard Utilization. Utilizing the sample data in one equation, the researchers provided a polynomial surface fit equation. This research seeks to provide evidence-based recommendations for optimizing port operations, exploring the feasibility and potential impact of JIT approach.

KEYWORDS: Container Traffic, Customs Clearance, Just-In-Time (JIT), Yard Utilization Level, Yard Capacity, Daily Truck Movement

1. INTRODUCTION

Ports and harbors are significant modes of transportation that serve as crucial nodes for maritime and trade activities. They play a vital role in transport, ports, and harbors, serve as gateways for importing and exporting goods, connect the Philippines to global markets, and enable the country to participate in international trade. Major ports in the Philippines drive the country's economic growth and development, so if there are problems in these major infrastructures, there could be significant adverse effects on a country's economy. The Philippine archipelago possesses a great advantage in terms of port locations that enable efficient maritime connectivity and trade activities. The Manila Port is one of the biggest ports in the country, located in Manila, the capital city of the Philippines. Manila South Harbour Port, part of the Port of Manila, operates, maintains, and manages the 80-hectare (200-acre) complex. As they handle large operations, inevitable problems emerge throughout these years, which cause delays in logistics and cargo operations, increases in taxes and shipping costs, and congestion in container terminals [13].

In ports, cargo operations refer to the handling, loading, and unloading of goods from ships, and these are managed by port authorities, terminal operators, and stevedoring companies. The primary port activities in terminals are loading and unloading cargo, the embarkation and disembarkation of passengers, ancillary services, the facilitation of ship arrival and departure, and the short-term storage of cargo in the yard to maintain regular stockings[14]. In addition, The Philippine Ports Authority (PPA) imposes fees on cargoes to use port facilities. All non-containerized international shipments passing via a government-owned wharf for import, export, or transshipment will be assessed wharfage based on the total metric or revenue tonnage.

This study focuses on implementing a Just-In-Time Policy as an improved strategy. A significant improvement in cargo operations, taxes, shipping, and storage difficulties in Manila South Harbour Port might be achieved with the help of the Just-In-Time System. The Just-In-Time strategy reduces inventory levels and eliminates lead times by coordinating the production and logistics processes. It also eliminates inventory to reduce costs associated with unnecessary handling and storage, and it positively impacts the environment by reducing the amount of waste produced, improving resource efficiency, and reducing emissions from transportation and storage.

Terminal Appointment Booking System (TABS)
(According to Administrative Order no. 2006 - 2018)

The South Harbor of Manila Port is currently implementing the Terminal Appointment Booking System (TABS) as a result of the economic blowout last 2014 due to massive Container and Port Congestion. The TABS' purpose is to rationalize the delivery and withdrawal of cargo to and from Manila Ports, specifically in South Harbor. Under the Authority of Article IV, Section 6-a (III) and (X) of Presidential Decree No. 857, as amended and Board Resolution No. 2678. Terminal Appointment Booking System (TABS) is a system that enables trucking firms and logistics providers to reserve appointments for container pick-up or delivery. By scheduling appointments, the system can regulate the arrival of trucks throughout the day, improving efficiency and preventing congestion during peak hours. The system also helps to optimize terminal resources by evenly distributing truck arrivals, leading to better utilization of labor and equipment and improved efficiency in container handling operations. By reducing congestion and wait times at the terminal gates, the Terminal Appointment Booking System (TABS) enhances operational efficiency for both terminal operators and trucking companies. It is a valuable tool that has significantly improved the efficiency and transparency of cargo handling at the Manila South Harbor port. It is a prime example of how technology can be used to modernize port operations and benefit all stakeholders involved in the shipping industry.

1.1 Background of the Study

The Manila South Harbour Port in the Philippines manages a substantial amount of cargo daily, making it one of the busiest ports in the world. It is necessary for both economic growth and competitiveness that commodities be moved through the port in a manner that is both effective and on schedule. It is widely acknowledged that the Just-In-Time (JIT) strategy is efficient for boosting operating efficiency, cutting costs, and increasing customer satisfaction. This study aims to investigate the details behind the Just-in-Time (JIT) strategy and the possible benefits of implementing it at the Manila South Harbour Port. The Port of Manila, despite its status as a major port, is plagued by several difficulties that drag down its total performance. These concerns include congestion, delays, inefficient cargo handling systems, and inventory management problems. Due to these issues, operating costs have climbed, productivity has decreased, and customers have become dissatisfied. Getting these issues under control necessitates taking an all-encompassing and systematic approach, which is accomplished through the utilization of the JIT strategy.

1.2 Statement of the Problem

The study's main objective is to Assess the effects of the Just-In-Time Policy as an improved system for the Manila South Harbour Port of the Philippines for improvement and solve the issues of congestion, Yard Utilization Level, Container Traffic, and Yard Capacity

Particularly, the study will address the following issues:

1. The Manila South Harbour Port experienced port congestion concerning the increase in Yard Utilization Rate.
2. The customs clearance process at the Manila South Harbour Port is often slow and bureaucratic, causing delays in releasing imported goods and increasing the risk of corruption.
3. The storage cost increased due to the additional fees for unclaimed containers and the delay of the shipping process.
4. The congestion of Manila South Harbour Port affects other ports, which results in a ripple effect.

1.3 Objectives

In relation to the main objective, the implementation of the Just-In-Time strategy as an improved policy for the Manila South Harbour Port of the Philippines has the following specific objectives that address the statement of the problem of the study:

1. Determine the specified costs of the Manila South Harbour Port in handling containers and cargoes.
2. Assess the effectiveness of Just in Time (JIT) implementation in the Yard Utilization Rate of Manila South Harbor.
3. Evaluate how an improved policy in the Manila South Harbour impacts the

efficiency and productivity of logistics. Determine the customs clearance process and requirements for container cargo at the Manila South Harbour Port.

1.4 Significance of the Study

The simulation of the Just-In-Time System is a notable recommendation to improve the Yard Utilization and Customs Clearance in Manila South Harbour Port. In view of this, the acquired results of this study would benefit South Harbour by increasing the overall efficiency, which helps to simplify processes, remove waste, and reduce costs. This results in quicker processing times for cargo, decreased congestion, and improved turnaround times for ships, all of which enhance production levels. JIT implementation stimulates collaboration and information sharing among many stakeholders, such as shipping lines, port operators, customs authorities, and logistics providers. This results in performance improvements along the supply chain. This partnership contributes to achieving a more synchronized and responsive supply chain, ultimately resulting in the timely delivery of goods to their destinations.

The JIT method, if implemented at the Manila South Harbour Port, can potentially increase the port's level of competitiveness in the context of the international trade environment. Shipping lines, exporters, and importers that value speedier and more dependable cargo processing are all potential customers for a port infrastructure that is more efficient and responsive. A port that operates efficiently has a significant influence on the economy of the nation. Cost reductions, more significant trade flows, and expanded company opportunities can all be attained through the effective management of cargo and the shortening of lead times. The utilization of JIT in the Port of Manila can contribute to economic growth by easing the flow of commercial transactions, thereby making the surrounding environment more inviting to business investment and startup activity.

1.5 Scope and Limitations

The study solely focuses on the Manila South Harbour Port and the particular problems concerning the Yard Utilization level, Yard capacity, Container Traffic, and Daily Truck Movement. The research concentrates only on Manila South Harbour Port and only looks at other ports. In addition, the scope of the investigation is limited to the Just-In-Time (JIT) Policy for investigation of the effects of this management strategy on the cost considerations indicated earlier. Other port operations and logistics facets are outside this study's purview and won't be covered in any of its subsequent discussions.

1.6 Literature Review

Although the Just-In-Time (JIT) policy is not currently implemented in port operations at Manila, this study aims to analyze its feasibility in this context. By examining the dynamics of various logistics and supply chain practices, the researchers can identify potential benefits and challenges of adopting JIT in ports. This literature review provides a foundational understanding that supports our exploration of JIT's applicability and effectiveness in port operations.

The manufacturing industry has long used various approaches to cut costs, improve quality, and increase productivity. One of the most effective management approaches is Just In Time (JIT), which originated in Japan in the 1950s and was adopted by Toyota and other manufacturing establishments. JIT has proven to be successful in raising productivity by eliminating waste and reducing excess inventory. As defined by Toyota, waste is anything other than the minimum amount of equipment, materials, parts, and workers required for production. JIT aims to continuously improve processes to achieve the ultimate goal of producing goods or services without any waste (Mazanai, M. 2012). For any organization, it's essential to assess how efficient their management is, as this can significantly impact their socioeconomic status and growth. According to research, using multiple theories can provide more detailed knowledge and insights into practices. A model for JIT distribution in supply-chain management is developed and solved by Farahani, R. Z., and Elahipanah, M. (2008). The distribution network of a three-tiered supply chain is modeled using a bi-objective function, with the twin goals of reducing inventory levels and costs. In a multi-time-period, multi-product, and multi-channel supply chain, delivery lag times and capacity limits are taken into account. This model of mixed-integer linear programming is solved using a hybrid non-dominated sorting genetic algorithm for large-scale issues. Fundamental logistical operations like inventory control and distribution planning have a large impact on supply chain expenses but a disproportionately large impact on the quality of service provided to clients. Each supplier is responsible for supplying the appropriate quantity of goods at the specified time and location in accordance with JIT policy. Having a system in place that can ensure stores receive their stock on time, despite limitations in capacity, is crucial.

2. METHODOLOGY

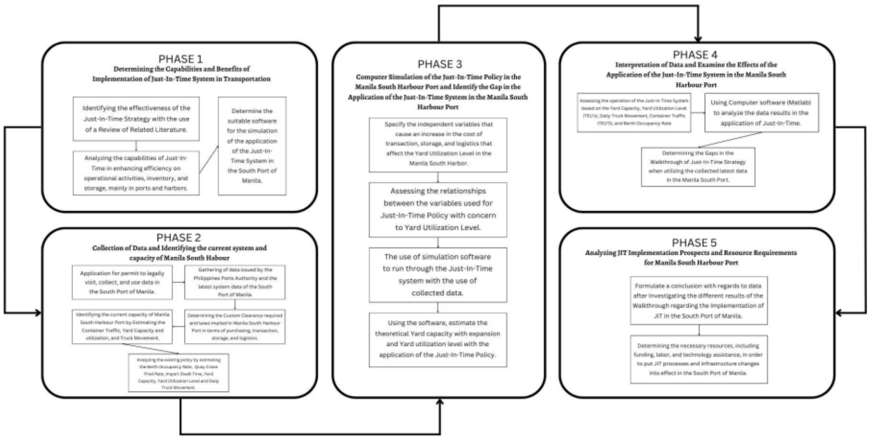
In the following chapter, the researchers delve into the approach of simulating the Just-In-Time (JIT) strategy as an improved policy for the Manila South Harbour of the Philippines. This chapter provides a complete understanding of the stages required in adopting the JIT strategy and revolutionizing the operations at one of the busiest ports in the world by establishing a systematic approach to the implementation process and providing an overview of the steps involved.

This chapter focuses on how the necessary variables are gathered and the methods the researchers used to carry out the study to achieve the overarching goal. In accomplishing the study's primary purpose, the researchers discussed the processes of evaluating and analyzing the data gathered. This chapter detailed how the research is carried out from beginning to end, including each phase and cycle. Last but not least, the data-gathering procedure, the data-gathering instrument, and the statistical treatment all define the steps taken to process raw data to produce a new one.

2.1 Conceptual Framework

The conceptual framework serves as a guide and provides the Manila South Harbour Port with an organized method for properly implementing JIT. It highlights the necessity for an integrated strategy by highlighting the relationship between process improvement and technological integration. The Port of Manila will improve its operating efficiency by adhering to this structure, lowering congestion levels, and minimizing delays.

Figure 1. Conceptual Framework



2.2 Research Design

In this study, the Just-In-Time Analysis of Port Operation in Manila South Harbour Port utilized a Quantitative Research design. The current state of the Manila Port system was evaluated through descriptive research since the study requires analysis of existing data, observations, surveys, and interviews. The Descriptive Research aided the researchers by providing a comprehensive understanding of the existing system before implementing Just-In-Time. In addition, the impact of JIT implementation on the port's efficiency and effectiveness was assessed through a quasi-experimental design and compared the port's performance before and after implementing Just-In-Time. This involved collecting data on port performance indicators, such as Yard Utilization Level, Yard Utilization Capacity, Container Traffic, and Daily Truck Movements, both before and after the implementation of JIT. The combination of descriptive and quasi-experimental methods is significant in having accurate and timely results to assess the effects of the Just-In-Time strategy as an improved system for the South Port of Manila.

2.3 Statistical Treatment

The first phase involved determining the capabilities and benefits of implementing the JIT system in transportation, which gives the idea of using Matlab software that can be used to simulate the study. Moreover, in this phase, the researchers thoroughly comprehend the information and variables involved in the study. The researchers chose MATLAB as a software solution for simulation due to its powerful computational abilities, flexibility in handling complex models, real-time integration, and ease of use in developing JIT analysis simulations to the port operations in Port of Manila. It allows for the rapid development and testing of mathematical models that simulate complex port operations such as yard utilization, cargo handling, and daily truck movement, all crucial for optimizing efficiency in a JIT context. The key evaluation criteria for selecting MATLAB included its flexibility in modeling complex systems, scalability, and performance accuracy. Comparative analyses against other simulation software confirmed that MATLAB's ability to handle real-time data, combined with its visualization tools, makes it the best-suited option for improving operational efficiency and decision-making in Manila's port operations.

In the second phase, the researchers gathered the necessary data from the identified variables, namely the dependent, independent, and mediating variables. In this phase, the data are collected through requesting data, physical visits, surveys, and interviews. The first phase utilized descriptive statistics to filter and interpret data for the study. Stage 3 and Stage 5 in Phase 2 used multiple linear regression in analyzing the suitable variables for the simulation of The just-in-time policy in Matlab. The study is currently a proposal, therefore, no actual activity-based analysis has been conducted to assess customs clearance procedures. The proposal sets the groundwork for these analyses, identifying critical factors and potential areas for improvement. In the third phase, the variable was identified, and researchers used Matlab to test or walk through the JIT system in the South Port of Manila. At the same time, the researchers identified the gap in applying the JIT system in the Port of Manila. The study employs a scenario-based approach to assess the efficiency and bottlenecks in port processes, particularly cargo handling and efficiency port operations. Each scenario is crafted to reflect realistic challenges that could affect the timely processing of cargo, helping to pinpoint potential inefficiencies and areas for improvement. The analysis highlights how these factors can impact the seamless flow of goods and services, directly influencing overall supply chain performance. The scenario-based JIT analysis provides a proactive framework that can guide policymakers and port authorities in making data-driven decisions to optimize the efficiency of Manila's port operations, ensuring smoother, faster, and more reliable cargo handling processes that support the overall growth of the economy.

In the fourth phase, the researchers assessed the variables and interpreted the necessary data from the Philippine Ports Authority (PPA), surveys, physical visits, and interviews. The researcher used a statistical tool, namely the Quasi-Experimental. Quasi-Experimental Research was one of the statistical approaches since the researchers are interested in investigating the connection between the execution of the JIT approach and the essential result variables. For instance, a quasi-experimental can be performed to establish how implementing JIT affects aspects such as the efficiency of ports, the changes in Yard Utilization, or Container Traffic. In this analysis, researchers adjusted for other variables that distort their findings and evaluated the unique impact of the JIT technique. The Quasi-Experimental is applied to the 2nd and 3rd stages of the 4th phase, while the 3rd stage will use multiple linear regression. In the study, several critical parameters were selected and estimated to accurately model and evaluate the efficiency of port operations and other aspects in the port such as logistics and supply chain. These parameters typically include time-based metrics such as the average handling time for cargo, daily tuck movement, container dwell times, and intermodal transfer times. Other factors, such as port capacity, and peak and off-peak traffic volumes, were also taken into account. The selection of these parameters was driven by their direct impact on the timing and flow of cargo through the port, aligning with the JIT philosophy of minimizing delays and ensuring that goods are processed at the exact moment they are needed.

This statistical treatment utilizes the dependent variable: Yard Utilization level. At the same time, we assessed the independent variables such as Daily Truck Movement, Container Traffic, and Yard Capacity. The study includes mediating variables: Custom Clearance, Tariff fees, and Booking schedules since it introduced delays and additional costs, potentially disrupting the precise timing required for optimal yard utilization.In this phase, the researchers formulated a summary report after investigating the connection between the execution of the JIT approach and the essential result variables and the different results of the walkthrough regarding the implementation of JIT in the South Port of Manila. Based on this study, the port operations can improve efficiency by cargo handling with processing needs. However, its implementation faces challenges due to bureaucratic customs clearance, long-standing operational habits, and localized corruption. To succeed, a shift in mindset among stakeholders, including port managers and frontline workers, is needed. The local infrastructure may not be fully equipped to handle the rapid coordination demanded by JIT systems. A comprehensive strategy that includes cultural adaptation, retraining, and gradual systemic reforms is needed to overcome these challenges.

Equation 1. The polynomial fit surface equation for Just In Time

$$f(x, y) = p00 + p10(x) + p01(y) + p20(x\ ) + p11(x)(y) + p02(y)$$

where,

x : Container Traffic
y : Daily Truck Movement
f(x,y):Yard Utilization
Level

In this simulation, the researchers created a model based on the data gathered and formulated an equation to be analyzed based on Just In Time. The researchers chose the nonlinear equation, specifically the polynomial surface, as it demonstrated that the significance value was more crucial than that of the linear equation based on the MATLAB simulation. Moreover, the researchers tested different equations, such as the linear equation, but the results were more significant with the polynomial surface.The researchers derived this formula to predict the yard utilization level that can be simulated in Just In Time. The x-value is the Container Traffic while the y-value is Daily Truck Movement, and the z-value or the variable that will be predicted is Yard Utilization Level.

3. RESULTS AND DISCUSSION

3.1 Custom Information of Manila Port South Harbor

The Bureau of Customs (BOC), operating with the Department of Finance (DOF), is mandated with executing efficient revenue collection, prevention, and suppression of smuggling and entry of prohibited imported goods, supervising and controlling the entrance and clearance of vessels, and engaged in foreign commerce, and enforces the Tariff and Customs Code of the Philippines, along with all other pertinent laws, rules, and regulations related to tariff and customs administration.

Customs Codes and Decrees according to Supreme Court Library:

- Section 105 of the Tariff and Customs Code
- Item# of Section 204 of the National Internal Revenue Code 1077
- CMO No. 43-89 defines the specific coverage of the regulations concerning tax and duty-free importation of Foreign Embassies, international institutions and consulates.
- CMO No. 41-89 provides the release of all diplomatic shipments, which may only be effected upon presentation of the documents required by said regulations.

- CMO No 47-2009 provides guidelines to cover the importation of donated relief goods/articles/equipment intended for distribution to calamity-declared areas and victims of disasters/calamities.

Table 1. Certificate Application Procedure for Import according to the Product/Cargo

Rice	National Food Authority
Sugar	Sugar Regulatory Administration
Radios and Communication Equipment	National Telecommunication Commission
Food, Drugs and Processed Goods	Bureau of Food and Drugs
Medical Equipment and Supplies	Bureau of Health Devices and Technology
Vehicles and Spare Parts	Environmental Management Bureau

Regarding importing cargo in the Philippines, different government agencies are mandated to ensure that the products/cargo are safe and legal. The government agencies provide documents or legal permits for the importers and have transaction costs.

3.2 Analyzation of Berth Occupancy Rate, Quay Crane Productivity Rate, Import Dwell Time, Yard Capacity, Yard Utilization Level, and Daily Truck Movement

Illustration 1. Floor Layout Plan of Manila South Harbour Port

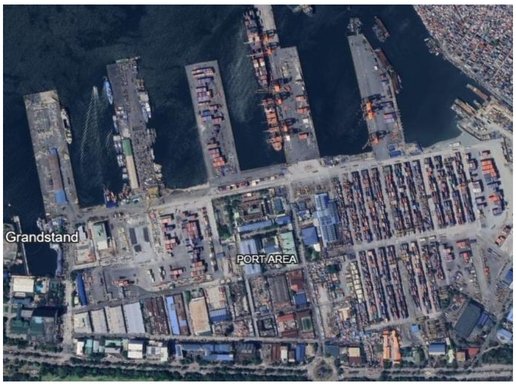


Table 2. Terminal Information

Berths	5
Depth	12m
Quay Cranes	9
RTGs	23

Others Equipment	Side loaders, Reach Stackers, Internal Transfer Vehicles, Forklifts
Reefer Outlets	260
Truck slots	250
Annual Capacity	+1.2M TEUs
System	Navis Sparcs

ATI's Container Terminal Division (CTD) stands as a significant international trade gateway in the Philippines, aligning itself with global safety, security, technology, and efficiency standards. Operating along Piers 3 and 5, the CTD delivers 24/7 arrastre and stevedoring services to international shipping lines, utilizing five working berths with a draft of 12 meters. The efficiency of port operations is attributed to modern planning and operational systems, coupled with highly skilled personnel possessing global and local experience.

The container terminal boasts nine ship-to-shore cranes, 23 modern rubber-tired gantries (RTGs), internal transfer vehicles, and other handling equipment, all optimized to provide exceptional customer service. Well-defined yards for laden and empty boxes, dedicated areas for reefer and dangerous cargoes, and support facilities for various services such as stripping and stuffing, container freight, x-ray examinations, and truck marshaling are also integral to the facility's infrastructure. South Harbor incorporates multiple access gates with weighbridges, automated truck queuing, call-up systems to enhance traffic flow, and radiation detection portals for cargo security.

Table 3. Handling Figures for 2020

Vessel Calls	4,291
Container Traffic (TEUs)	1,042,120 TEU

Table 4. Handling Figures Bulk and Break Bulk for 2020

Bulk (MT)	881,257 MT
Break bulk (MT)	1,102,197 MT

Table 5. Annual Average Daily Traffic at Roxas Boulevard (R:1) from 2019-2022

	Truck	**Trailers**	**Cars**	**Others (PUVs, MCs, etc)**	**Total**
2019	975	3,079	121,467	78,061	203,582
2020	1,158	2,501	105,863	81,104	190,626
2021	3,076	1,849	95,063	109,351	209,339
2022	1,077	2,050	90,400	92,552	186,079

3.3 Port Tariff at South Harbor

Port tariffs play a crucial role by generating revenue for port authorities, covering operational costs, and facilitating infrastructure development. They act as a regulatory tool, encouraging efficiency, fair cost allocation, and transparency within the maritime industry. Additionally, competitive tariff structures can enhance a port's attractiveness and global market competitiveness.

3.3.1 Charges on Storage

The South Harbor only charges for storage when the cargo remains more than the allowable calendar days. Each type of cargo has a time period, as stated in the table below:

Table 6. Free Storage period for all types of cargo

For Imported Cargoes	Five (5) Calendar days after the day that the last item of cargo is discharged for the carrying vessel.
For Export Cargoes	Four (4) Calendar days from the day that the cargo is received at the port.
For Foreign Transhipment	A total of fifteen (15) Calendar days from the day of arrival to the day of departure.
For Domestic Cargoes Entering any port	Two (2) Calendar days after the date of cargo entry into the port.
For Domestic Cargoes Discharged at any port	Two (2) calendar days after the day that the last item of cargo is unloaded from the carrying vessel.
For Domestic Cargoes that are "Shutout" (not loaded on their scheduled vessel)	Two (2) Calendar days after the vessel's departure

3.3.2 Specified Cost

Table 7. Cargoes and Container fees according to Philippine Ports Authority

If Imported	
Cargoes in Sack/Bags/Bulk/Uncrated Live Animals/Steel Products Logs and Lumber/Heavy Lift Per Metric Ton	
Others Per Revenue Ton	Php 30.55
If Exported	
Cargoes in Sack/Bags/Bulk/Uncrated Live Animals/Steel Products Logs and Lumber/Heavy Lift Per Metric Ton	Php 18.35
Others Per Revenue Ton	Php 15.25
Foreign Transhipment A single charge per metric or revenue ton payable by shipping agent	
Cargoes in Sacks/Bags/Bulk/Steel Products, Logs and Lumber/Heavy Lift Per Metric ton	US$0.833
Others Per Revenue Ton	US$0.694

PROVIDED that the minimum charge shall be P10.00

Table 8. Wharf Based On Their Total Revenue Or Metric Tonnage according to Philippine Ports Authority

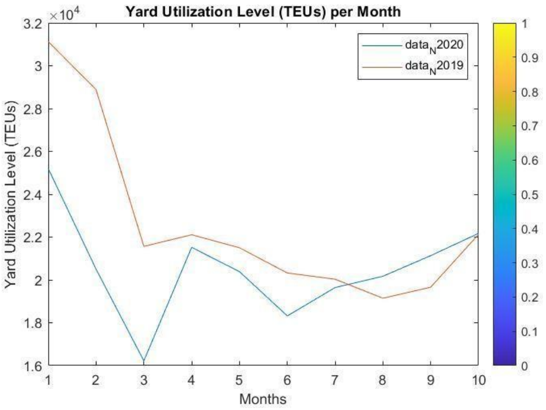
If Imported	
20 - ft	Php 519.35
35 - ft	Php 656.85

40 - ft	Php 779.05
45 - ft	Php 916.50
If Exported	
20 - ft	Php 259.70
35 - ft	Php 329.95
40 - ft	Php 391.05
45 - ft	Php 458.25
Foreign Transhipment	
Per TEU	US$ 1.00

The costs of the cargoes and containers in the Manila South Harbour are specified in Table 7 and Table 8, respectively. The prices of each differ depending on the weight for cargoes and the height for containers. This data collected is considered as mediating variables but does not directly affect the model. The model focuses more on the yard utilization level, container traffic, and daily truck movement. It is not included since the researchers identified that the costs of shipments do not significantly impact the primary metrics of yard utilization level, container traffic, and daily truck movement, which are the main focus of the study.

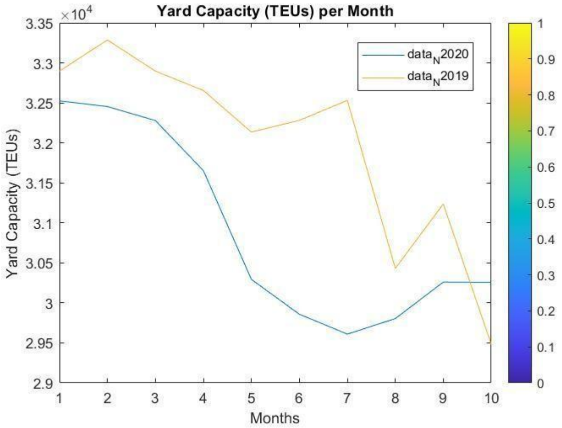
3.4 South Harbor Performance and Congestion Indicators for 2019-2020

Figure 2. Yard Utilization Level (TEUs) per Month in the years 2019 and 2020



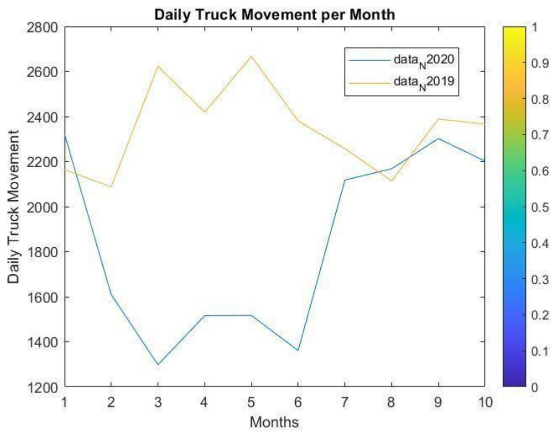
It represents data from two different years: 2019 (orange line) and 2020 (blue line). The x-axis represents the months, ranging from 1 to 10 (January to October), while the y-axis represents the Yard Utilization Level in TEUs, ranging from approximately 1.6 x104 to 3.2 x104 TEUs. For both years, there was a significant drop in yard utilization from the first to the third month, followed by an increase. However, the utilization level in 2020 is consistently lower than in 2019. This suggests that yard utilization was less in 2020 compared to 2019.

Figure 3. Yard Capacity (TEUs) per Month in the year 2019 and 2020



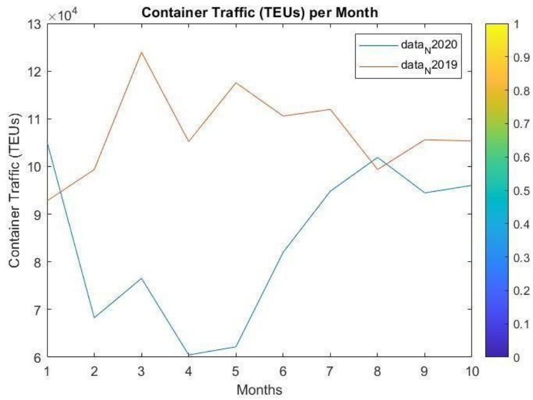
The line graph compares the yard capacity, measured in TEUs (Twenty Equivalent Units), per month for the years 2019 and 2020. The months are represented on the x-axis, which ranges from 1 to 10 (January to October). The y-axis represents the yard capacity in TEUs, with values ranging from approximately 2.9 x 104 to 3.35 x 10^4. There are two lines on the graph: a blue line representing the data for 2020 and a yellow line representing the data for 2019. Both lines show fluctuations in yard capacity over the months, with a noticeable decline around the middle of the year, followed by a rise.

Figure 4. Daily Truck Movement per Month in the year 2019 and 2020



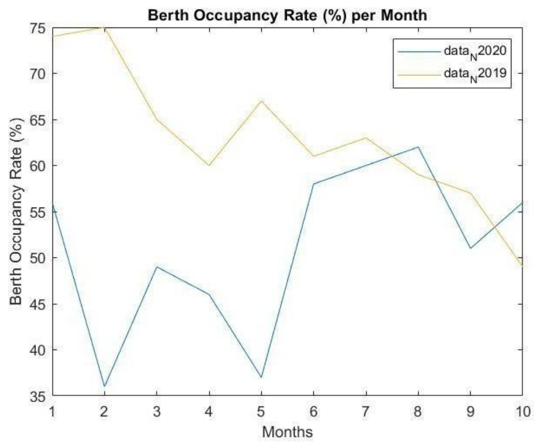
The compares the Daily Truck Movement per month for the years 2019 and 2020. The x-axis represents the months, ranging from 1 to 10, while the y-axis represents the daily truck movement, ranging from approximately 1200 to 2800. The yellow line represents the data for 2019. It shows a peak in truck movements around the third month, followed by a sharp decline until the fifth month, and then a gradual increase again. The blue line represents the data for 2020. It shows a decrease in truck movements for the first 3 months until it peaks in the seventh month, followed by an increase. This graph shows the variability in the Daily Truck Movement over the months for both years, indicating the dynamic nature of truck operations. The fluctuations could be due to various factors such as changes in demand, operational efficiency, and changes in shipping routes or schedules.

Figure 5. Container Traffic (TEUs) per Month in the years 2019 and 2020



The graph represents the monthly container traffic, measured in TEUs (Twenty Equivalent Units), for the years 2019 and 2020. The x-axis denotes the months, numbered from 1 to 10, while the y-axis shows the container traffic in TEUs, scaled by a factor of 10^4. Two distinct lines represent data for each year: an orange line for 2019 and a blue line for 2020. In 2019, container traffic peaked around month 3 and then experienced a significant decline until month 4 before rising again to another peak at month 5. After this second peak, there was another decline. In contrast, in 2020, there was a steady increase from month 1 to month 3, followed by a sharp decline until month 4, and then remained relatively stable with slight fluctuations through to month 10. This graph provides a comparative view of the container traffic for these two years

Figure 6. Berth Occupancy Rate (%) per Month in the years 2019 and 2020



The graph represents the Berth Occupancy Rate (%) per Month for two different years, 2019 and 2020. The x-axis represents the months, numbered from 1 to 10, while the y-axis shows the berth occupancy rate in percentage, ranging from 35% to 75%. The yellow line represents data from 2019, and the blue line represents data from 2020. Both lines show significant fluctuations over these months. For the year 2019 (yellow line), there is an increase in berth occupancy rate from month one to month two, peaking at around 70%. It then experiences a decline until April before rising again and finally declining towards month ten. For the year 2020 (blue line), there is a steep decline from month one to month two, where it reaches its lowest point at around 35%, then a sharp increase peaking at approximately 65% in August before gradually declining towards September.

3.5 Assessing the Relationships between Yard Utilization, Container Traffic, Daily Truck Movements, and Yard Capacity.

The simulation of the Just-In-Time Policy through MATLAB focuses on making the yard utilization level more efficient. In this simulation, multiple linear regression is utilized to identify the significance level and regression square between the sample data. Yard utilization level is considered the dependent variable, while daily truck movement and container traffic are the independent variables. To assess the relationship between these variables for the Just-In-Time Policy, we conducted a multiple linear regression analysis. This analysis allowed us to evaluate the strength and nature of the relationship between yard utilization level and the independent variables, daily truck movement and container traffic, thereby determining the most suitable data for improving yard utilization efficiency.

Table 9. Model Summary

R	R Square	Adjusted R-Square	Significance Level
0.9347	0.8737	0.520	0.062

Predictors: Daily Truck, Movement, and Container Traffic
Dependent Variables: Yard Utilization Level

The R Square value indicates that there is an 87.4 % chance of predicting the dependent variable through independent variables. This means that the Daily Truck Movement and Container Traffic have the capability to predict the Yard Utilization level through the Just-In-Time Application. In the table, the model has a 93.8% Confidence Interval, which means that the capabilities of the Just-In-Time Application have a significant impact on the Yard Utilization Level of South Harbor.

3.6 Simulation results of Just-In-Time Policy in the Yard Utilization Level of the Manila South Harbour

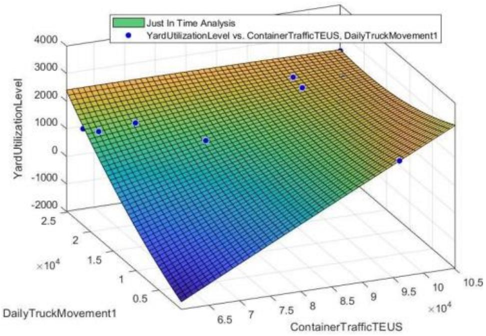


Figure 7. Yard Utilization Level vs. Daily Truck Movement and Container Traffic with Just In Time

Based on the three variables and the figure above, the model shows that the three variables have a relationship that is directly proportional. With the Just In Time to Matlab simulation, the researchers predicted the Yard Utilization Level based on the following data. Compared to the data collected and simulation of Just In Time, the Yard Utilization Level goes down compared to the data gathered by the Philippine Ports Authority.

Table 10. Just-In-Time Simulation after Adjusting Container Traffic

Months	Data collected			Adjusted Container Traffic	Just In Time Simulation
	Container Traffic	Daily Truck Movement	Yard Utilization Level		
January	105,166	2,323	77%	104,166	**73.6728%**
February	68,258	1,610	63%	67,258	**63.7275%**
March	76,533	1,298	50%	75,533	**51.3266%**
April	60,468	1,516	68%	59,468	**71.5117%**
May	62,172	1,517	67%	61,172	**67.8410%**
June	81,988	1,361	61%	80,988	**57.0651%**
July	94,819	2,118	66%	93,819	**66.8376%**
August	101,904	2,168	68%	100,904	**70.9874%**
September	94,450	2,302	70%	93,450	**73.0414%**
October	96,040	2,202	73%	95,040	**68.8239%**

Based on the table, most of the month has increased its Yard Utilization Level, which indicates that Just In Time reduces the Yard Utilization Level in which the container or cargo is being transported on time and not being congested as time passes. Moreover, the variable that the researchers adjusted was the Container Traffic, which will make the Yard Utilization Level higher, making the operation in Manila South Harbour Port more efficient and productive. Furthermore, Just In Time is an inventory management system that reduces the congestion in the container process, making the Manila South Harbour Port more productive and efficient.

4. CONCLUSION AND RECOMMENDATION

4.1 Conclusion

In conclusion, the study titled "Just in Time Analysis of Port Operation in Manila" has identified significant issues affecting the efficiency of the Manila South Harbour Port. The port has been congested due to an increased Yard Utilization Level. Moreover, the storage costs have escalated due to additional fees associated with unclaimed containers and delays in the shipping process. The TABS Policy plays a crucial role in the streamlined process of claiming the containers in the storage of South Harbour since there are thousands of truck movements every day. Therefore, if there are violations that cause delays, there will be significant effects on the prior schedules of the booking system since there are numerous flows of containers inside and outside of South Harbour. The inefficient use of Yard Utilization Capacity in the Manila South Harbor causes congestion not only to the Port but also to Roxas Boulevard (R:1), which affects the movement of vehicles. The COVID-19 pandemic began in late 2019, with the first cases reported in Wuhan, China, in December 2019. The World Health Organization (WHO) declared it a Public Health Emergency of International Concern on January 30, 2020, and later a pandemic on March 11, 2020. By late 2020, the pandemic had significantly impacted global operations, including port activities.

In 2019, before the pandemic’s onset, port operations and other industries were functioning normally without the disruptions caused by COVID-19.

While data from the Philippine Ports Authority (PPA) in the years 2019 and 2020 shows a high Yard Utilization Level at Manila South Harbour Port, simulations based on Just-in-Time principles predict a significant decrease in Daily Truck Movement while increasing Container Traffic, indicating potential inefficiencies in current operations. The Analysis of the suitable data for the JIT Simulation of Yard Utilization consists of two trials. The researchers conducted Multiple Linear regression to assess if the Container Traffic, Yard Capacity, and Daily Movement of Trucks correlate with the dependent variable, which is the Yard Utilization level. With the statistical test, the result shows that the Daily Movement of Trucks and Container Traffic shows possible relationships, but the Daily Truck Movement has the highest possible correlation to Yard Utilization level among the two independent variables. In the Matlab Simulation of the Just-In-Time Policy, the three variables employed indicate an evident decline in Yard Utilization Level over time, signifying that containers or cargo are being transported punctually without experiencing congestion. This reduction in Yard Utilization Level demonstrates the effectiveness of the Just-In-Time policy in streamlining the container processes. Essentially, Just-In-Time is an inventory management system implemented to alleviate congestion, ultimately enhancing the productivity and efficiency of the Manila South Harbour Port. The simulation results suggest that timely cargo transport contributes to a more efficient operation, aligning with the core principles of Just-In-Time Policy in the South Harbour.

The daily truck movement and Container Traffic in the South Harbour imposed changes, which indicates that the application of the improved system has a significant impact on the yard utilization level. This discrepancy suggests that implementing Just-in-Time practices, focusing on optimized cargo flow and reduced dwell times, could dramatically improve yard utilization and alleviate congestion issues at the port. Failure to address these critical issues will incapacitate the port's operations and hinder the Philippines' economic growth and international trade competitiveness.

Based on the findings, policymakers should consider implementing Just-in-Time practices to optimize cargo flow and reduce dwell times, thereby improving yard utilization and alleviating congestion at the Manila South Harbour. Strengthening the enforcement of the TABS Policy is crucial to ensure timely truck movements and adherence to schedules. Additionally, investment in infrastructure and technology to support efficient container tracking and management can enhance overall port productivity and support the Philippines' economic growth and international trade competitiveness.

The following were sought out in this study:

➢ The storage costs have significantly escalated due to additional fees associated with unclaimed containers and delays. The lack of optimization in Yard Utilization Capacity at Manila South Harbor is a primary contributor to this congestion, underscoring the urgent need for improved operational strategies.

➢ The Matlab Simulation of the Just-In-Time Policy reveals a clear and consistent decline in Yard Utilization Level over time. This trend indicates that containers and cargo are being transported punctually, effectively eliminating congestion. The reduction in Yard Utilization Level robustly demonstrates the Just-In-Time policy’s efficacy in streamlining container processes and enhancing overall operational efficiency.

➢ The Just-In-Time Simulation shows a marked improvement in the Yard Utilization levels of Daily Truck Movement and Container Traffic. The simulation results strongly suggest that timely cargo transport significantly contributes to more efficient operations, aligning perfectly with the core principles of the Just-In-Time Policy at South Harbor.

➢ The Terminal Appointment Booking System Policy is pivotal in ensuring a streamlined process for claiming containers. Any violations causing delays in customs clearance can severely disrupt the schedules of the booking system, given the high volume of container flows in and out of South Harbor.

4.2 Recommendation

The study focused primarily on cargo handling to enhance operational efficiency, cut down on costs and environmental impact, increase the port's level of competitiveness, and influence the economy. Therefore, the researchers recommend that considering the following can improve the study: the mobility, specifically the truck volume and congestion regarding entry and departure of the cargo based on land transport and terminal operation on case-to-case condition of the cargo based on the policy of the Bureau of Customs. In this study, the researchers did not consider human error or social issues in the simulation; thus, the study would be more realistic if that error and social issues were considered during Matlab simulation. In addition, the researchers recommend that future research use Manila International Container Terminal (MICT) and Manila North Harbour as the scope of the study, as the different branches have distinct roles, such as passenger/human transport, Ro-RO, and domestic trade.

ACKNOWLEDGEMENTS

The researchers would like to acknowledge the Officials of the Philippine Ports Authority and South Port Management Office Manager Ms. Catherine Esto and her Executive Secretary Cielito Cabarco for the assistance and Mapúa University for the opportunity to showcase learnings and most profound interest in the field of Civil Engineering specifically Ports and Harbour.

APPENDICES

Figure 8: IPO Diagram

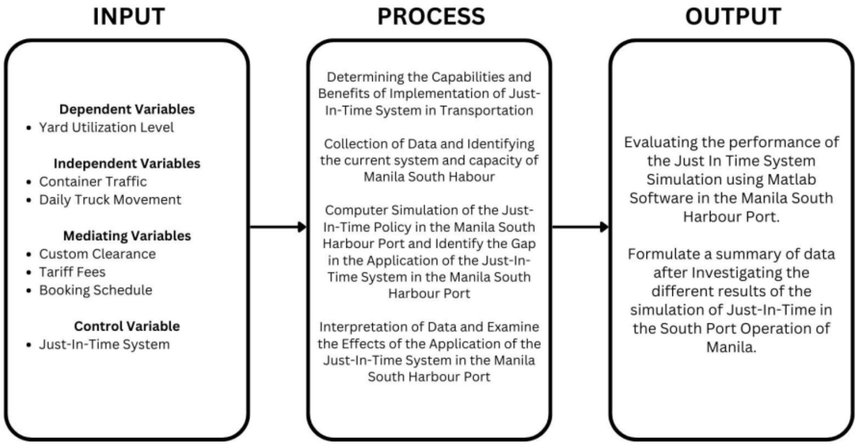


Figure 9: Data from PMO-NCR South

PHILIPPINE PORTS AUTHORITY
PMO-NCR SOUTH

SOUTH HARBOR & MICT PERFORMANCE/CONGESTION INDICATORS
JANUARY-OCTOBER 2020 & CY 2019

2020	Vessel Traffic Calls (Container Vessel)			Berth Occupancy Rate (%)		Quay Crane Prod Rate (Moves/Hour)		Container Traffic (TEUs)			Import Dwell Time (Days)		Yard Capacity (TEUs)			Yard Utilization Level (TEUs)			Yard Utilization Level (%)			Daily Truck Movement	
	SH	MICT	Total	SH	MICT	SH	MICT	SH	MICT	Total	SH	MICT	SH	MICT	TOTAL	SH	MICT	TOTAL	SH	MICT	TOTAL	SH (in Units)	MICT (in TEUs)
JANUARY	76	148	224	56%	59%	25.8	24.9	105,166	203,712	308,878	10	8	32,525	61,612	94,137	25,199	50,214	75,413	77%	82%	80%	2,323	7,159
FEBRUARY	54	107	161	36%	44%	28.8	26.2	68,258	160,830	229,088	8	8	32,454	63,577	96,031	20,503	37,213	57,716	63%	59%	60%	1,610	6,158
MARCH	69	127	196	49%	57%	25.4	24.9	76,533	178,210	254,743	9	6	32,279	63,513	95,792	16,219	39,374	55,593	50%	62%	58%	1,298	4,774
APRIL	53	97	150	46%	47%	26.5	25.5	60,468	129,006	189,474	12	14	31,653	63,932	95,585	21,520	45,813	67,333	68%	72%	70%	1,516	4,613
MAY	54	107	161	37%	37%	26.1	27.0	62,172	136,950	199,122	11	10	30,294	64,336	94,630	20,384	30,454	50,838	67%	47%	54%	1,517	4,499
JUNE	72	121	193	58%	44%	24.7	27.6	81,988	149,015	231,003	8	8	29,858	65,090	94,948	18,319	29,121	47,440	61%	45%	50%	1,361	5,091
JULY	75	150	225	60%	61%	23.2	25.7	94,819	188,381	283,200	6	7	29,610	65,178	94,788	19,643	33,089	52,732	66%	51%	56%	2,118	6,041
AUGUST	81	154	235	62%	59%	23.9	26.0	101,904	191,493	293,397	7	6	29,804	64,309	94,113	20,171	37,565	57,736	68%	58%	61%	2,168	6,053
SEPTEMBER	79	143	222	51%	63%	24.7	24.3	94,450	190,375	284,825	8	6	30,260	63,683	93,943	21,133	40,801	61,934	70%	64%	66%	2,302	6,758
OCTOBER	75	138	213	56%	49%	23.2	26.2	96,040	188,582	284,622	7	6	30,257	60,776	91,033	22,174	38,105	60,279	73%	63%	66%	2,202	6,477
YTD Total	688	1,292	1,980					841,798	1,716,554	2,558,352													
2020 Monthly Average	69	129	198	51%	52%	25	26	84,180	171,655	213,196	9	8	30,899	63,601	94,500	20,527	38,175	58,701	66%	60%	62%	1,842	5,762

2019	Vessel Traffic Calls			Berth Occupancy Rate (%)		Quay Crane Prod Rate (Moves/Hour)		Container Traffic (TEUs)			Import Dwell Time (Days)		Yard Capacity (TEUs)			Yard Utilization Level (TEUs)			Yard Utilization Level (%)			Daily Truck Movement	
	SH	MICT	Total	SH	MICT	SH	MICT	SH	MICT	Total	SH	MICT	SH	MICT	TOTAL	SH	MICT	TOTAL	SH	MICT	TOTAL	SH	MICT
JANUARY	61	118	179	74%	78%	15.6	15.3	92,767	183,998	276,765	9	11	32,897	60,839	93,736	31,128	55,283	86,411	95%	91%	92%	2,164	7,159
FEBRUARY	61	117	178	75%	67%	19.1	18.0	99,352	168,541	267,893	8	10	33,286	60,036	93,322	28,885	51,756	80,641	87%	86%	86%	2,088	6,315
MARCH	80	152	232	65%	72%	26.6	22.1	123,960	230,671	354,631	8	8	32,897	60,544	93,441	21,564	45,909	67,473	66%	76%	72%	2,623	6,138
APRIL	73	159	232	60%	75%	27.1	19.8	105,215	209,249	314,464	8	8	32,655	61,348	94,003	22,109	46,574	68,683	68%	76%	73%	2,419	6,655
MAY	79	143	222	67%	66%	23.9	22.6	117,552	204,770	322,322	7	8	32,135	61,348	93,483	21,500	43,613	65,113	67%	71%	70%	2,667	6,963
JUNE	79	149	228	61%	60%	26.5	26.3	110,577	195,479	306,056	7	7	32,282	60,836	93,118	20,323	38,700	59,023	63%	64%	63%	2,380	7,247
JULY	83	153	236	63%	56%	27.0	26.3	111,965	210,941	322,906	6	6	32,531	60,691	93,222	20,031	36,667	56,698	62%	60%	61%	2,257	8,865
AUGUST	84	145	229	59%	59%	27.4	27.0	99,360	208,396	307,756	7	7	30,432	60,738	91,170	19,144	38,370	57,514	63%	63%	63%	2,114	6,588
SEPTEMBER	88	151	239	57%	56%	26.5	26.9	105,604	213,078	318,682	7	6	31,236	60,738	91,974	19,660	41,636	61,296	63%	69%	67%	2,389	6,987
OCTOBER	82	145	227	49%	49%	27.0	27.1	105,340	211,222	316,562	7	7	29,481	61,157	90,638	22,126	42,658	64,784	75%	70%	71%	2,366	7,059
NOVEMBER	87	151	238	66%	59%	24.4	25.7	117,460	218,879	336,339	8	8	31,229	61,394	92,623	23,823	47,093	70,916	76%	77%	77%	2,583	6,204
DECEMBER	80	146	226	54%	51%	27.5	25.8	110,914	196,452	307,366	7	8	31,571	61,547	93,118	22,529	44,019	66,548	71%	72%	71%	2,296	6,261
TOTAL	937	1,729	2,666					1,300,064	2,451,676	3,751,740													
2019 Monthly Average	78	144	222	63%	62%	25	24	108,339	204,306	312,645	7	8	31,886	60,935	92,821	22,735	44,357	67,092	71%	73%	72%	2,362	6,870

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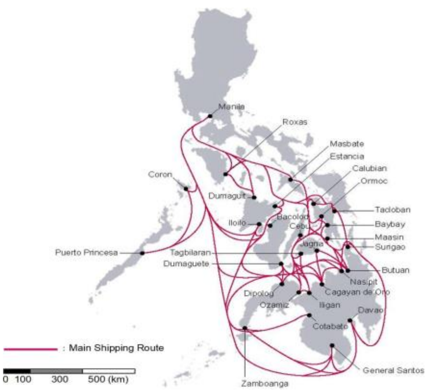
Figure 10: Main shipping routes in the Philippines



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