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A Study of Subic Bay Maritime Traffic Condition and Risk Analysis

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Abstract:

This study focused on the maritime traffic condition at the Subic Bay Metropolitan Authority, Philippines. It is based on a one-year survey conducted in 24-hour monitoring of shipping traffic movements. Every month, the set is rigged in proximity to the Bay where the movements of ships are targeted. The data collected by the equipment are the ship's tracks, the time of passage; the sizes and types of ships captured according to their LOA (length overall). These surveys were carried out in a one-day duration, each month, for a period of one (1) year to realize the pattern of movements of each ship captured around the Bay. The one-year survey conducted had shown that vessels continue to visit the Bay in various conducts of commerce. The tracks showed that the existing wharves and piers can handle medium-sized ships at present. The tracks, likewise, demonstrated that the entry/exit of vessels was scattered implying a random route chosen by vessels on a single area of the Bay. Based on the analysis of traffic conditions, it was identified that the bay lacks a traffic management system, like monitoring of movements of sea-crafts while plying in the bay, especially in the Subic Bay Metropolitan Authority area. It is then recommended to continue improving the infrastructure, systems, and redevelopment of the Bay, and to conduct a follow-up/continuum study to analyze the overall safety conditions of the Bay including the off- Subic Bay Metropolitan Authority area.

Keywords: *Automatic Identification System, Maritime Traffic, Risk Analysis, Subic Bay, Maritime Traffic Management System.*

Introduction

Subic Bay is a major seaport in the Philippines and Southeast Asia. Located about southwest of Luzon Island and about 100 kilometers northwest of Manila Bay, it has a deep natural harbor with an excellent and sheltered anchorage, naturally protecting it from typhoons. This same feature further sharpens its competitive edge for deep sea, short sea and inland shipping with 15 operational piers and wharves, which include a bulk fertilizer terminal, a bulk grains terminal, a general cargo terminal, and a passenger/cruise ship terminal, as well as shipbuilding and ship repair facilities. In addition to these port facilities that can handle all kinds of sea vessels, the Port of Subic also has two modern container terminals with a total handling

capacity of 600,000 TEUs per annum (Team, n.d.).

The Port of Subic is likewise an ideal logistics and trans-shipment hub, as its strategic location along major sea lanes makes it easily accessible to regional markets and international shipping ports as depicted by Figure 1 the real-time scenario taken at 1000H, 29 July 2022 from Marine Traffic website. At the same time, storage warehouses, as well as cargo handling service providers, shipping agencies and forwarders, are conveniently located within the pier area.

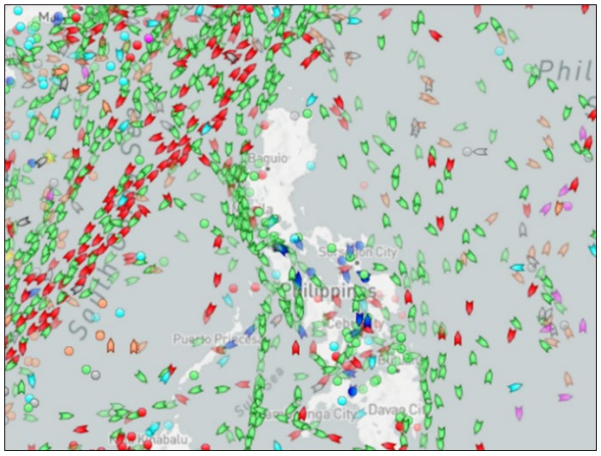

Figure 1. Map Showing Real-time Traffic Situation in the Region

Aside from the great commercial value of the Port of Subic, its deep blue waters provide a perfect backdrop to the entire Subic Bay Freeport not only as a vital port and investment site but also as an attractive tourism haven. Subic Bay, likewise, has about 50 beaches, resorts, hotels, waterparks, and leisure parks along the coasts of the bay that can invite cruises and contribute to the tourism industry in the area (Inc, G. P., n.d.).

The Subic Bay is also home to Subic Bay Metropolitan Authority (SBMA) which is the operating and implementing arm of the Government of the Philippines for the development of the 262 square mile (670 square kilometer) area of Subic Bay Freeport (SBF) into a self-sustaining tourism, industrial, commercial, financial, and investment center to generate employment opportunities. This area was the former US Naval facility in Subic Bay (Authority, S.B.M., n.d.).

It is the main commercial port and tourism attraction in the bay area with an area for residential, housing and places to enjoy living.

Subic Bay is a large-sized port. Table 1 shows the diverse types of vessels regularly calling at Subic ports. The maximum length of the vessels recorded to having entered this port is 327 meters LOA. The maximum draught is 12.7 meters. The maximum Deadweight is 290,490 MT (297,171 LT).

Table 1. Types of Vessel/Percentage

No.	Type of vessel	Percentage
1	Container	18
2	General cargo	16
3	Bulk carrier	13
4	Oil/Chemical tanker	12
5	Oil Products tanker	8

Based on the actual data from Port of SUBIC BAY/AIS Marine Traffic (accessed in June 2022, the types of vessels regularly calling at Subic Bay are Container Ship (18%), General cargo (16%), Bulk carrier (13%), Oil/Chemical tanker (12%), and Oil products tanker (8%). The total number of vessel traffic is equal to 67% and no record was found of the undetected 33%. This is due to the fact that only gatelines detected by the AIS was considered in this study.

Table 2 provides the piers and wharves, their facilities and services offered. These are mostly located in SBMA, but a few are along the coasts of Subic Town. Another, Hanjin Heavy Industries and Construction, Philippines (HHIC), located at the tip of the Redondo Peninsula, in Sitio Agusuhin, inside the Bay and was owned by SBMA. It was established in 2006 and had been a major contributor to local workers' employment. As of mid-2011, the shipyard had delivered 20 ships but by early 2019 it filed for bankruptcy where it eventually closed.

Table 2. Piers, Wharves and Facilities

No.	Berths	L x W x D (m)	Facilities / Service
1	Alava Wharf		
	Original	520 x 18 x 12	Passenger, Ferry and Cargo vessels. Foreign Naval vessels
	Extension	180 x 18 x 12	
2	Boton Wharf		
	East side	411 x 18.9 x 10.2	Bulk cargos; fertilizer terminal; diesel storage tanks
	West side	237 x 18.9 x 4.6	
3	Bravo Wharf	411 x15 x 6	Cargo ships; mooring/tugboat; crane
4	Leyte Pier	300 x 32.5 x 14	Grain terminal and storage tanks; portal cranes; warehouses; weigh bridge
5	Marine Terminal		
	East bulkhead	237 x 35 x 12.9	General cargo; Ro-Ro; tanker; fishing vessels
	West bulkhead	237 x 35 x 12.9	19 warehouses
	MT-9	97 x 35 x 12.9	3 weigh bridges
6	Nabasan Wharf	100 x 18.9 x 14	Maritime training facility (IDESS)
7	POL Pier	253 x 23.1 x 12.8	Tanker (privately operated); Storage tanks
8	Rivera Wharf	906 x 18 x 9	General cargo ships; Lay-up ships; cable ships; Ph Naval vessels; ancillary crafts
9	Sattler Pier	180 x 24.4 x 12	General cargo vessels; Warehouses; weigh bridge
10	NCT-1 and NCT-2	280 L x 13 D	4 Gantry cranes; container stacking foundations; weigh bridges; security gates
11	Subic Fish Port	Located at Subic town, Zambales	

Figure 2 shows the map of the different ports and wharves at Subic Bay. The different wharves include Camayan Wharf, Nabasan Wharf, Boton Wharf, Rivera Wharf and Bravo Wharf. Leyte Pier, Alava Pier, POL Pier, Sattler Pier and Access Pier are the different piers. The port of Subic Bay is complemented with port facilities and infrastructure that can support a wide range of businesses.

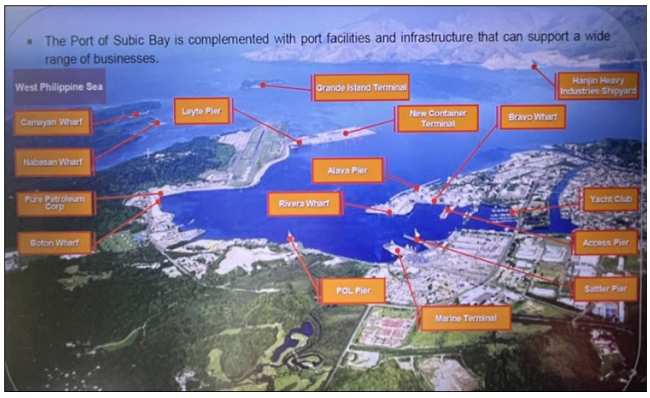

Figure 2. Map of Subic Bay Showing the Different Ports, and Wharves in the SBMA Area.
Source: Subic Bay website

Conceptual Framework

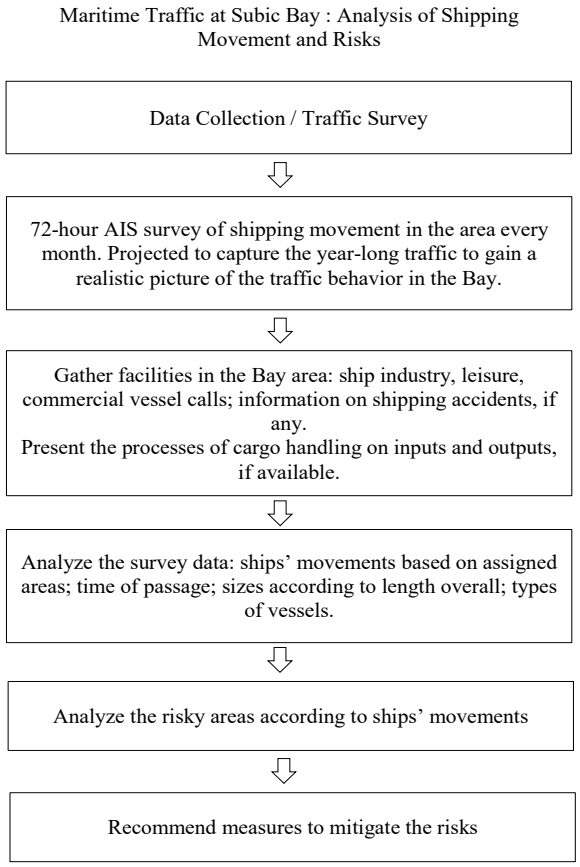

Figure 3. Research Paradigm

Figure 3 shows the real-time scenario taken at 1000H, 29 July 2022 from the Marine Traffic website. At the same time, storage warehouses, as well as cargo handling service providers, shipping agencies and forwarders, are conveniently located within the pier area.

Limitation

Only those fitted with AIS navigational aid, as required by International Convention for the Safety of Life at Sea (SOLAS) were captured.

Those small boats like bancas, small domestic fishing vessel, and sometimes, those non-SOLAS vessels that contribute to the traffic density of the area.

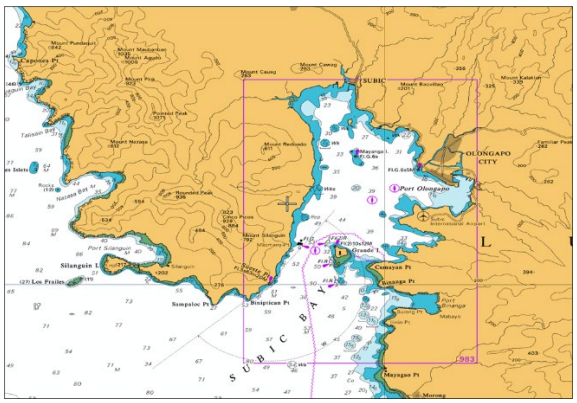

Figure 4. Locale of the Study
Source: Part of BA Chart 4491, inclusive BA 983

Figure 4 presents the location of the study, the Subic Bay, which is located in the Philippines, at coordinates N 14° 50' 04.54" - E 120° 15' 02.52". Subic Bay, is at SW Luzon Island, Philippines. The Bay as well as the towns and establishments surrounding it are collectively known as Subic Bay.

The Bay was long recognized for its deep and protected waters, but development was slow due to lack of level terrain around the bay.

Statement of the Problem

The study is aimed at analyzing the maritime traffic condition and risks at Subic Bay. Specifically, it answered the following:

1. What is the profile of the Subic Port in terms of:

a. Maritime accidents

b. Ship calls

2. What is the Subic Port Vessel and Cargo-handling process?

3. Based on AIS Survey results, what is the traffic condition of Subic port according to vessel type, size of vessel, and time of transits?

Based on analysis of traffic condition, what are the identified risk-related

Materials and Methods

Research Design

The study used quasi-longitudinal experimental and descriptive research. Quantifiable processes were also used to determine relationships between variables. In a longitudinal study, participants are observed, and measurements are taken over a long period of time. Longitudinal studies either go forward in time (prospective) or backward in time (retrospective). Descriptive designs collect information about variables without changing the environment or manipulating any variables, so they do not look at possible cause and effect.

Relative to the study, the gatelines were observed and measurements were performed in one year without manipulating any variable.

Instrument

The study concerning maritime traffic movement in Subic Bay used the Automatic Identification System (AIS) to gather data.

The data were grouped, tabulated and demonstrated to paint a clear picture of the pattern of shipping movements around the Bay.

The variable "Size" is determined by the "Length overall (LOA) of each sea craft in meters" which is grouped by:

a) "S1" is 0m – 50m;

b) "S2" is 51m – 100m;

c) "S3" is 101m – 150m;

d) "S4" is 151m – 200m; and

e) "S5" is 201m – 250m.

The area of study in the Subic Bay is primarily concentrated in the SBMA ports, wharves and piers, where gate-lines are placed to capture vessels transiting through them. These gate-lines are denoted as Points "A", "B", "C", and "D".

Thereafter, a whole year's presentation of the total tracks was shown in Figure 6. Every month survey graphed and demonstrated, Figures 7-18, each tracked ship.

Recorded accidents were also included, although these are few and mostly occurred inside shipyards.

Port procedures are likewise in place for vessels' entry, documentation and clearances until its departure from the port are shown by flowcharts in Figures 5 and 6.

Procedure

The study is based on a one-year survey conducted in a 24-hour monitoring of shipping traffic movements monthly using the AIS programmed unit. The set captures details of the movement of every ship and craft fitted with AIS equipment as required by the SOLAS Convention and maritime regulations of the Subic Bay area.

Every month, the set is rigged in proximity to the Bay where the movements of ships are targeted. The data collected by the equipment are the ship's tracks; the time of passage; the sizes of ships captured according to their LOA; and the types of ships. These surveys were carried in a one-day duration, each month, for a period of one (1) year to realize the pattern of movements of each ship captured around the Bay.

The study, likewise, gathered data about maritime accidents/incidents in the Bay. All information was included in the analysis of the performances and behaviors of the ships within the areas and determines the risks involved.

Results and Discussion

Profile of Subic Port

Maritime Accidents

Table 3 shows the total number of maritime accidents investigated by the Maritime Industry Authority (MARINA) from 2016 – 2020 according to Statistica Research Department published October 15, 2021. The table, however, did not specify whether any accident listed occurred in the Bay area. In 2020, there were 95 maritime accidents investigated by MARINA. This number of investigated maritime accidents by the government office reached its peak in 2018 (Statista, n.d.).

Table 3. Number of Maritime Accidents

Year	Frequency
2016	41
2017	48
2018	152
2019	127
2020	95

No recorded major accidents have occurred in the Bay area for the last five (5) years. Table 4 shows only those on record as culled from local newsprints (Macatuno, 2014).

Table 4. Maritime Accidents Occurred in Subic Bay (Including Shipyards)

No.	Incident/ Accident	Date	Casualty	Location	Remarks
1	Aground	24-Dec-14	None	Subic Bay	Maneuvering problems through rough seas
2	Shipyard accident	07-Oct-11	6 killed 11 injured	Keppel Subic Shipyard	Keppel owned ship. Platform/ramp collapsed where workers are standing. The 6th worker died in hospital.
3	Shipyard accident	13-Mar-08	2 Dead	Hanjin Subic Shipyard	No data available

Ship Calls

The cumulative years 2017-2019 statistics by Subic Ship Department on vessels' calls to Subic Bay had been demonstrated in this section. Five (5) types of ships were grouped as Motor Tanker, Container vessels, Cruise ships, Motor vessels and Others shown in Tables 5 to 9.

Motor tankers, Table 5, shows that domestic ships mostly called at Subic Port with 73% while foreign had 26% only in 2019 figures. For Container ships, Table 6, only one (1) called at Subic Port in 2018 for domestic while there were 486 (2017), 511 (2018) and 602 (2019) calls for foreign ships.

Table 5. Motor Tanker

Year	2017	2018	2019
Domestic	472	349	469
Foreign	144	145	169
Total	616	494	638

Table 6. Container Ships

Year	2017	2018	2019
Domestic	0	1	0
Foreign	486	511	602
Total	486	512	602

In Table 7, no domestic Cruise ships visited the Bay area in the years 2017-2019. There is no locally registered cruise ship yet in the country. However, on 2018-2019, around 18 foreign cruises visited and boost tourism in the area. Table 8 shows that foreign ships dominated most of the vessels that visited the Bay.

Table 7. Cruise Ships

Year	**2017**	**2018**	**2019**
Domestic	0	0	0
Foreign	1	19	18
Total	1	19	18

Table 8. Motor Vessels

Year	**2017**	**2018**	**2019**
Domestic	191	199	200
Foreign	718	711	605
Total	809	910	805

"Others", shown in Table 9, are the vessels which are not included in Tables 5 to 8 comprised the biggest number of visits, 1,011 of which domestic ships has 79% of vessels that called on the Bay in 2017 to 2019.

Table 9. Others

Year	**2017**	**2018**	**2019**
Domestic	589	429	803
Foreign	177	171	208
Total	766	600	1,011

Over-all, Table 5 to Table 9 showed the ship calls from 2017 to 2019 where the Cruise ship has the least number of ships arrived in the country while "Others" vessels dominated the visits, both domestic and foreign.

Subic Port (SBMA) Vessel and Cargo Handling Process

Entry of Vessel

Figure 5 shows the process of entry of a commercial vessel into Subic Port (SBMA) from filing of vessel's entry through the Boarding Officers: Custom, Immigration and Quarantine, Agent, Personnel for cargo papers, and the PCG; to vessel's discharging of cargoes to their Receivers.

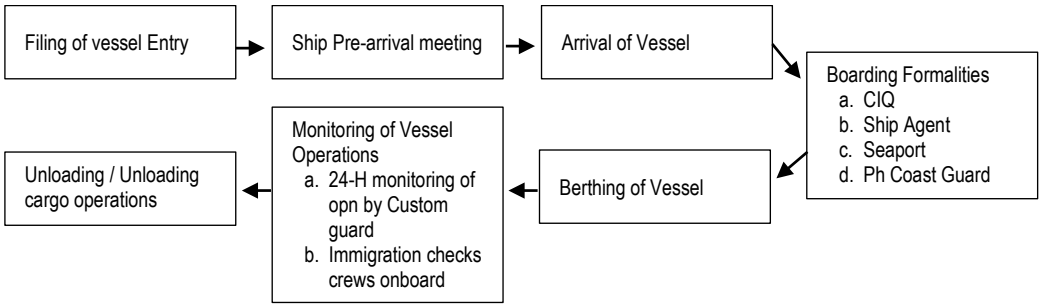

Figure 5. Flowchart of Vessel Entry into Subic Port

Exit of Vessel

Figure 6 shows the procedure of exit (the activities of the port officers and authorities, and documentation) of vessel from completion of cargo operation to its eventual departure from the port.

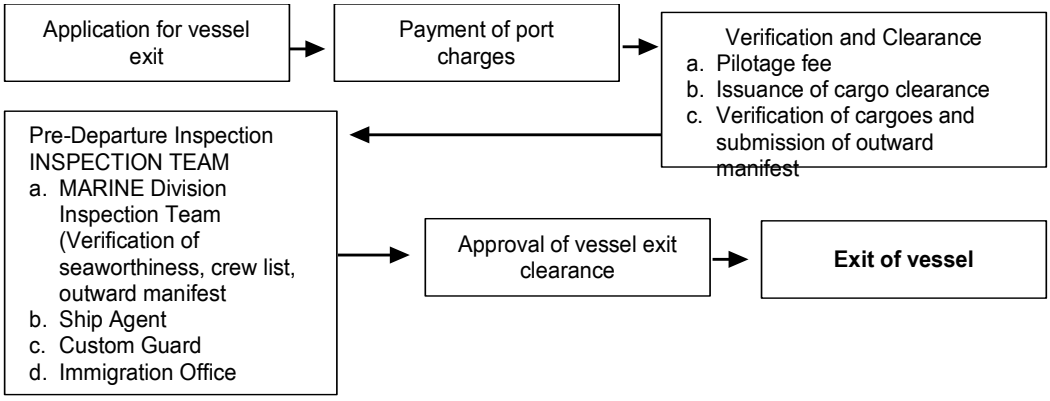

Figure 6. Flowchart of Vessel Exit from Subic Port

There are processes also for "Cargo Admission" and "Application for Gate-pass Management System" where taxes are paid for cargoes. For "Local Transshipment" (Cargo), a procedure likewise is in place until its departure from the port as shown in Figure 6.

Traffic Condition Based on AIS Survey

The study determines the behavior of maritime traffic/movement in the selected areas of Subic Bay. This would likewise determine the compatibility of these areas of the Bay to more robust commercial endeavors that would put the Bay in the map of advanced and employable ports in the Southeast Asian ports.

In the surveyed areas, Points A, B. C and D, the captured vessels were totaled and presented in graphs according to types, sizes (lengths) and times of passing at their respective points in a 24-hour period.

There were 173 vessels captured in the period of the survey, one day per month, in a year of survey. They were grouped according to the types, that is cargo, tanker, tug, and others.

The following figures show the situation of traffic movement in the Bay in the one-year survey period.

Figure 7 shows the total captured vessels in a one-year period of the survey.

The survey installed Gatelines, herein, denoted as Points "A', "B", "C" and "D" to capture vessels on specific areas. The areas chosen are the wharves in the Bay which are commonly cater commercial vessels. Point A covers Boton Wharf, Subic Seaport Terminal, SGS (Subic

Bay), Inc.; Point B captures Global Terminals and Development Inc., Subic Dock, 2017 Nabasan Pier Naval Area, Alava Pier, Marine Terminal, Bravo Wharf, Rivera Wharf, Sattler Pier, Point C targets sea crafts from Rivera wharf, Alava pier and Point D covers the maritime movements from Leyte Wharf, Subic New Container Terminals 1 and 2.

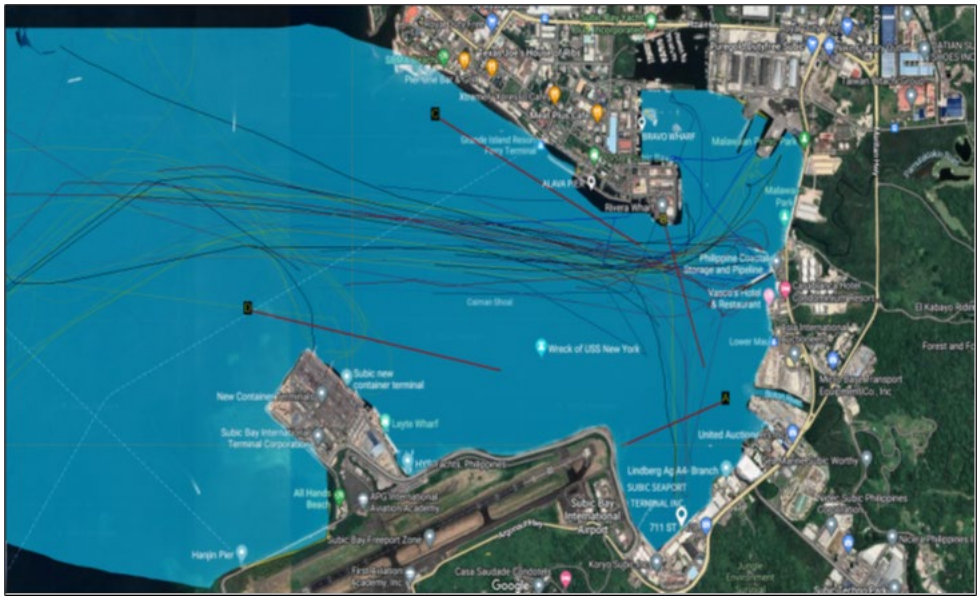

Figure 7. AIS Captured Tracks: Whole Year Survey

Vessels' Tracks

This section presents the tracks of the vessels captured in the one-year period. Each figure shows the shipping movement for each month in each day's survey. The tracks on February (Figure 9), August (Figure 15) until December (Figure 19) show increase in volume of transits which means that on those months ships' calls were more frequent than the rest of the year. It also demonstrated that most tracks are concentrated from Alava pier, Rivera wharf, POL pier, Marine terminal, Sattler pier, Access pier, Yacht club and Bravo wharf (See Figure 2). These piers and wharves are the busiest and commercially visited/berthed along the Bay's ports.

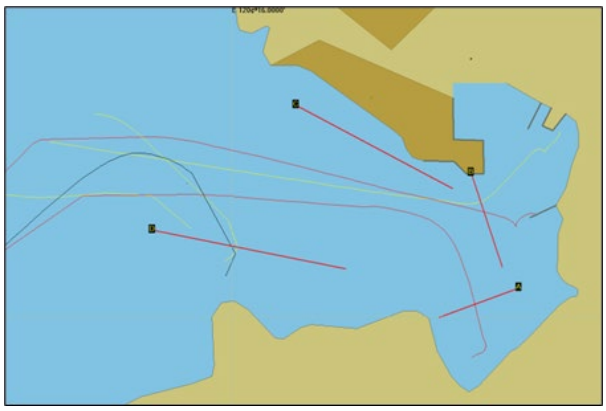

Figure 8. January Survey

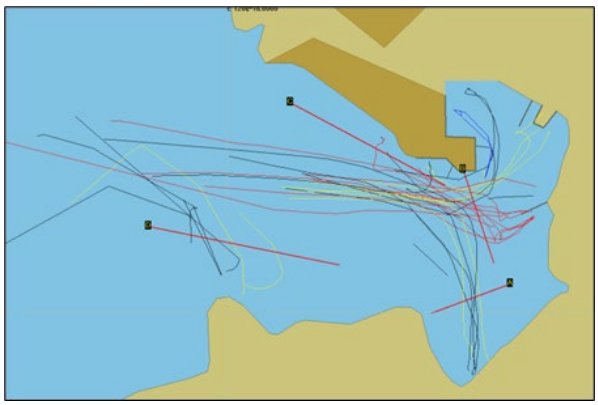

Figure 9. February Survey

January 2019 data shown in Fig 8, there were (6) vessels transited in the survey area in a day's survey: Tankers (2), Cargo (3) and (1) ETC. In Fig 9, February data had 30 vessels were captured: Cargo has (8), Tankers (11) and ETC also (11).

March has only 7 vessels, Fig 10, and they were Cargo 5 and ETC 2. April data, Fig 11, has 10 ships: Cargo 6, Tankers and ETC both have 2 each.

May transits have only 4 vessels for a day's survey: Cargo and ETC have 2 each as shown in Fig 12. Fig 13, June, shows 10 ships were captured: 6 for Cargo and both Tankers and ETC have 2 each.

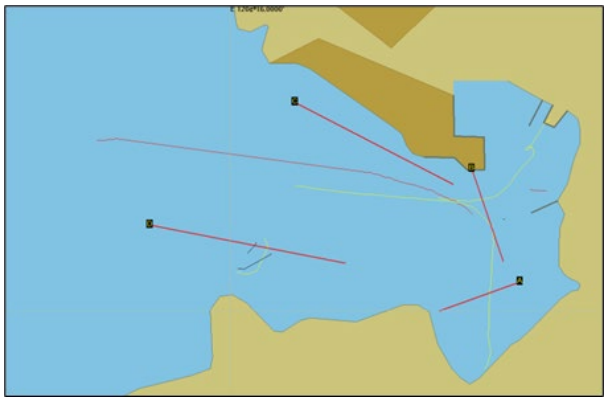

Figure 10. March Survey

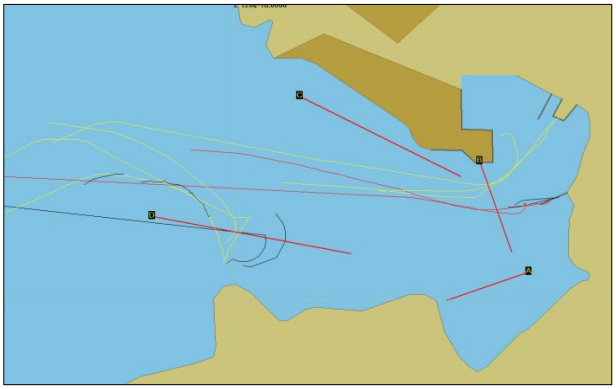

Figure 11. April Survey

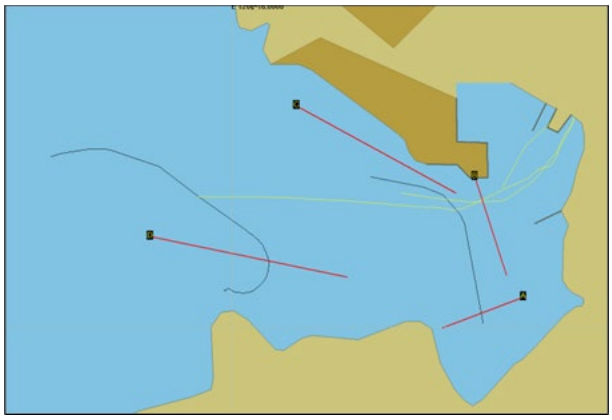

Figure 12. May Survey

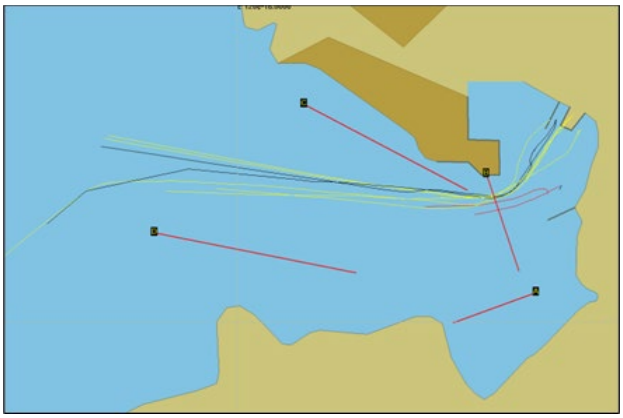

Figure 13. June Survey

Figure 14 shows the July survey which captured 15 vessels: Cargo 7, ETC 6, and 2 for Tankers while August data shown in Fig 15 has 14 vessels: Cargo has 9, Tanker 3 and 2 for ETC.

September data targeted 22 ships as demonstrated by the various tracks shown in Fig 16. Cargo has 13, Tankers 7 and 2 for ETC. October had 16 ships, Fig 17, with Cargo 8, Tanker 6 and ETC only 2 ships.

For the later month of the year 2019, November and December data, Fig 18 and 19 respectively, captured 17 vessels: Cargo has 10, Tankers 5, and ETC at 2. In November: Cargo 10, 5 Tankers and 2 for ETC, while December had 22 vessels: ETC vessels had the most at 8, followed closely by Tanker at 7, Tug occupied the 3rd place at 4 and Cargo only has 3.

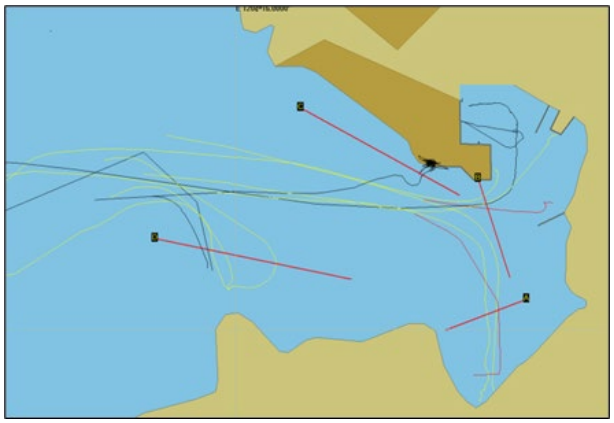

Figure 14. July Survey

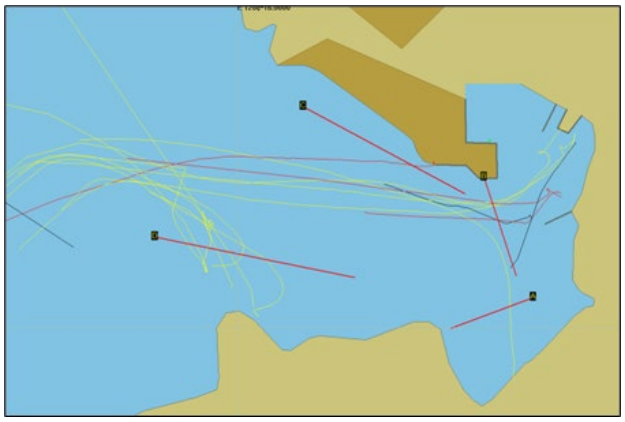

Figure 15. August Survey

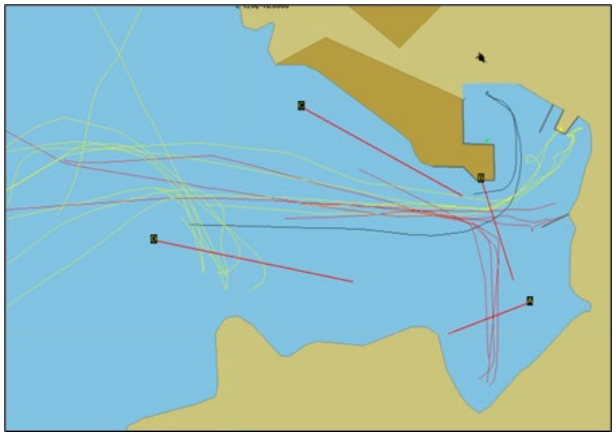

Figure 16. September Survey

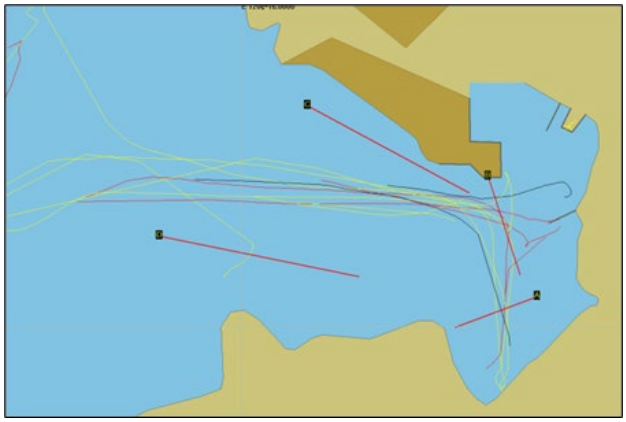

Figure 17. October Survey

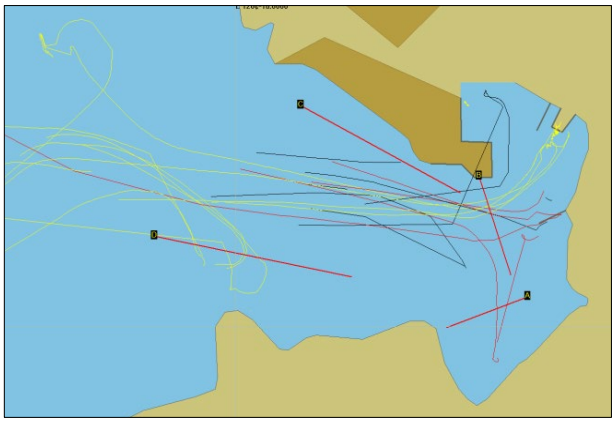

Figure 18. November Survey

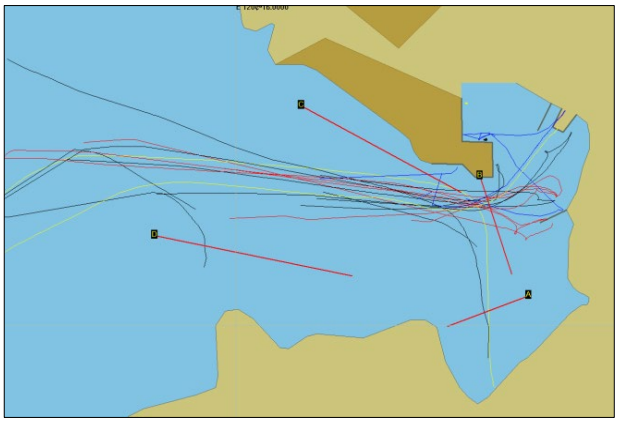

Figure 19. December Survey

Summation of Type, Size and Time

This section graphs the total numbers of vessels per type, size and time of transits in the survey period.

Figure 20 shows the types of vessels with the cargo having the maximum numbers of 80 vessels captured. It was followed by tankers and ETC at 47 and 42 vessels respectively. There were four (4) tugs detected. Figure 21 shows the sizes of vessels that were captured. The sizes were grouped according to the bracketed lengths.

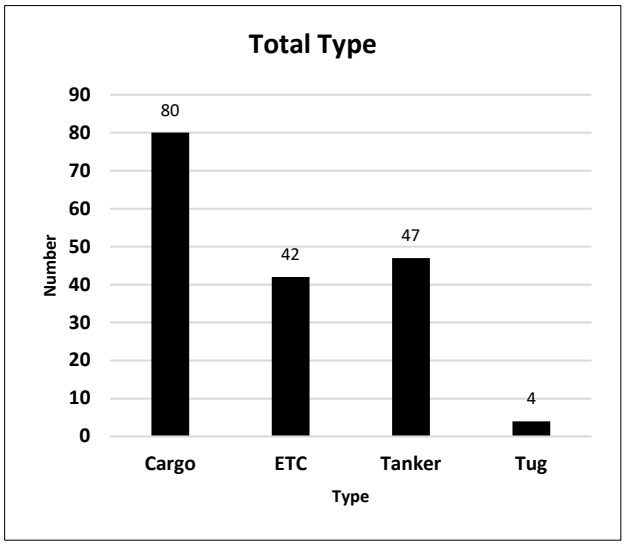

Figure 20. Total Number Based on Ships' Types

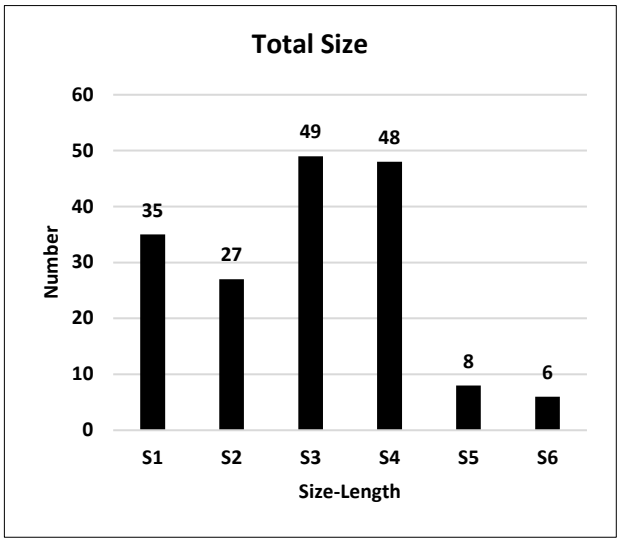

Figure 21. Total Number Based on Ships' Size

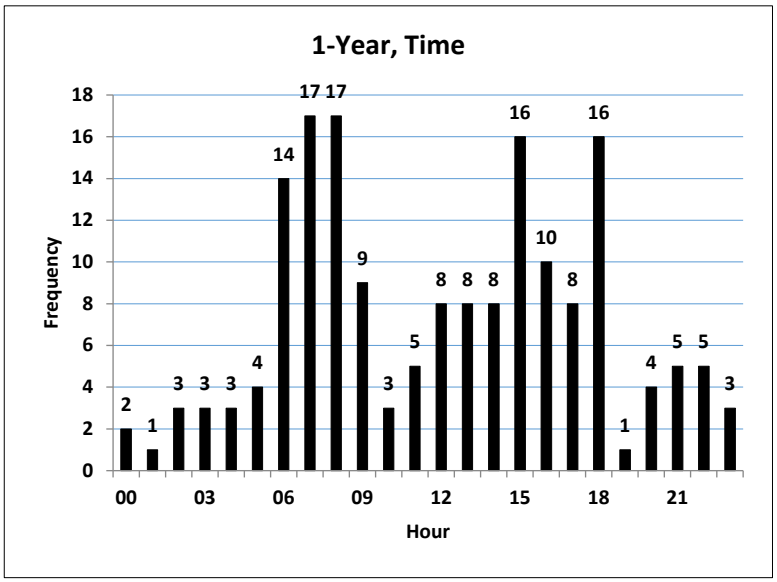

Figure 22. Total Number Based on Ships' Time

Fig. 22 (Data 1-Year, Time) captured the mobility of sea-crafts peaked at the early morning between 0600 (14) to about past 0800H (17s), and from whence it rose again at 1500H and 1800H (both 16).

Summation of Type, Size and Time According to Assigned Points (Gate-lines)

The following figures are the presentation of data at the different Points assigned during the survey that are found to have the most mobility of sea-crafts in the Bay.

Point A – Summation by Type, Size, and Transit Time

Figures 23, 24 and 25 are the graphs of Point A (Gate-line A) and this is the area where Pure Petroleum Corp. jetty used for discharging petroleum products and Boton Wharf which is used for transshipment vessels, fishing boats and bulk cargoes, fertilizer terminals by SSTI, are located.

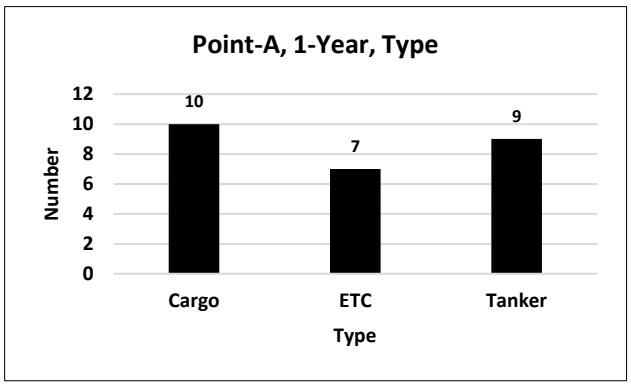

Figure 23. Point A, 1-Year, Type

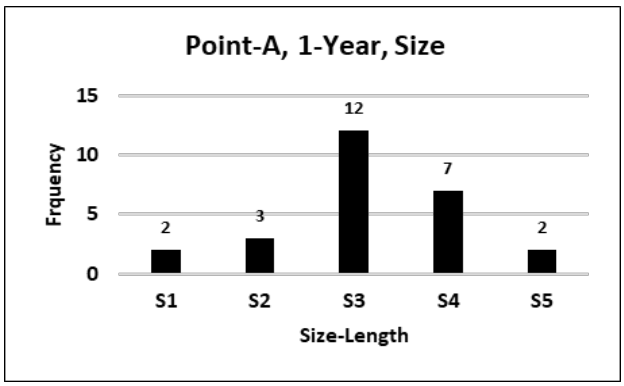

Figure 24. Point A, 1-Year, Size

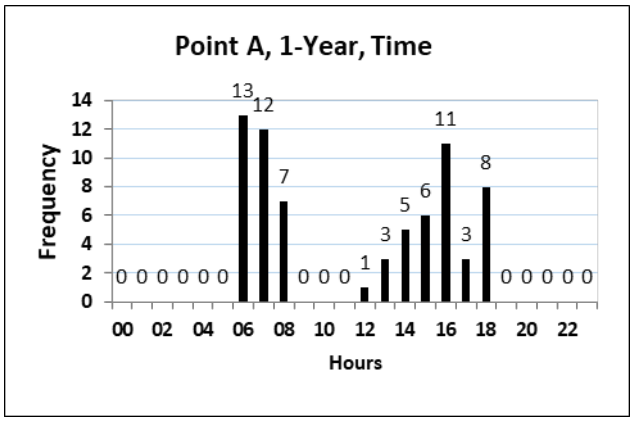

Figure 25. Point A, 1-Year, Time

Figure 23 graphed all 26 vessels captured at Point A during the survey according to type. It shows that cargo dominates at 10, the tanker followed at 9 and the ETC at 7.

Figure 24 had the S3, 150m – 200m, vessels with the most transits at Point A. This was followed by S4 and the rest are the minimal of 2-3 vessels only.

Figure 25 graphs the time where transits are prominent at Point A, in a 24-hour period. It shows that the early morning hours of 0600H-0700H, 13 and 12 respectively. In the afternoon, it starts to rise from early afternoon and peaks at 1600H (11) and ends at 1800H (8).

Point B – Summation by Type, Size and Transit Time

Point B captures the POL pier (used for petroleum products), Marine Terminal and Sattler pier (used for general cargo, e.g., rice, corn, etc., Ro-Ro, cargo ships and tug boats, tankers fishing boats), Access pier is a ship repair facility (Subic Dock Inc.), Yacht club, Bravo wharf (tug boats, hydrographic vessels and cargo ships) and Rivera wharf (used for ferry boats, Philippine Naval ships and landing of small watercrafts / general cargo, like lumber, heavy lifts, livestock, etc., naval ship, cable ship, and ship for lay-ups.

Figure 26 shows the average transits of vessels at Point B on a 24-hour basis. There's a mass of transits in early morning, from 0600-0900H, which peaked at 10 vessels and was followed by mid-afternoon (1500H, 12) at the highest number of transits.

Figure 27 graph, Cargo and Tanker (36 and 38, respectively) dominate the vessels captured in the period of survey at Point B.

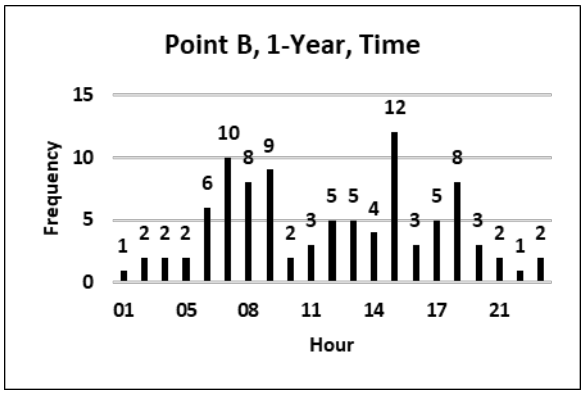

Figure 26. Point B, 1-Year, Time

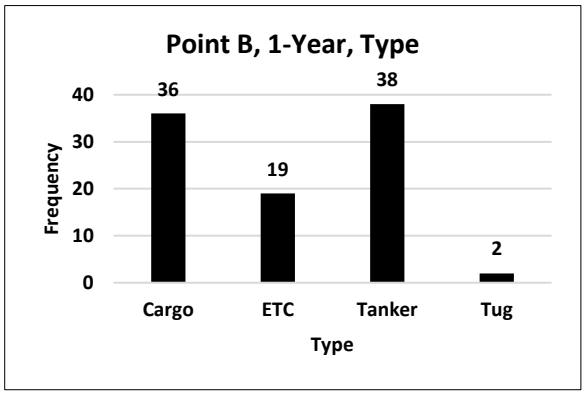

Figure 27. Point B, 1-Year, Type

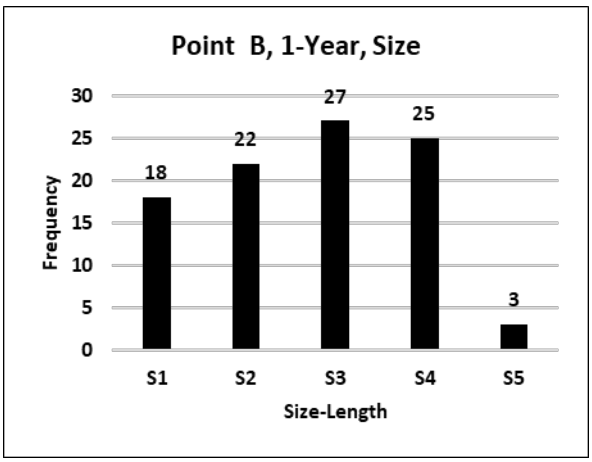

Figure 28. Point B, 1-Year, Size

Point C – Summation by Type, Size and Transit Time

Gate-line C (Point C) is where Alava pier and used by foreign and local naval vessels, passenger ships, cruise ships and ferry boats.

This area, Point C, Figure 29, has very limited vessels transits where 0300H (2), 1100H (2) and 1700H (2) are the highest number. The range of movement is only from 0300H to 2100H.

Figure 30 at Point C, ETC type of vessels dominates this area where 6 vessels passed. Tanker follows and Tug (2). There is one Cargo vessel passed.

In the graph of Figure 28, the sizes of the vessels' targeted are quite consistent in Point B where it starts from 18 at S1, 22 at S2, it peaks at S3,27, and 24 at S4. An outlier at S5 (4) was targeted where large vessels belong.

Point C, Figure 31, in this area, all vessels' sizes were targeted with S3, 101-150m, has the highest at 5 vessels.

Point D – Summation by Type, Size and Transit Time

Point D is assigned to cover the traffic movement in the area of Leyte pier, and the New Container Terminal.

Point D, (Gate-line D), Figure 32, only two (2) types of vessels transited: Cargo has 32 and ETC with 13. This is the area where the New Container Ports are situated and the Leyte pier which has grain terminals.

Figure 33, Gate-line D, "S4 – 150-200m LOA" has the most transits in this area with 17 vessels, followed by smaller craft of "S1 – 50-100m LOA" with 13 vessels. There are 7 bigger ships in "S6 – 250-300m LOA" crossed this gate-line.

This area was visited by large container ships at NCT 1&2.

Figure 34, the summation of vessels' transit in this area according to time, shows that vessels crossed this gate-line at the beginning and at the dawn of the day, from 0600-0800H (4 each) and 1800H with 7 ships). It also shows that the area is busy with transiting vessels every hour of the day.

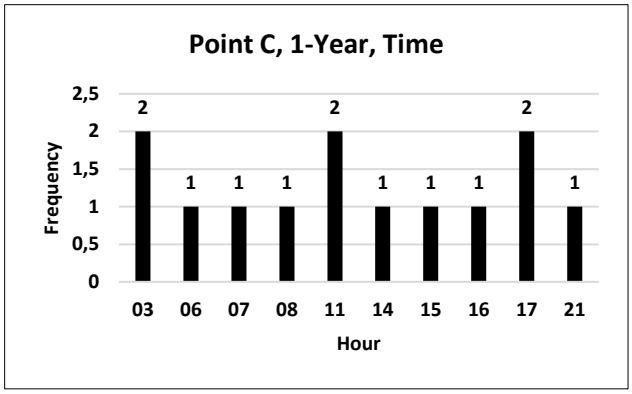

Figure 29. Point C, 1-Year, Time

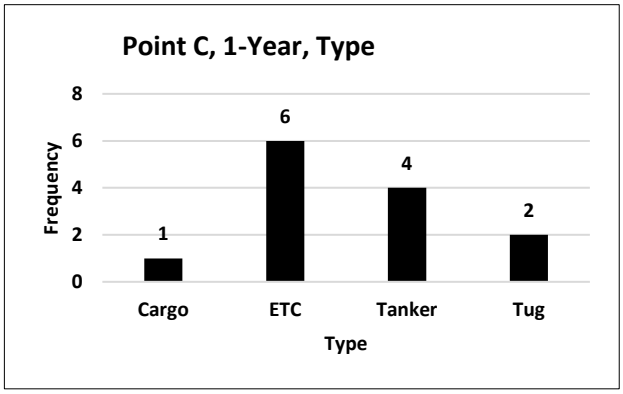

Figure 30. Point C, 1-Year, Type

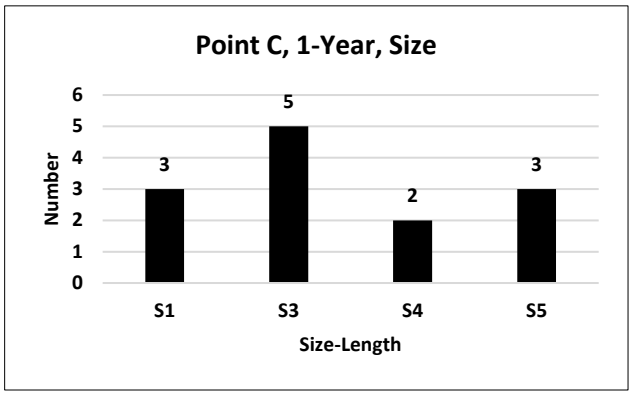

Figure 31. Point C, 1-Year, Size

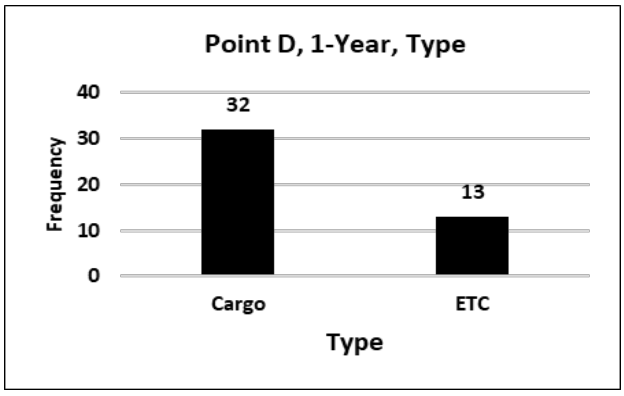

Figure 32. Point D, 1-Year, Type

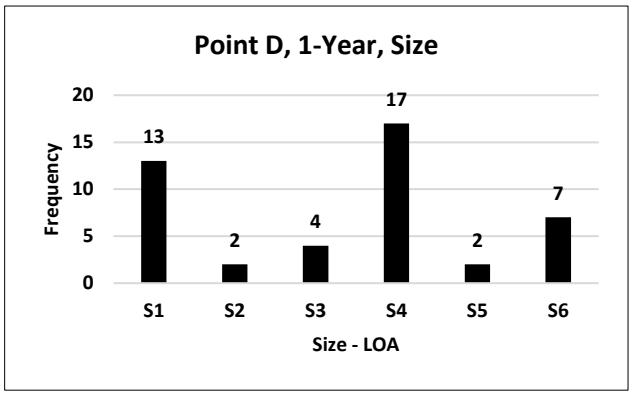

Figure 33. Point D, 1-Year, Size

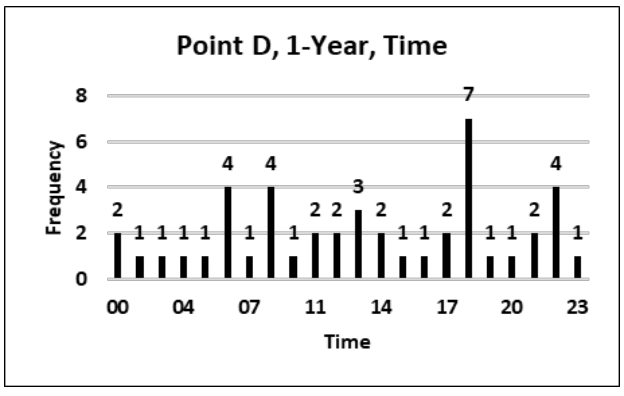

Figure 34. Point D, 1-Year, Time

Identified Risk-Related Issues

This study sets up three indicators of ship type, ship size and transit time. It also includes geophysical attributes of the Bay and locations of each port/wharf. Based on the analysis of traffic conditions, the identified risk-related issues were the following.

1. The Bay lacks a traffic management system, like monitoring of movements of sea-crafts while plying in the Bay, especially in the SBMA area.

2. No identified and/or in-placed traffic route system that can mitigate accidents, like collision, grounding, pollution and congestion in some of the busy point of the survey theater.

3. No identified security measures for vessels while or prior to entering the Bay.

4. No identified safe area to stay for vessels, domestic or foreign, that may seek refuge in cases of distress and/or emergency as required by IMO POR Resolution 949 (2003).

5. As depicted in figures nos. 8-19, and the cumulative tracks in Fig. 7, most vessels converged along the periphery of Rivera and Alava wharves of different types, and at different times of the day which may increase the risk-hazards in the area, partly due to No.1 and 2 above.

6. Although the Bay is known for its deep water, AtoN lacks the busiest corners and areas of convergence.

Conclusion

The study presented the maritime situation of the Bay and its potential to be a major maritime hub in the Southeast Asian corridor. It sits in a prominent location wherever vessels come from and proceed in relation to the commercial ports in the region. The facilities, although not as advanced as the other major port of the country but has more to offer in term of leisure visits. It has plans for redevelopment that can propel it to modernization. It handled large container vessels on its new container terminals and other piers and wharves that can accommodate various types of cargoes in volume as shown in Tables 1 and 2. Also, it has deep and protected waters for these types of vessels and other types as well. These potentials and activities provided a major boon to the regional and local economy.

1. No major maritime accidents at sea except the aground incident which was caused by inclement weather. Incidents with casualties occurred mostly in the shipyards.

2. Increased volume of calls in all types of vessels in the SBMA area. This pandemic once contained, will make this area more progressive due to the in-place infrastructures, sound systems and of the redevelopment as per the 10-YEAR MIDP.

3. The one-year survey conducted, even amidst the pandemic, had shown that vessels continue to visit the Bay in various conducts of commerce.

4. Based on analysis of traffic conditions, there were identified risk-related issues: VTMS; Route systems; Security issues as previously summarized, and no identified safe area to stay for vessels, domestic or foreign, that may seek refuge in cases of emergency.

5. Though there were risks identified, the study has presented a positive and optimistic view of the potential of Subic Bay to become a major hub in shipping commerce.

Recommendations

As stated, there is still a need for redevelopment of the Bay. The following recommendations, borne of this study, are conveyed:

1. To continue improving the infrastructure, systems and redevelopment of the Bay.

2. There should be a vessel management system, a VTMS that can monitor the movement of ships and all ancillary crafts in the area and its approaches.

3. To construct shipping routes along the waterways and in the approach channels and fairways. This is to ease management and control of the traffic which reduces the hazards of navigation, thus mitigating the risks. This is more prevalent when the density of traffic movement increases due to the viability of the port to be a major hub in maritime commerce.

4. Placing more AtoN in the routes, approaches and narrow channels. These aids to navigation will improve efficiency, and more

"turn-around" of ships, thus avoiding delays and reducing costs, especially in container reception and handling.

5. Conduct a follow-up/continuum study to analyze the overall safety conditions of the Bay including the off-SBMA area.

Conflict of Interests

No conflict of interest.

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