

Sustainable Port Cities - Colón



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Chapter 1: Strategic Location



FIGURE 1: MAP OF STRATEGIC LOCATION OF PORT OF COLON

Note . From CruiseMapper
(n.d.),<https://www.cruisemapper.com/?poi=87>

other ports in the region. (Seatrade Maritime, 2021; Panama Maritime Authority, 2024).

The Port of Colon is also connected to the Colon Free Trade Zone via a road network in approximately 1.5 km from the southern gate of Free Trade Zone (Colon Free Zone, n.d.). The Colón Free Trade Zone is the largest in the Americas and the second largest in the world, serves as a trade hub and export hub for the Caribbean, Central America, and South America (Colon Free Zone, n.d.). In addition, the Port of Colon has access to the Colon Logistic Park, a logistics park combining warehousing and distribution located on the premises of the Colon Container Terminal (CCT) (Colon Container Terminal S.A., n.d.). Thanks to its dense network of connections to these industry hubs, the Colon port has increased the role of the Port of Colon in the global supply chain. The Port of Colón has increased its container handling capacity by approximately 150% compared to the 1990s and reduced the inland transit time between the two oceans by 10–12 hours (Sea trade Maritime, 2021; Georgia Tech Panama Logistics Innovation Center, 2025; Panama Maritime Authority, 2024).

Finally, the Port of Colon which is a gateway between the Americas, Europe, and Asia, serving as the region's leading container and bulk transshipment hub. Colon port functions as a gateway by facilitating interoceanic transport and regional distribution. The integration with free trade zones further strengthens the port's strategic position in the region (Oxford Business Group, 2017; World Bank, 2024).

The Port of Colón serves as a container transshipment hub in Central America and plays a key role in facilitating maritime trade between the Atlantic and Pacific Oceans (see figure 1) (Lloyd's List, 2021; Britannica, n.d.).

The Port of Colon is located near shipping routes. Its location in the Caribbean, north of the Panama Canal, one of the world's most important shipping corridors, gives the Port of Colon direct access to major shipping routes including the East Coast of the U.S.A. - Asia (Far East), the East Coast of the U.S.A. - West Coast of South America, Coast to Coast of South America, Europe - West Coast of South America, and the East Coast of the U.S.A. - West Coast of Central America (Georgia Tech Panamá, 2025). This has made the Port of Colon a gateway connecting the Atlantic and the canal, significantly impacting interoceanic trade by reducing waiting, loading, and transit times by 1.5 to 2 days compared to

Chapter 2: Port connectivity

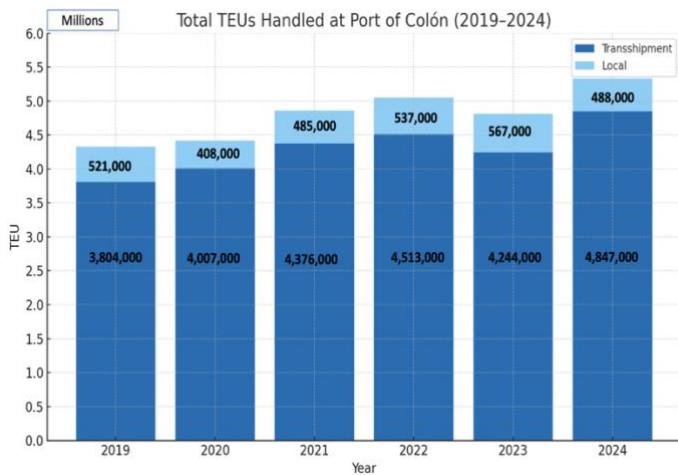


FIGURE 2. TOTAL TEUS TRANSSHIPMENT AND LOCAL AT PORT OF COLÓN (2019-2024). SOURCE FROM: GEORGIA TECH PANAMA (2023), [HTTPS://LOGISTICS.GATECH.PA/PLATAFORMA-LOGISTICA/ACTIVOS-](https://LOGISTICS.GATECH.PA/PLATAFORMA-LOGISTICA/ACTIVOS-)

routes. To be more specific, in the East Asia region within 18 to 20 days (port of Nagoya, port of Hong Kong, port of Shanghai, and port of Busan), in the North America region within 3 to 7 days (port of Los Angeles, port of New York and port of New Jersey), in the South America region within 1 to 10 days (port of Valparaiso, port of Santos, and port of Cartagena), in the Europe region within 11 to 13 days (port of Rotterdam, port of Hamburg, port of Antwerp) (Embassy and General Consulate of Panama, 2021)

Regarding inland transport connections, the Port of Colón has the ability to connect the Autopista Panamá-Colón expressway and railway to many cities such as Panama City (about 45 minutes by expressway and 1 hour and 30 minutes by rail), Colon City (about 5 to 20 minutes depending on the terminal), Santiago de Veraguas (about 3 to 5 hours) (Georgia Tech Panama, 2023). The main facilities of the expressway include 19 overpasses, 5 viaducts, 5 bridges and 3 interchanges, along with a 4-lane divided road, optimized for container trucks and commercial vehicles. While this 76 km long rail line operates up to 10 trains per day in each direction, handling about 500,000 containers per year (Port Economics, Management and Policy, 2025; Panama Canal Railway Company, 2024).

Colón port connectivity has a significant impact on the economic performance of the Colón region, increasing total logistics-related employment by approximately 35–40%, equivalent to more than 20,000 new jobs (direct, indirect and induced) compared to before the Colon port connectivity was completed in 2010 (IDB Invest, 2023; Port Economics, Management and Policy, 2025)

Panama provides strong connectivity to the Port of Colon by integrating these facilitates to ensure the seamless movement of goods between maritime operations and commercial distribution operations (Oxford Business Group, 2017; ECLAC, 2023).

The Port of Colón is a pure transshipment port (Lloyd's List, 2021; Trade.gov, 2024). Figures 2 supports this argument by showing that the throughput of the port of Colon is consistently between 85% and 91% transshipment. For example, in 2024, the Colon port's annual throughput was 5,395,134 TEUs while the total throughput of transshipment was 4,847,000 TEUs, which is equivalent to 89% of the throughput being transshipment.

Port of Colon have connections to ports around the world through the maritime

Chapter 3: Annual Cargo Throughput

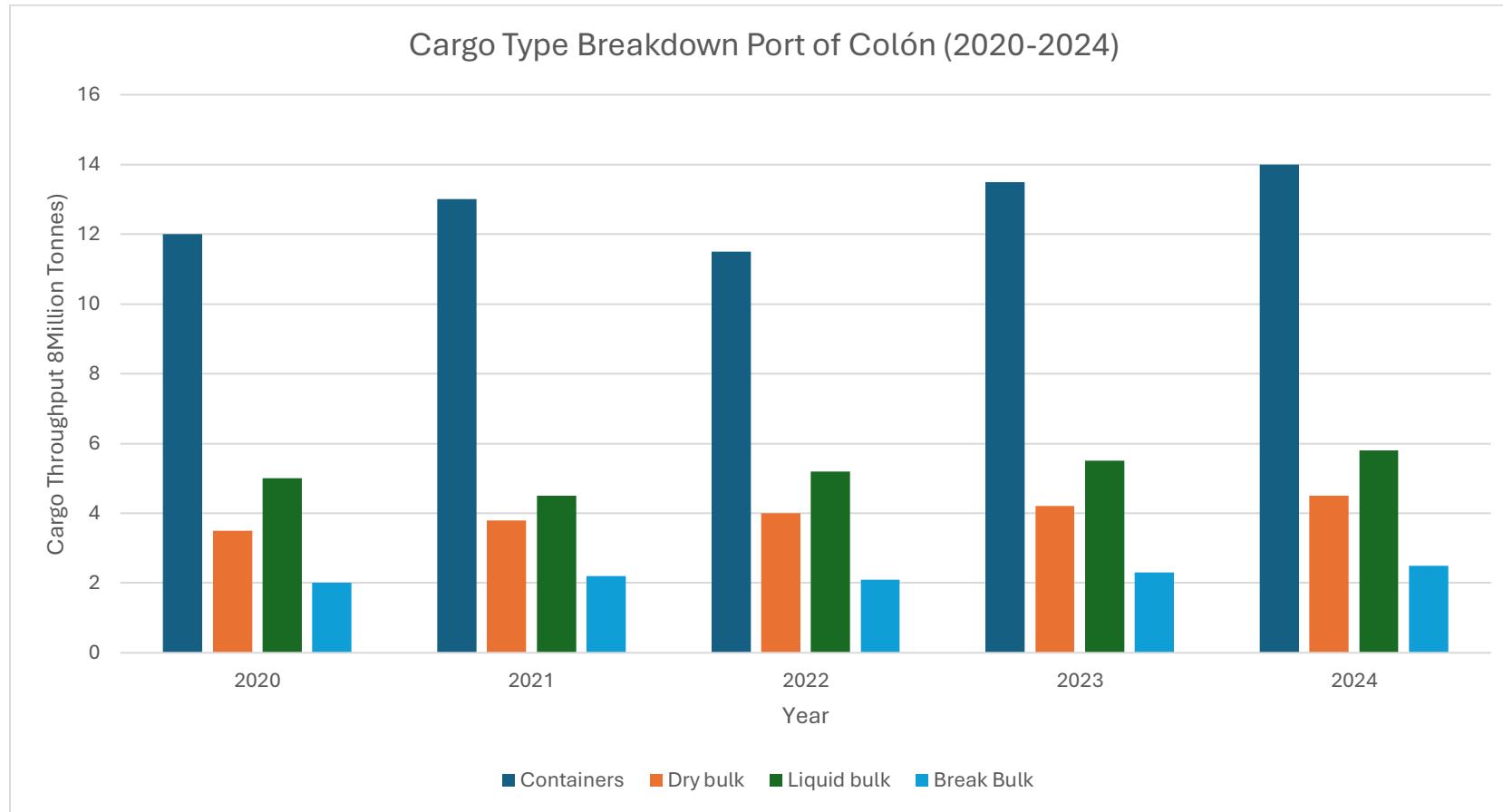


FIGURE 3: CARGO TYPE BREAKDOWN PORT COLON (2020-2024)

Data from: Seatrade Maritime 2025, <https://www.seatrade-maritime.com/ports-logistics/panama-ports-container-volumes-up-15-1-in-2024>

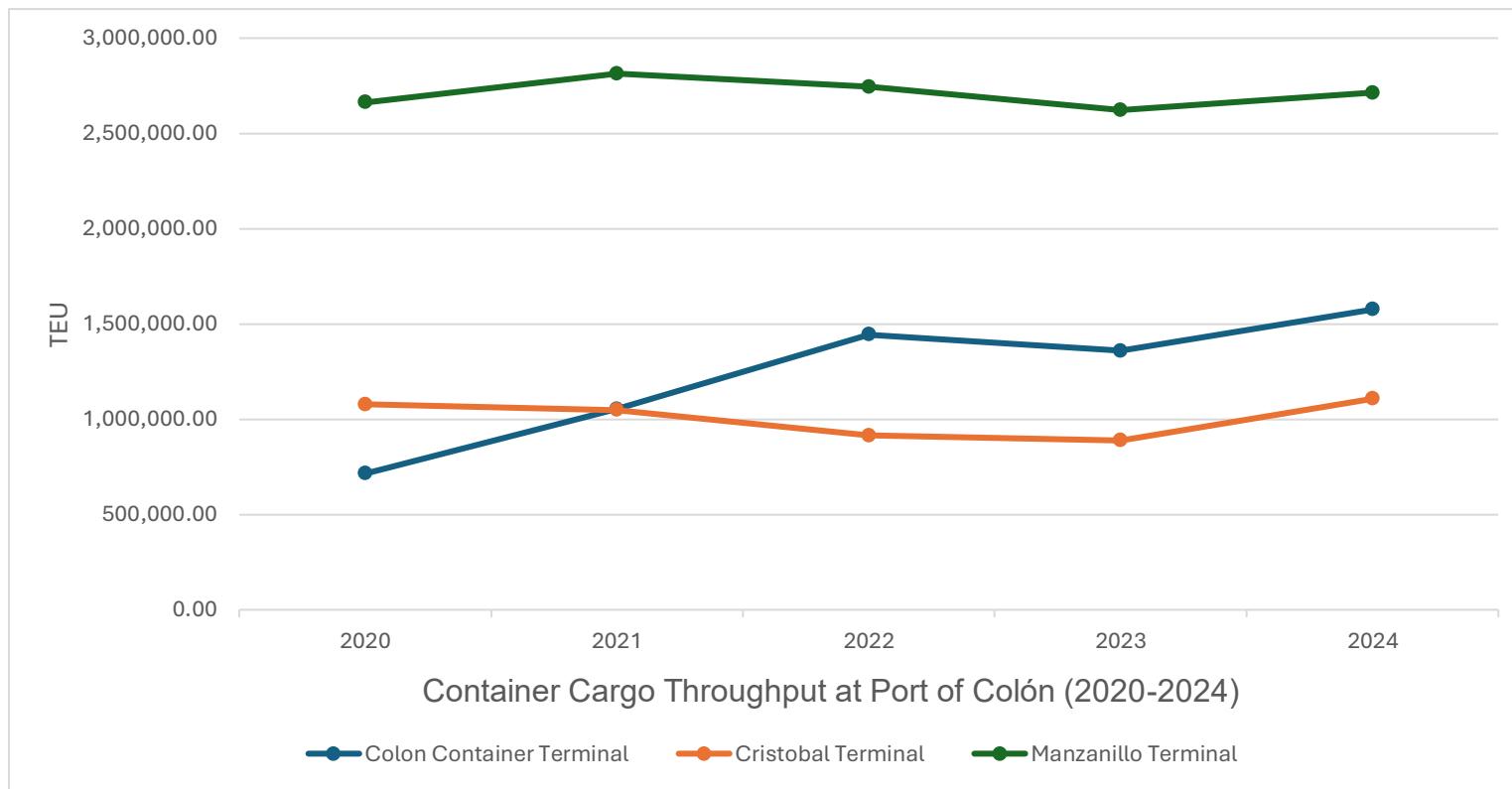


FIGURE 4: CONTAINER CARGO THROUGHPUT AT PORT OF COLÓN (2020-2024).

Note. Data From Portal Logístico De Panama. (n.d.). [Manzanillo International Terminal - Panama Logistics Web Portal](#)

If we look at the figure 3, discussing the cargo type throughput for Colon in the past five years, we can highlight some major instances. Although the amount of container traffic has grown steadily between 2020-2024 from 12 million to 14 million tons, there was a small drop in 2022. This was not a consequence of a drop in container trade demand, but due to hydrological constraints in water shortage that lead to canal restraints. More specifically, the drop of water levels of the Gatun Lake, which lead to stricter cargo restrictions. Cargo load on ships were reduced and some vessels deviated from passing the canal entirely. Approximately 10% of less cargo passed through the canal in that late quarter of 2022, thus reducing container throughput on ports that heavily rely on canal flows, such as Colon. (BTS, 2024).

Once the canal levels recovered due to rainy season, the port was able to continue to handle its steady increase in cargo throughput. They were able to attract high volume through allocated timeslots through port operators, discounts and reservation systems. The rebound suggests the port is well placed and efficient in recapturing container throughput but also highlights the fragility of the port's operations when subject to extreme weather phenomena. This suggests that water availability is strongly linked with container throughput and canal capacity. With global warming and an increase environmental stress, this poses a significant latent risk for the future readiness of the port.

Figure 4 shows the Port of Colón's container cargo throughput between 2020 and 2024 in TEUs, showing divergent patterns between the Cristóbal Terminal and the Colón Container Terminal. Colón Container Terminal's capacity to handle larger vessels following the Panama Canal expansion, investments in contemporary infrastructure, and a greater reliance on transshipment hubs in the wake of global supply chain disruptions during COVID-19 have all contributed to its steady growth, nearly doubling its volume from less than 800,000 TEU in 2020 to more than 1.5 million TEU in 2024.

The Cristóbal Terminal, on the other hand, saw a slow decrease from slightly more than 1 million TEU in 2020 to less than 950,000 TEU by 2023. This was due to outdated infrastructure, a lack of space for growth, and competition from other ports like Cartagena. Although the terminal trails behind Colón, a slight rebound in 2024 indicates some recovered demand. These changes are a reflection of larger global trade realignments, in which maritime alliances prioritize efficiency and consolidate routes, giving preference to high-capacity, contemporary terminals. While the future of Cristóbal will rely on modernization initiatives and its capacity to adjust to changing trade dynamics, the Port of Colón's trends point to a future in which Colón Container Terminal firmly establishes itself as a regional leader. The port has invested in better equipment (hybrid yard cranes) since 2024 and that is why there was an increase of the cargo throughput in that year. And larger storage areas, which helps speed up operations and handle more containers at the port. Shipping lines are also bringing in larger vessels, this way the vessels can carry more cargo at once. The stronger demand for imports and exports in Central and South America is also a key reason for this growth in cargo throughput as regional economies continue to expand their manufacturing and consumer markets (CEIC Data, 2025; OECD, 2024).

Chapter 4: SWOT Analysis (Port of Colón)

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none">▪ Strategic location at the entrance of the Panama Canal.▪ Home to the Colón Free Trade Zone (CFTZ), the largest free port in the Americas and second in the world.▪ Good connectivity to the Americas by disposition of railways, roads and proximity to Tocumln International Airport.	<ul style="list-style-type: none">▪ Discourage to invest due to underdevelopment, poverty and crime in the city of Colón.▪ Political instability in Panama leading to government corruption.▪ Environmental vulnerability to natural catastrophes- hurricanes and coastal Erosion.
OPPORTUNITIES	THREATS
<ul style="list-style-type: none">▪ Port expansion to handle Post-Panamax and New Panamax ships.▪ Growth opportunities for logistics and warehousing in the Free Trade Zone.▪ Rising tourism in the Caribbean could boost local economy.	<ul style="list-style-type: none">▪ Competition from nearby ports: Kingston, Bahamas freeport and Cartagena.▪ Increase in global trade disruption due to pandemics and economic crisis▪ High risk of smuggling, drug trafficking and piracy.

1 Strength: Home to the Colón Free Trade Zone (CFTZ), the largest free port in the Americas and second in the world.

It considerably strengthens its position as logistics and distributor hub not just for South America, but for the resto of the world. It is one of the biggest strengths for the port as the Free trade zone is the largest one in the Americas and the second largest in the world (ECLAC, 2023). It fosters all kinds of essential port activities and is essentially a hub for commercial activity such as warehousing and re-exporting and many companies take advantage of this by offering tax incentives. This enhances the expansion of the multinational logistic firms, creation of jobs and the country's competitiveness in world trade (World Bank, 2024). The fact that the CFTZ is inside the port reflects its efficiency in moving its goods from the port to other inland connections with reduced shipping times (Oxford Business Group, 2023).

1 Weaknesses: Environmental vulnerability to natural catastrophes-hurricanes and coastal Erosion.

It poses as a significant risk for the ports long term resilience which wouldn't attract possible future investors. It is located along the Caribbean coast, notorious for frequent hurricanes and other weather phenomena. The port is subject to coastal erosion threatening nearby logistics facilities and are costly to mitigate. The port is also subject to the rapid global rising sea levels, providing a risk to its infrastructure (IMF, 2024; ECLAC, 2023; UNCTAD,2023).

1 Opportunity: Growth opportunities for logistics and warehousing in the Free Trade Zone.

Logistical expansion of the CFTZ provides a significant opportunity for the port due to its excellent inland connectivity to the highway and railway to the rest of the isthmus. This expansion would diversify the economy and improve its competitiveness with other maritime hubs, potentially becoming the largest free trade zone in the world. They could capture new foreign investors that are looking for cost efficient distribution and would also provide an opportunity to the local community for high value and specialized jobs (Trade.gov, 2024; World Bank, 2024).

1 threat: High risk of smuggling, drug trafficking & piracy

As a transshipment hub, the port suffers as a main target of illegal activities by organized crime networks that exploit the limited container inspections for such high cargo imports (Interpol, 2023). Panama has a weak reputation for security and regulation from these illicit activities and could repulse investors and partners from establishing business (Reuters, 2024) Stronger port security systems and transparency measures facilitated by a less corrupt government need to be put into place.

Chapter 5: Size

The port of Colon can generally handle up to New-Panamax (up to 12,500TEUs) and ULCS (up to 21000 TEUs), although with some restrictions on the latter at full cargo depending on tide conditions and sea level. This capacity is supported by its physical infrastructure, where colon has a total land area of approximately 3.5km² and harbor water area of 10km² while Cartagena covers slightly smaller harbor area (see Figure 5). The size of both the water and land allow for the port to handle its high on growing throughput and its numerous container handing / port activities (CCT Services Page, 2025).

Other proportions of the port such as the channel depth of 16.4m, quay length of 2500m and turning basin diameter of 600m provide with spacious and safe maneuvering for the mega-vessels even in high vessel traffic conditions and low dwell times (see appendix 1) (Panama Maritime Authority, 2025). The ability to simultaneously handle such big vessels is supported by its multiple berths (see figure 6) where in terms of berth specifications, the Colon Central terminal (CCT) has four deep water berths from 14m-16m in draft depth and berth length of up to 780m, configurations that allow vessel capacity to exceed 14000 TEUs and work towards future expansion.

The port has invested in expansion projects that have the focus on further deepening harbor channels, increasing berth length and modernizing the handling equipment such as the Hybrid Tyred gantries. This allows for the port to remain competitive with other regional hubs such as Kingston and Cartagena and were made possible to accommodate Post-Panamax and New-Panamax after the Panama Canal expansion (World Bank, 2024).

To keep up with demand and sustain growth and efficiency, the port still needs to invest on high operational costs such as dredging which are required to keep adequate depth and navigability for mega-vessels: Additionally coming up with ways to be more environmentally responsible, as sediment displacement and costal erosion is present and affecting the community and wildlife of the area (OECD, 2024; ECLAC, 2023). Although, the ports deep water capacity, extensive quay infrastructure and location makes the hub stand out of other maritime ports and handle high throughput efficiently.

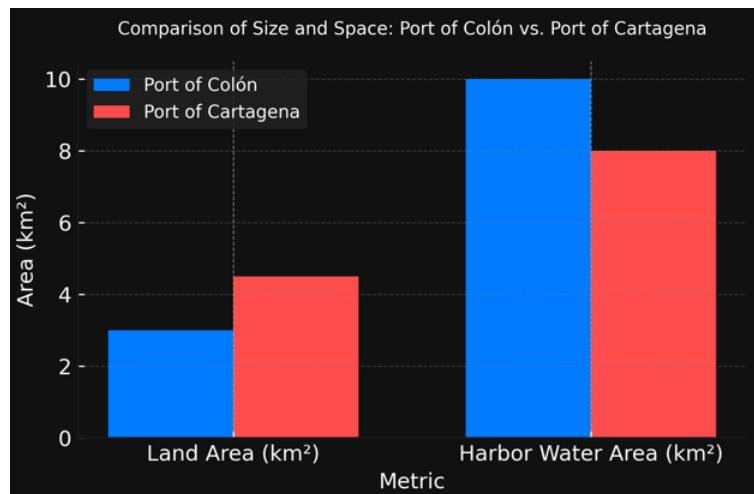


FIGURE 5:COMPARISON OF SIZE AND SPACE: PORT OF COLÓN VS. PORT OF CARTAGENA

Note. Data from CEIC Data (2025). <https://www.ceicdata.com>

	Meter draft	Container berth length
Berth 1	14m	478m
Berth 2	14m	478m
Berth 3	16m	780m
Berth 4	16.5m	780m

Source: CCT website- services page

FIGURE 6:BERTH DIMENSIONS AND DEPTH AT COLÓN CONTAINER TERMINAL

Note. Data from CCT website – Services page (2025). <https://www.cct.com.pa>

Chapter 6: Space



FIGURE 7. PORT OF COLON'S MAP LAYOUT

NOTE. SOURCE FROM GEORGIA TECH PANAMA (2025). [HTTPS://LOGISTICS.GATECH.PA/EN/LOGISTICS-PLATFORM/LOGISTICS-ASSETS/SEAPORTS/MAIN-SEAPORTS-IN-PANAMA/CRISTOBAL/](https://logistics.gatech.pa/en/logistics-platform/logistics-assets/seaports/main-seaports-in-panama/cristobal/)



FIGURE 8. AREA THE PORT OF COLON OCCUPIES. NOTE:
SOURCE FROM:

(GEORGIA TECH PANAMÁ,
2025).[HTTPS://LOGISTICS.GATECH.COM](https://logistics.gatech.com).

has a special berth that only this terminal has, which is a Ro-Ro berth of about 300 meters long, which is used to receive wheel-vehicles such as trucks and cars, helping to reduce operational conflicts between wheel-vehicles and containers. Colon port only deploys Ro-Ro berth at MIT because MIT has the advantage of being in calm waters and has the deepest berth depth (10 to 16.4) in the port. These factors help Ro-Ro ships easily dock, lower the ramp, and drive down safely (Port Economics, 2025; (Logistics.gatech.pa, 2024)). In terms of CCT, this terminal has a strategic location because it is located right next to the Colon Free Trade Zone, helping to reduce the time the ship is at berth from 1 to 2 hours for a call of about 4,000 moves compared to the other two terminals. The area is about 743,000 square meters; the storage capacity is approximately 90,000 TEU. According to Figure 7, CCT has installed 4 berths with an average depth of 14 to 16 meters and a length of 239 to 390 meters, with 2 berths that can accommodate New-Panamax. CCT has a shorter average berth length than other terminals due to the barrier on the sea surface and the logistics area behind. The radius of CCT's Quay length is nearly 600 meters (Logistics.gatech.pa, 2024). In terms of Cristobal, this terminal's location is a disadvantage because of close to the city center of Colon, which limits the area of container

In terms of MIT terminal, the area is about 606,000 m², the storage capacity is 81,137 TEU. According to Figure 7, MIT has installed 8 berths with an average depth of 10 to 16.4 meters and a length of 200 to 400 meters, especially 2 berths that can accommodate up to Ultra Large Container Ship (see in appendix 1). MIT owns the deep berth because MIT is in Coco Solo Bay, the deepest water area in Colon Bay and has a strategic role as the main transshipment hub. MIT also has a turning length of nearly 600 meters. In addition, MIT

and yard operation time to ensure safety and minimize environmental impact on nearby residential areas.

The proof is that the free time for import, export and transshipment is very short, only 7 days, and empty containers are only 4 days. Cristobal has an area of approximately 428,500,000 m², but the container storage area is only 120,000 m² due to the limitation of its proximity to residential areas. Cristobal has a storage capacity of approximately 521,892 TEU. According to Figure 7, The terminal has 8 berths with an average depth of 11.5 to 15.8 meters and a length of 139.85 to 349.89 meters. The turning radius of Cristobal is approximately 600 meters (Logistics.gatech.pa, 2024).

The Intermodal yard is effectively integrated into the Port of Colon through the CCT and MIT terminals. These two terminals are integrated with the intermodal system because they have flat land separate from residential areas, enough space to accommodate container yards, logistics warehouses, and railway lines within the port's operating area. The intermodal yard is where containers are unloaded from ships to container storage, then the containers are transported directly to the Colon Free Trade Zone by tractors (from vessels to trucks or tractor-trailers) or loaded onto rail cars for transfer to Balboa Port (from vessels to rail) or the containers are loaded onto container trucks for inland access (from vessels to trucks) (Hutchison Ports, 2023; IDB Invest, 2023).

In terms of inland connection, according to Firgue 8, the Port of Colon has the Panama-Colon Highway, which connects directly from CCT and MIT to Panama City and the center of Colon. This highway also creates a seamless logistics connection with the Colon Free Trade Zone and Colon Logistic Park. For rail, the Port has the Panama Canal Railway, nearly 80km long, with a station and container unloading ramp within the MIT and CCT campus, allowing containers to move directly to Balboa and Panama City (Panama Canal Railway Company, 2023).

The unique feature of the Port of Colon is that it is right next to the city center of Colon. Therefore, the positive impact on the surrounding area is an increase in total logistics-related employment more than 20,000 new jobs (direct, indirect and induced) (IDB Invest, 2023; Port Economics, Management and Policy, 2025) and helps nearly 2,000 businesses in with the growth of customers of businesses recorded at nearly 19% per year over the past 10 years. On the other hand, the Port of Colon causes air pollution due to emissions from port operations are approximately 750 tons per year per vehicle (Mc Gill University, 2018).

Chapter 7: Speed and Smartness



FIGURE 9. DIGITAL PORT COMMUNITY SYSTEM IN PORT OF COLON. SOURCE FROM:
[HTTPS://PORTECONOMICSMANAGEMENT.ORG/PEMP/CONTENTS/PART3/DIGITAL-TRANSFORMATION/PORT-COMMUNITY-SYSTEM/](https://PORTECONOMICSMANAGEMENT.ORG/PEMP/CONTENTS/PART3/DIGITAL-TRANSFORMATION/PORT-COMMUNITY-SYSTEM/)

Freight Forwarder, Shipping Agency, Port Authority, Container Depot, Terminal Operator, Custom, Ocean Carrier, Inland Carrier, Foreland, Hinterland. This platform operates in the following way:

First, Multi-party data integration. Portcel connects data from stakeholders and synchronizes all that data on a single platform, eliminating manual entry and information discrepancies. In more detail, Port Authority provides data on berth schedules and vessel arrival/departure times, while Customs provides clearance status and cargo inspection. Ocean Carriers together with Freight Forwarders allow the system to access information about manifest, booking, schedule. Meanwhile, Terminal Operators together with Container Depots send data about container tracking and gate-in/out. Finally, Inland Carriers provide domestic transportation data (Panama Maritime Authority, 2024).

Follow by Digital workflow. All documents including bill of lading, customs declaration and gate pass are digitized and stored on the cloud storage system instead of manual processing. This improvement helps stakeholders to register for approval, payment and traceability online. When each step is completed, the system immediately sends notifications to stakeholders to help coordinate continuously to improve efficiency and speed up processing (Portcel Annual Report, 2024).

Next is Single Window - One -Time Submission. With this system, stakeholders only need to provide information once. The system can automatically classify data to relevant stakeholders and automatically disconnect information to unrelated parties.

The Port of Colon has applied two technology innovations to its port operations, including the Digital Port Community System (Portcel) and Integrated Operations Control Center (CICO), to help improve the efficiency of container cargo handling and speed.

The first is the Digital Port Community System (Portcel) which has been applied since 2023. Based on Figure 9 this is a digital platform system that connects all stakeholders in the port logistics chain, including Exporter, Importer,

Finally, Data Analytics and KPI Tracking. Portcel collects data and displays real-time performance data such as vessel waiting time, container handling time, and truck arrival time, which leads to increased efficiency when tracking turnaround time, dwell time, and berth occupancy. Therefore, port managers can make instant decisions (CICO Operations Report, 2025).

Based on the operational process, Portcel has had a positive impact on port processing times and efficiency. The figures below are compared to the period before the innovation in 2022 and now in 2025. Document processing time has been reduced from 3-4 days to 6-8 hours, equivalent to achieving up to an 80% reduction in time. Container clearance time after customs clearance has been reduced by 70% compared to before applying Portcel (reduced from 24-36 hours to less than 10 hours). At the same time, this system helps reduce the amount of paperwork in port operations from 87% to 30%. In addition, the waiting time for ships to dock has also been significantly reduced from 8-10 hours to 3-4 hours, which means a reduction of nearly 60%. Meanwhile, the average turnaround time of the port of Colon has been reduced from 1.8 - 2 days in 2022 to 1.1 days in 2025 based on figure 9 and 10 (CEICDATA, 2025).

The second innovation is the Integrated Operations Control Center (CICO) which has been applied since 2018. This is a centralized digital operations center with the purpose of managing, monitoring and coordinating all activities at the Colon port. How CICO works is as follows:

Initially, Centralized Real-Time Dashboard. On the central screen, all visual data related to ships, containers, equipment, personnel and vehicles are transmitted to the system from which operators can directly monitor (CICO Operations Report, 2025).

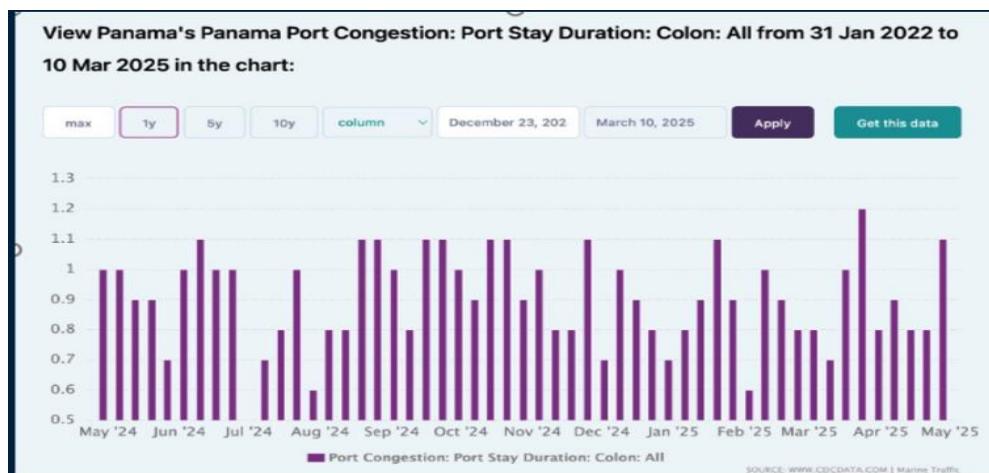
Secondly, AI-Based Predictive Planning. CICO also uses AI to forecast ship arrival times based on Automatic Identification System (AIS) data. It is capable of automatically assigning berths and scheduling appropriate loading and unloading and predicting congestion at the container storage or entrance gate (Port Technology International, 2024).

The next one is Automated Resource Allocation. This technology also automatically sends commands to mobilize equipments and personnel to the correct berth location where the ship is about to arrive, eliminating delays due to manual execution (Panama Maritime Authority, 2024).

Lastly, Incident and Contingency Management. In case of incidents such as late arrival, damaged equipment, lost containers, CICO immediately reports this abnormal data through sensors. From there, activate real-time alerts to relevant departments for handling (CICO Operations Report, 2025).

Based on the operational process, CICO has had a positive impact on port processing times and efficiency. The figures below are compared to the period before the innovation in 2018 and now in 2025. Thanks to CICO's reasonable allocation of berth usage time, berth utilization rate increased by 18% compared to before. In addition, equipment idle time decreased by 60%, from 25% to less than 10%. In particular, incident response time at Colon port was drastically reduced from 1-2 hours to 20 minutes. At the same time, truck waiting time at the gate was reduced from 90 minutes to 30 minutes. According to figure 10, vessel turnaround time was reduced from 1.8 days to 1.1 days, equivalent to a 40% reduction (see in appendix 1). Eventually, CICO helps to reduce processing cost per TEU from \$15.2 to \$9.8. (CEICDATA, 2025).

FIGURE 10. PORT OF COLON'S TURNAROUND TIME. SOURCE FROM: [HTTPS://WWW.CEICDATA.COM](https://www.ceicdata.com).



Chapter 8: Sustainability

The active sustainability of the port of colon can be measured through three different dimensions: Environmental, Economic and Social.

The economic and environmental sustainability are interlinked, as the port has had significant advancements through economic sustainability through its modernization and of the sustainable infrastructures. The installation of the Hybrid Rubber-Tyred Gantry (RTG) cranes is marked as one of the most impactful environmentally sustainable initiatives. The old diesel cranes would pump 10-12 gallon of fuel per hour and the new hybrid models are at just 1.2 gallons an hour (see figure 11), marking a significant 90% reduction in fuel usage and its carbon footprint. This change translates to a reduction of 1,200 metric tons of carbon dioxide emissions per crane annually (*California Air Resources Board, 2022; EcoCrane, 2012*). Benefits have risen as they have reduced average cargo dwell times, vessel stay to just 0.5 days and protected the surrounding environment/ecosystems (*SeaTrade Maritime, 2024*). It is also evident through the port emissions that have suffered a steady decline from 95k metric tons of carbon dioxide in 2017 to around 58k metric tons in 2024 (see figure 12), a great sustainable advancement that aligns with the country's decarbonization goals and transition to a greener & cleaner future.

It is due to environmentally sustainable initiatives like that one that enhance the economical sustainability of the port. The port supports around 3,000 new direct and indirect jobs from this initiative that contribute to the total of the 108,000 employees in all port related services and activities. The port of colon plays a vital role in the regional employment and economic health of the local population (*KraemerLaw, 2024; Propanama, 2024*). The initiative has also improved the trade competitiveness and the long term financial viability by throughput and increase in investment attractiveness.

Colon's role as a socially sustainable maritime hub (see appendix 2) are reflected through its scholastic supports that they have been offering. The Manzanillo International Terminal (MIT) in collaboration with the local Panama authorities distributed 1,378 backpacks to local underprivileged and granted 117 full ride tuition scholarships alongside 247 school supply vouchers (*MIT Sustainability Report, 2023*). This generous initiative also offered to train 2,500 public school teachers in efficiently identifying learning disabilities and directly assisted 234 students through specialized programs.

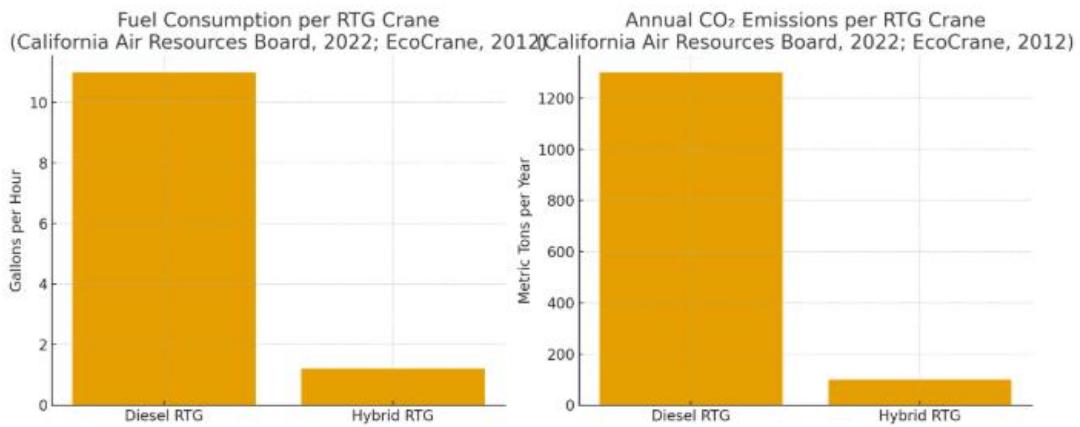


FIGURE 11:FUEL AND CO₂ PERFORMANCE COMPARISON FOR DIESEL VS. HYBRID RTG CRANES

Note. Data from California Air Resources Board (2022) & (EcoCrane, 2012)

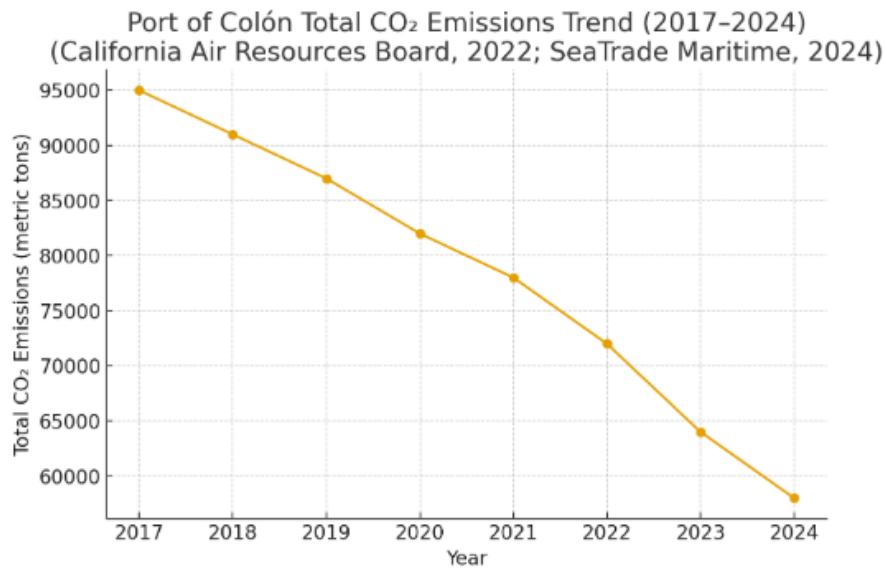


FIGURE 12:PORT OF COLÓN TOTAL CO₂ EMISSIONS TREND (2017–2024)

Note. Data from California Air Resources Board (2022) & SeaTrade Maritime (2024)

Chapter 9: Port competition

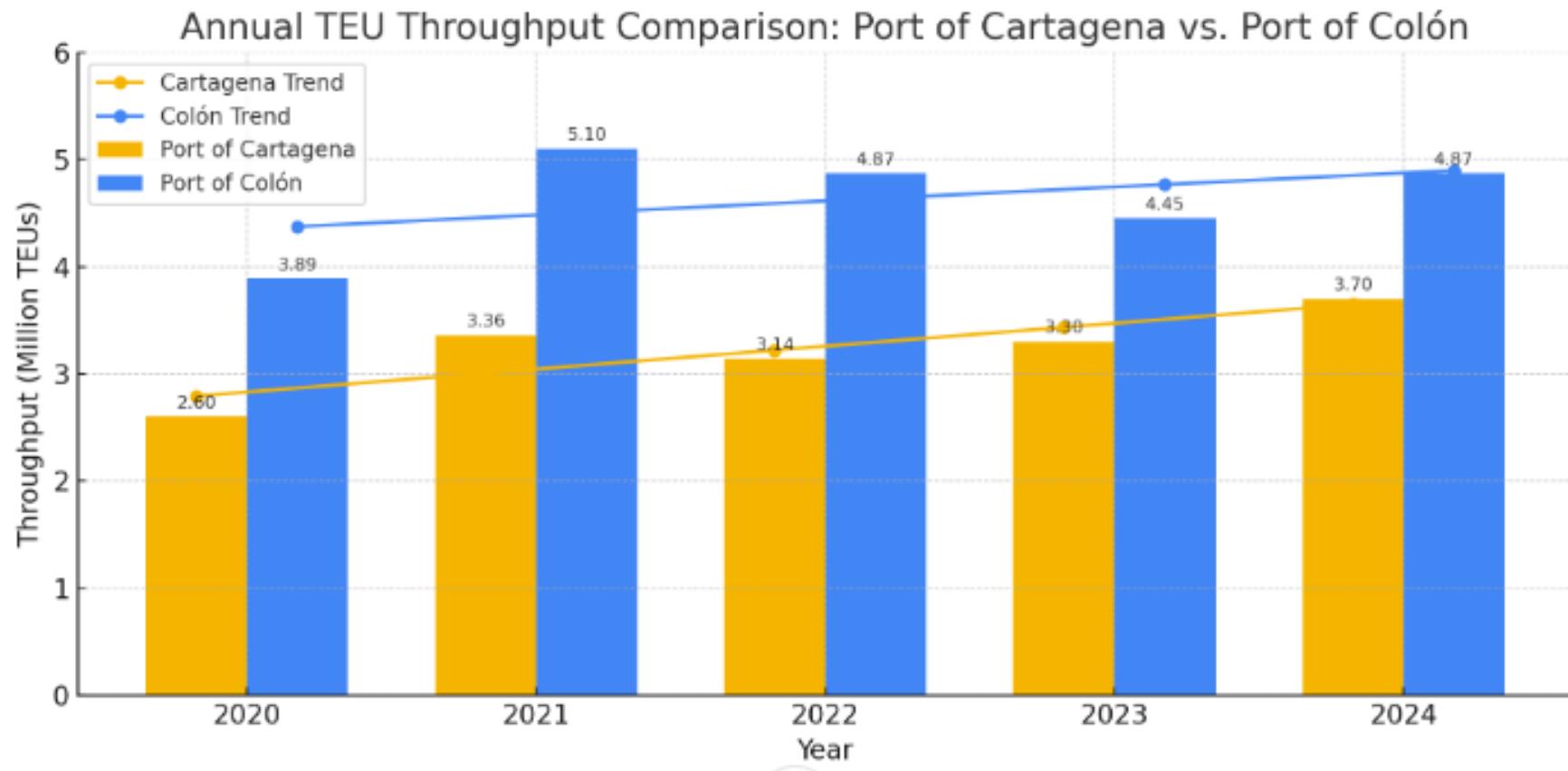


FIGURE 13: ANNUAL TEU THROUGHPUT COMPARISON CHART PORT OF COLON VS PORT OF CARTAGENA

Note. Data from Grupo Puerto de Cartagena. (2024) <https://www.puertocartagena.com>; Superintendencia de Transporte de Colombia. (2024). <https://www.supertransporte.gov.co>

As seen in figure 13 from 2020–2024, the port of Colón consistently handles a higher annual throughput at 4.8 – 5.1 million TEUs than Cartagena's 2.6 – 3.7 million TEUs (*World Shipping Council, 2024; Porteconomics, 2024*). Seeing as Colón moves almost twice as many TEUs than Cartagena, it justly reflects Colón as a major transshipment hub due to its connection to the most frequented port in the world: The Panama Canal (*TTNews, 2024*). In this port vessels can load and unload efficiently and relay cargo in global routes. Cartagena in contrast, handles smaller throughput and reflects a regional gateway port role. Its focus is import-export and feeder services in place of large-scale canal shipments, where Colón standouts as having a bigger strength in this aspect (*Labrut, 2023*).

Colón has an exceptional and arguably better position as it has a characterized east–west trade flow. This is due to its proximity and Atlantic entrance position to the Panama Canal and the presence of direct access to the Colón Free Trade Zone (CFTZ) (see appendix 2; *Trade.gov, 2024*). Cartagena is located 265 km from the world's most important canal and can't capture immediate canal-linked transshipment volumes. Instead, they rely more on intra-regional services that connect the U.S., Caribbean, and Europe (*Grupo Puerto de Cartagena, 2024*).

Colón has three deep-berth transshipment terminals that are equipped with innovative technology such as advanced cranes and digital automation (see appendix 2; *Logistics.gateh.pa, 2024*). It has permitted lower cost per unit at 380 USD per container, even though internal logistics remain high at 1,525 USD per container (*Oxford Business Group, 2023*). These technological advancements have allowed a steady throughput growth from 2.6 million TEUs in 2020 to 3.7 million in 2024 (*Superintendencia de Transporte de Colombia, 2024*). Cartagena operates with SPRC and CONTECAR, which are Port Community Systems that implement Port 4.0 practices (*SteerGroup.com, 2024*).

Panama's Free Zone regulations that include tax incentives for foreign companies and expedited customs that encourage transshipment activities have directly impacted the growth of the Colón Free Trade Zone. Additionally, they have supported the city's dominant regional role and exposed it to fluctuations in canal traffic and global trade volumes, which explains its slight slip between 2021 and 2023 (see figure 13 *Porteconomics, 2024*). Cartagena port growth is more linked towards diversification in exports supported by the Colombian regulatory framework and investment in sustainability, plus forming new maritime alliances (*Grupo Puerto de Cartagena, 2024; Seatrade Maritime, 2023*).

Whilst Colón outperforms its competitor in raw TEU output, Cartagena operational modernization and activities support its growth as a regional sustainable competitor, not in the pure transshipment scale that Colón is, posing an overall minor threat (*World Shipping Council, 2024*).

Chapter 10: Conclusion - Future Readiness

Overall, the port of Colón is largely ready for the future. This is because of the five phenomena (size, space, speed, smartness and sustainability). First, the port can handle large vessels because of the deep water channel, the berths, the quay length and the capacity of the vessels mentioned in chapter 5. The port of Colón is already increasing their demand due to the key factors mentioned before. These factors are necessary to keep pace with their competitors like the port of Cartagena. But for their future growth they have to improve the depth and channel limits, so that the largest ships that can handle up to 18,000 TEUs can come to the port easily.

The Manzanillo International Terminal is the most well positioned terminal because of the deep water location. The Colón Container Terminal benefits from the Free Trade Zone, reducing the berth time and the storage capacity of the TEUs. Also the good road and rail connections around the Colón Container Terminal. This terminal is for now efficient but the urban areas around the terminal face noise and pollution issues. And the heavy road traffic causes congestion near the port. The Cristobal Terminal is efficient because it is closed to the Colón city. Even though the Cristobal Terminal has multiple berths, the terminal has only a small space for container operations.

The digital tools that the port has such as PORTCEL and the Integrated Operations Control Center CICO are improving efficiency at the port and will keep supporting the growth of the port. The PORTCEL digitalizes the whole port by linking with all the workers to have a good connection. That will improve the future demand of the port and paperless activities. CICO improves efficiently on operational control and fast decision makings for any delays. Unfortunately, these digital platforms are highly expensive to upgrade or even to expand the automation.

The port has ongoing investments in technology, environment and community. The biggest environmental improvement of the port are the Hybrid Rubber Tyred Gantry cranes because these cranes reduced the fuel use by 90%. Unfortunately, these cranes are only available at one terminal, the port should also invest in these unbelievable cranes for the other two terminals. About the economic sustainability that have strengthened the port are the new 3,000 jobs created with around 108,000 employees in port related services. The ongoing infrastructure upgrades have reduced the ship stays. The port is basically increasing their competitiveness and efficiency in for a greener infrastructure. The port is also improving their social sustainability by having connections with the education of the city Colón. By doing this, the port is building a positive relationship for their port and strengthens their community with other social programs. Overall, the port is going in the right direction for being more sustainable.

By comparing with the Port of Cartagena, the strengths and weaknesses of the Port of Colon are clarified. In terms of strengths, the annual throughput of the Port of Colon is 4.8-5.1 million TEUs, which is double that of the Port of Cartagena with 2.6-3.7 million TEUs, which shows that the Port of Colon is a large-scale transshipment hub. Being located at the gateway to the Panama Canal and the Atlantic Ocean has helped to consolidate the superior strategic position of the Port of Colon in the global transport network.

In addition, the port also has modern and automated technology such as PORTCEL and CICO, which has significantly reduced operating costs per container and improved operational efficiency. Finally, the Port of Colon is located next to the Colon Free Trade Zone (CFZ) and has government support with attractive tax incentives that have supported the growth of the port and at the same time attracted more international investors.

However, in addition to the strengths mentioned above, the comparison with the Port of Cartagena also shows the weaknesses that the Port of Colon needs to overcome to become more future ready. First, the annual throughput of the Port of Colon, although high, is heavily dependent on the cargo traffic through the Panama Canal. Therefore, the port is very vulnerable to fluctuations in global trade. While having high productivity, domestic logistics costs are still high, reducing the port's operating efficiency from the optimal level. Besides, compared to the Port of Cartagena, the Port of Colon also lacks diversity in port operations because the port focuses mainly on transshipment instead of developing regional exports. Finally, the Port of Cartagena stands out with its application of Port 4.0 while the Port of Colon still has many limitations in green and sustainable transformation.

Thus, the comparison between the Port of Colon and the Port of Cartagena shows the superiority in scale, strategic location and annual throughput of the Port of Colon. On the other hand, this also shows dependence, lack of flexibility and insufficient diversity and sustainability.

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Appendix 1: Key Performance Indicator Chart

Name of Container Port:

Port of Colón

1. What kinds of ships visit the port? (Small, medium, or very large container ships.)

Input: All of them, but not the MGX-24.

Source of Information:

The Freight LLC. (2025, August 16). *Colon ,PAONX - The Freight*. The Freight. <https://thefreight.net/port/colon-paonx/>

2. How many ships arrive at the port? (Daily, weekly, or monthly.)

Input: 52 daily

Source of Information: *Port of Colon (Panama) - Arrivals, Departures, Expected vessels - VesselFinder*. (n.d.).

[https://www.vesselfinder.com/ports/PAONX002#:~:text=Colon%2C%20Panama%20\(PAONX\),Ships%20in%20port:%2028](https://www.vesselfinder.com/ports/PAONX002#:~:text=Colon%2C%20Panama%20(PAONX),Ships%20in%20port:%2028)

3. How long does a ship stay at the port from arrival to departure? (Turnaround time)

Input: 1.1 day (~19 hours)

Source of Information: CEICdata.com. (2025, March 18). *Panama Port congestion: port stay duration: colon: container ships*. Economic Indicators | CEIC.

<https://www.ceicdata.com/en/panama/port-congestion-port-stay-duration-by-port-and-vessel-type/port-congestion-port-stay-duration-colon-container-ships>

4. How long does a ship wait before it gets a spot at the dock? (*Berthing time from anchorage*)

Input: No publicly disclosed data.
Source of Information:

5. How many hours was the ship being loaded/unloaded vs. just waiting?

Input: No publicly disclosed data.
Source of Information:

6. How many TEUs were loaded & unloaded onto the ship?

Input: No publicly disclosed data.
Source of Information:

7. How long does a ship wait after arriving before it can dock?

Input: Average waiting time is 0.8 days (19-20 hours)
Source of Information: CEIC Data. (2025). *Panama: Port congestion – Port stay duration: Colon: All* [Data set]. CEIC. Retrieved September 16, 2025, from <https://www.ceicdata.com/en/panama/port-congestion-port-stay-duration-by-port-and-vessel-type/port-congestion-port-stay-duration-colon-all>

8. How many TEUs can the port handle in a day, week, or month?

Input: In a month, approximately 131.289 TEUs at the Colón Central Terminal.
Source of Information: Portal Logístico De Panama. (2025). Colon Container Terminal. [Colon Container Terminal - Panama Logistics Web Portal](#)

9. How long do trucks wait outside the port before entering?

Input: No publicly disclosed data.
Source of Information:

10. What type of live tracking system(s) does the port use to monitor ship and cargo movements?

Input: AIS Tracking systems for vessels, CCTV security images for the ports

Source of Information:

SSA Marine. (n.d.). *Proyección portuaria* [Port operations security page]. SSA Marine Panama. Retrieved September 16, 2025, from <https://www.ssamarine.pa/en/operations/proyecion-portuaria/>

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11. How long do containers stay at the port before being picked up or shipped out? (dwell time)

Input: Average dwell time is 9 days

Source of Information: Port Technology International. (2025, May). *Global ports see rising container dwell times in May*. Port Technology International. Retrieved September 2025, from <https://www.porttechnology.org/news/global-ports-see-rising-container-dwell-times-in-may/>

12. What are the port's earnings and costs per TEU or ship visit? Provide any other financial benchmarks used by the port.

Input: No publicly disclosed data.

Source of Information:

13. Energy consumption per TEU or ship call (How much energy is used to handle each container or ship visit)?

Input: No publicly disclosed data.

Source of Information:

14. Emissions per TEU or ship call: (How much pollution is created by each container or ship visit)?

Input: Emissions for a container ship around 0.14 tons per TEU

Source of Information: *Colon Port Overview | Strategic maritime hub in Panama.* (n.d.). seeded.ai. <https://seadex.safecube.ai/en/port/PAONX>

15. How does the port handle trash and leftover materials to follow environmental rules (waste management practices)?

Input: They often regulate and follow management laws such as Law No. 56, General Law of Ports (2008), and Integrated Management systems (IMS) that includes managing environmental impact.

Source of Information: Colon Container Terminal, S.A. (n.d.). *Integrated Quality, Safety, Occupational Health, Environment And Safety Management System Policy*. Retrieved from <https://www.cct-pa.com/organization-principles.html>

16. Which renewable energy sources does the port use?

Input: No source on renewable energy specifically in colon terminals, but Panama has lots of renewable energy specifically hydropower.
Source of Information: Prensa Latina. (2024, November 3). *Panama generates electricity from renewable sources of energy*. Prensa Latina. Retrieved September 2025, from <https://www.plenglish.com/news/2024/11/03/panama-generates-electricity-from-renewable-sources-of-energy/>

Appendix 2: Port comparison Chart

Criteria	 Port of Colón	 Port of Cartagena	citation
Infrastructure	Three large deep berths transshipment terminals, advanced cranes & high TEU capacity	Deep berth multipurpose terminals (CONTECAR, SPRC) with strong container capacity	puertocartagena.com manzanillo.com.pa
Proximity to Partners	Strategic positioning at Atlantic entrance to the Panama Canal & Direct access to Colón Free Trade Zone	Strategic location, 265 nm from Panama Canal with main US-Caribbean-European routes	trade.gov colonfreezone.com
Workforce	Highly productive and bilingual workforce; skilled labor with support from Panama canal logistics ecosystems	Skilled maritime workforce with expansion to maritime academies and the Cartagena Free Zone	investincartagena.com panamacanal.com
Port restrictions	Minimal cargo restrictions; operates under Panama Canal authority regulations	Minimal operational restrictions; operating as free zone with liberalized customs	Inspenet.com ; Trade.gov
Regulatory Environment	Situated within Panama's Free Zone with tax advantages and expedited customs processes	supportive regulatory environment that promotes sustainability and private investment	SteerGroup.com ; RVO.nl
Technology	Automation, digital tracking, and a double-rail interface are features of modern container terminals.	The Advanced Port Community System is putting "Ports 4.0" into practice.	Logistics.gatech.pa ; Inspenet.com
Costs	Lower operational cost and shorter inland transport times (~US \$390 per container to port).	Higher inland logistics cost (~US \$1,525 per container) due to internal transport time.	OxfordBusinessGroup.co
Revenue	Declining slightly due to reduced canal traffic and regional competition	Growing due to expansion of exports and increase in container routes	Trade.gov Reuters.com

