
**Massachusetts Institute of Technology**

# Assignment 2

*The Panama Canal Expansion Plan and its Effect On the Intermodal US Mini-Landbridge Service*

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# Introduction

The Panama Canal Authority (ACP) has proposed an expansion plan for the Panama Canal (the Canal) to be implemented by 2014. The plan is deemed necessary for the Canal to remain competitive with alternate worldwide trade routes for two primary reasons. First, as total world tonnage being shipped increases, so have ship sizes, many of which are post-Panamax in size. This growing fleet is a market share that the *current* Canal obviously cannot serve, which suggests that **larger** locks and navigation channels will be needed to remain competitive. Secondly, the Canal is already operating at about 85% capacity, with demand ever-increasing, and as a result causes many delays on a regular basis. This capacity crunch suggests that **more** locks in parallel to those in operation are needed for the Canal to remain competitive. The ACP's plan accounts for both of these needs, as it suggests adding a new set of locks that are larger than the original.

The scope of this project has been influenced heavily by the markets that the Canal is likely to serve. The primary revenue-generators have become containerships (40% of total revenues in 2005), dry bulkers (19%), and car carriers (11%) (Panama Canal Authority). Post-Panamax containerships, capesize bulkers, VLCC/ULCC's, and even many cruise ships are all too large to transit the Canal, though are built because of their economies of scale. Despite their size, these vessels can operate for two reasons. First, many trade routes operate independently of the need to transit the Canal, such as the container trade between India and Europe. Secondly, those trades that might have involved the Canal find alternatives. A prominent example of this is the US "mini-landbridge" concept, where cargo is brought to the US west coast via containership, then shipped via rail to markets on the US east coast.


**Figure 1. Two APL routes from Asia to NYC: all sea (left) and mini-landbridge (right)**

*Source: APL website*

Courtesy of APL Limited. Used with permission.

The primary target of the Panama Canal expansion project is the containership market, which is growing both in ship size and tonnage. In that market, the US mini-landbridge is perhaps the strongest realistic competitor of all

potential trades. This fact raises the very serious question of how each service will affect the other after construction.

## Market outlook

Before examining either the Panama Canal or mini-landbridge routes, it is important to establish the market within which both are competing. One valuable indicator is containership fleet growth. Capacity is growing rapidly, with most companies claiming that it is additional, not replacement. It is expected that, out of this growth, liner capacity on the trans-Pacific trade will grow 12% by the end of 2006. This estimate includes eight carriers that will have expanded their fleets by more than 15% (Damas, P.)! The size of ships is growing as well. Between 1995 and 2005, the average containership size fleet grew from 1,535TEU to 2,230TEU (R.K. Johns & Associates). Post-Panamax fleet expansion is illustrated in Figure 2.

**Post-Panamax Container Vessel Fleet**

| Shipping Company | Existing Post-Panamax Vessel Fleet (Feb. 2006) | | | New Orders forPost-Panamax Container Vessels | | | Total Fleet in 2011 | |
|---|---|---|---|---|---|---|---|---|
| | Total Capacity of existing Post-Panamax Vessels | TEU Range | Total Existing Post-Panamax Vessels | Total Capacity of New Orders | TEU Range | Total Post-Panamax Vessels on order | Number of Post-Panamax Vessels | TEU Capacity |
| Maersk Line* | 409,066 | 3,700 - 9,200 | 62 | 388,108 | 12,000 - 6,500 | 42 | 104 | 797,174 |
| Mediterranean Shipping (MSC) | 146,525 | 9,200 - 5,500 | 20 | 95,000 | 9,200 - 5,500 | 13 | 33 | 241,525 |
| CMA-CMG | 107,074 | 9,160 - 5,700 | 16 | 42,920 | 9,160 - 8,200 | 5 | 21 | 149,994 |
| Evergreen Mar. Co. | 151,310 | 5,364 - 7024 | 27 | 57,241 | 7,024 | 8 | 35 | 208,551 |
| Hapag Lloyd Cont. | 45,916 | 8,600 - 7,180 | 6 | 50,600 | 8,600 - 8,100 | 6 | 12 | 96,516 |
| China Shipping | 81,712 | 8,468 - 5,618 | 14 | 52,230 | 9,580 - 8,530 | 6 | 20 | 133,942 |
| Hanjin Shipping Co. | 37,126 | 5,308 | 7 | 52,000 | 6,500 | 8 | 15 | 89,126 |
| APL | 92,030 | 5,500 - 4,300 | 20 | | | | 20 | 92,030 |
| Coscon | 84,978 | 5,270 - 5,576 | 16 | 80,000 | 10,000 | 8 | 24 | 164,978 |
| Nippon Yusen Kaisha (NYK) | 79,179 | 6,492 - 4,743 | 13 | 123,600 | 8,200 - 6,500 | 16 | 29 | 202,779 |
| Mitsui O.S.K. | 71,537 | 4,708 - 6,350 | 13 | 80,350 | 8,100 - 6350 | 11 | 24 | 151,887 |
| OOCL | 115,632 | 8,063 - 4,960 | 20 | 32,252 | 8,063 | 4 | 24 | 147,884 |
| K"Line" | 78,220 | 5,500 - 5,624 | 14 | 87,546 | 8,120 - 5,624 | 12 | 26 | 165,766 |
| Yang Ming | 55,132 | 5,512 | 10 | 73,000 | 8,000 | 9 | 19 | 128,132 |
| Hamburg Sud | 33,312 | 5,552 | 6 | 55,560 | 5,500 | 10 | 16 | 88,872 |
| Hyundai | 32,315 | 4,411 - 5,700 | 6 | 116,400 | 8,600 - 6,800 | 15 | 21 | 148,715 |
| Others | 895,884 | 4,330 - 9,449 | 135 | 680,083 | 9,580 - 5,527 | 89 | 224 | 1,575,967 |
| **Total** | **2,516,948** | | **405** | **2,066,890** | | **262** | **667** | **4,583,838** |

*Includes vessels from P&O Nedlloyd, now Maersk Line.
Source: Shipping Intelligence Network, 1 February 2006, Clarkson Research Services

**Figure 2. Newbuild schedule for post-Panamax containerships**

*Courtesy of Panama Canal Authority.*

*Source: PanCanal.com.*

Despite the overall strong containership capacity growth, demand growth in this market has actually decreased over the past few years, as shown in Figure 3.

| *Year* | *Eastbound Growth* | *Westbound Growth* |
|---|---|---|
| 2004 | 15.60% | -- |
| 2005 | 11.60% | 10.40% |
| 2006 | 8.00% | 5.30% |
| 2007 | 6.60% | 5.70% |

**Figure 3. Near-term trans-Pacific trade growth**

*Source: Damas, P.*

While this near-term overcapacity has led to some rate volatility, long-term growth is inevitable by virtually all measures. The ACP supports this notion, as illustrated by their estimated demand growth through 2025 shown in Figure 4.

| PCUMS Tons Per Market Segment* | Year 2005 | Year 2025 | |
|---|---|---|---|
| | | Canal without an expansion | Canal with an expansion |
| Containers | 98 | 185 | 296 |

**Figure 4. Expected containership tonnage demand on Panama Canal**

*Courtesy of Panama Canal Authority.*

*Source: PanCanal.com.*

# Panama Canal status

## *Expansion project*

An expansion of the original Panama Canal was considered all the way back in 1939, when the US Army Corps of Engineers began to cut a path parallel to the locks at either end for the construction of additional, larger locks. The locks were intended to accommodate the largest war and commercial vessels of their day. Significant work was completed until 1942, when construction stopped due to US involvement in WWII. While no work had yet begun on the lock installations, new cuts were made. These cuts are still intact and will be used as the starting points for the new construction effort.

The current Canal lock system is composed of three sets of locks. The Gatun Locks lie on the Atlantic side and consist of two lanes of three locks each that raise and lower vessels from the Gulf of Mexico eighty feet to Gatun Lake. The Pedro Miguel Locks are closer to the Pacific side, and consist of two lanes of one lock each that raise and lower vessels from Gatun Lake to an intermediate level. The final set of locks are the Miraflores Locks, which consist of two lanes of two locks each, and they raise and lower vessels from that intermediate level to the Pacific Ocean.

The modified configuration is to consist of two sets of locks. Each lock set will consist of one lane of three locks each. Each lock set will raise and lower vessels from sealevel to the Gatun Lake level. Figure 5 and Figure 6 illustrate the modifications.

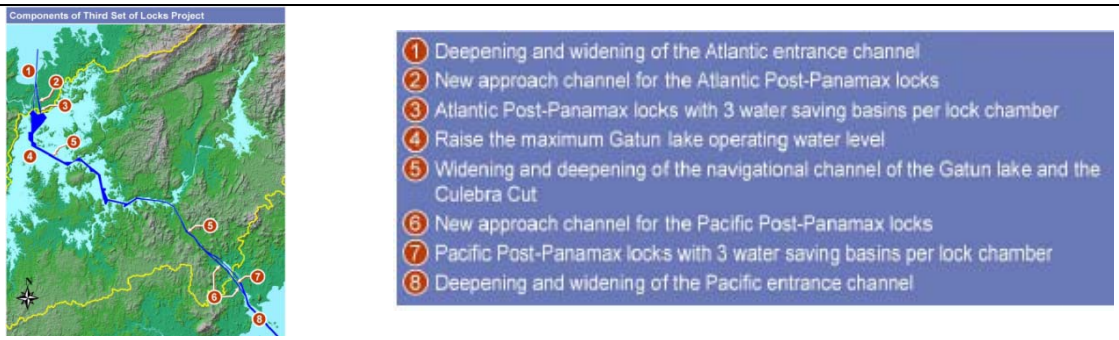


**Figure 5. Panama Canal expansion description**

*Courtesy of Panama Canal Authority.*
*Source: PanCanal.com.*

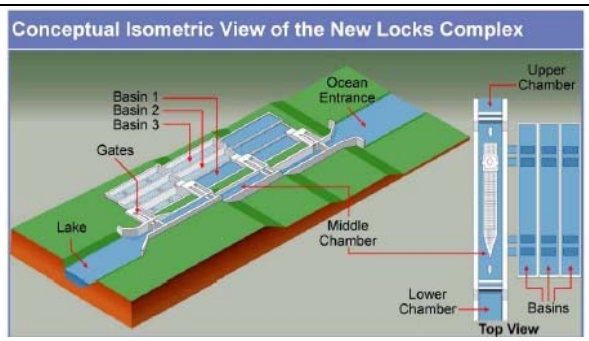


**Figure 6. New lock arrangement**

*Courtesy of Panama Canal Authority.*

*Source: PanCanal.com.*

The new lock dimensions are to be 427m in length, 55m in breadth, and 18.3m in depth. The ACP claims that these dimensions should be capable of handling vessels with an LOA of 366m, B of 49m, and T of 15m, though it is likely that ship owners will push the limits further over time. These tentative dimensions correlate roughly to a 10,000TEU containership. The project is slated to be complete by 2014.

## *Other projects*

The ACP is already undergoing some other projects to boost Canal capacity in an effort to stay ahead of demand. Without these smaller projects, ACP data suggests that 100% Canal capacity would likely be reached by late 2007. The side projects under development include installing an enhanced lock lighting system; installing two tie-up stations at the Gaillard Cut; widening the Gaillard Cut; improving the tug fleet; implementing an improved scheduling system; dredging Gatun Lake; modifying the existing lock structures to increase allowable draft by 0.3m; deepening the Pacific and Atlantic entrances; and constructing a new spillway in Gatun Lake for flood control.

Figure 7 illustrates the current and estimated capacity and demand of the Canal over the next twenty years. The modifications currently underway provide the step-wise capacity increases shown between 2006 and 2011, while the large step in 2014 reflects the new lock capacity.

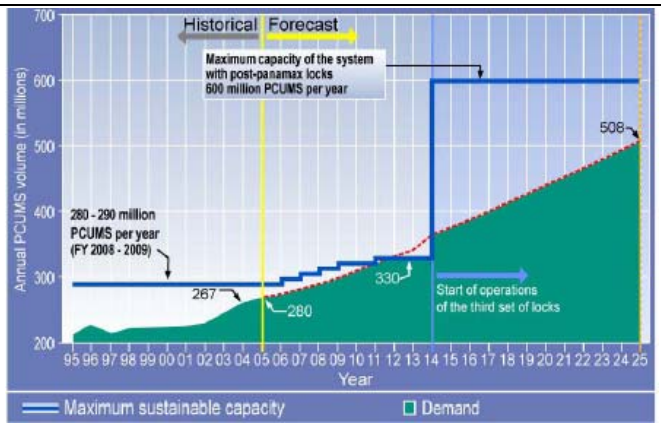


**Figure 7. Capacity increase expected at the Canal**

*Courtesy of Panama Canal Authority.*

*Source: PanCanal.com.*

## *US east coast ports*

Any all-sea transportation route to the US east coast is dependent upon east coast ports being able to handle the traffic. These ports are currently expanding their operation, as shown in Figure 8.

**Main U.S. East Coast Ports**

| Port | Movements Year 2005 (M. TEU) | Capacity (M. TEU) | | Investment | Current Maximum Depth | Improvements |
|---|---|---|---|---|---|---|
| | | Current | Future | | | |
| NY/NJ | 4.40 | 4.60 | 6.20 | B/. 1,700 M. | 14m (46') | Channel deepening to 15.24m (50') of draft, additional space, 4 Post-Panamax cranes |
| Savannah | 1.70 | 2.41 | 4.37 | B/. 707 M. | 12.8m (42') | 640m (2,100') dock length, storage area, Post-Panamax cranes, deepening to 14.6m (48') |
| Charleston | 1.98 | 2.00 | 4.00 | B/. 823 M. | 13.7m (45') | Construction of new terminal, 4 Super Post-Panamax cranes, yard equipment |
| Virginia | 1.98 | 2.40 | 10.22 | B/. 2,756 M. | 13.7m (45') | APM terminal will be complete by July 2007, channel dredging from 15.2m (50') to 16.8, (55'), 29 Post-Panamax cranes, inland port, long term: construction of Craney Island terminal (2017 - 2032) |

Source: Port Authorities, April 2006

**Figure 8. Capacity increase expected at east coast ports**

*Courtesy of Panama Canal Authority.*

*Source: PanCanal.com.*

Between 2001 and 2010, ports are expected to increase capacity by 38%, with most focus on northern ports at 52% and southern ports at 22%. While these ports remain congested and often have queues waiting to enter, these expansion rates are expected to keep with port demand (World Containerport Outlook).

While the planned modifications should serve to improve port capacity, east coast port efficiency is quite low at 2,000 TEU/yr/acre, while the world

standard is around 10-15,000 TEU/yr/acre (Damas, P.). Further, real estate costs for east coast ports remain some of the highest around, and environmental regulations often hinder expansion. These factors are serious today, and are likely to become even more significant over time. The health of these east coast ports is vital to a successful all-water trade route.

# Mini-landbridge status

## *US west coast ports*

US west coast ports face even tougher problems than do east coast ports. They are currently operating at high capacities and are also limited in options to increase their throughput. One reason for this, as on the east coast, is the cost of property. Another reason is the even more-stringent environmental regulations that exist to minimize dredging, raise air emissions standards, and limit expansion. The environmental regulations are beginning to be passed on to shippers as well. This may tend to shift traffic away from ports such as those of Los Angeles and Long Beach, which are phasing in air-emission standards for all vessels calling on the port over the next five years.

Contrast this to the other side of the Pacific, where many Chinese ports are doubling or tripling their capacities in the immediate timeframe. Further, it is estimated that these ports may only reach 51% utilization in 2009, meaning that the full effect of these ports may lie further in the future. To match such expansion, it is estimated that the west coast would have to add a port the size of Port Elizabeth each year (Damas, P.).

West coast ports are expected to increase capacity by about 35% between 2001 and 2010, with a 28% increase in the north and 38% increase in the south. Capacity improvements are expected to be sufficient for northern ports, though southern port capacity, which is most crucial, is expected to be insufficient. This also may shift business north (World Containerport Outlook).

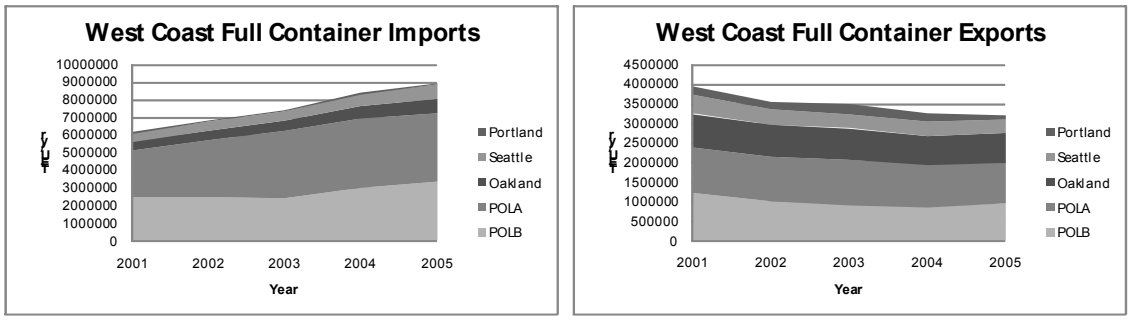


**Figure 9. Imports and exports for the major west coast ports**

*Source: Websites of the Ports of Portland, Seattle, Oakland, Los Angeles, and Long Beach*

Similar to east coast ports, these ports are also not as efficient as their foreign counterparts, operating at about 5,000 TEU/yr/acre (versus the 15,000 TEU/yr/acre world average). In the same light, Hong Kong, Singapore, and

Taiwan generate 610-700,000 TEU/yr/berth while west coast ports average around 350,000 TEU/yr/berth (Damas, P.).

It appears that these inefficiencies exist not due exclusively to a lack of infrastructure, but instead to logistics management. This may be an opportunity for the ports to increase capacity without requiring more land, berth space, or equipment.

There is also talk of a possible port in Canada or, more likely, Mexico, that would provide a similar mini-landbridge service to those offered along the US west coast. However, at this point it is just that: talk. Any new port would not be online for years and may find significant political opposition from existing ports. Shipping such a high volume over the US border would also raise considerable security concerns.

### *US rail system*

The mini-landbridge option was not economically feasible until the advent of double-stacked trains. Still, container shipping remains a lower margin cargo for railroads than chemicals and coal. Infrastructure improvements are being made, however, to handle the growth coming through west coast ports, such as the effort to double-track virtually the entire corridor between Los Angeles and Chicago by 2007 (Damas, P.). Overall, though, the system is congested, has been known to cause backups at the ports, and requires substantial capital investments to increase capacity.

## Each option and its market

### *Mode comparison*

Generally, the mini-landbridge route is quicker, less reliable, and more expensive. The all-water Panama Canal route is longer, more reliable, and less expensive.

Time favors the landbridge option because a significant amount of sailing distance is replaced by rail, which is both faster and has less distance to cover. Reliability favors the Canal option because there are fewer intermodal transfers and choke points. Consider the landbridge involves two additional intermodal transfers and many possible rail bottlenecks throughout the country. Conversely, the Panama Canal is a sole potential bottleneck on the all-water route. Both options are subject to port congestion.

Cost also favors the Canal option since the Canal transit toll plus additional daily operating vessel costs due to the longer transit time still amount to significantly less money than the additional intermodal and trans-continental rail transfer costs required by the mini-landbridge. Figure 10 offers a simple and rough calculation amongst the mini-landbridge, Panama Canal as it is, Panama Canal with expansion, and Suez Canal. The calculation of these values is provided in *Appendix A. Cost calculation amongst routes*.

The Canal expansion project has already had the short-term effect of making that route more expensive due to the increased tolls, though is likely to have a long-term effect of lowering cost since, although tolls are based upon tonnage and is therefore linear with ship capacity, operating larger ships on an all-water route through the Canal will increase the ship's economy of scale. This is likely to lower overall cost, as illustrated in Figure 10.

**Container service from Japan to NYC**

| | Mini-Landbridge | Panama Canal (now) | Panama Canal (expanded) | Suez Canal |
|---|---|---|---|---|
| **Fleet and Vessel Particulars** | | | | |
| | Fleet size 5 vessels<br>Vessel size 10000 TEU<br>Throughput 520000 TEU/yr | Fleet size 8 vessels<br>Vessel size 4800 TEU<br>Throughput 249600 TEU/yr | Fleet size 8 vessels<br>Vessel size 10000 TEU<br>Throughput 520000 TEU/yr | Fleet size 10 vessels<br>Vessel size 10000 TEU<br>Throughput 520000 TEU/yr |
| **Opex to Operator** | | | | |
| | Cost $ 2,475 /TEU<br>Time 17 days | Cost $ 1,079 /TEU<br>Time 26 days | Cost $ 978 /TEU<br>Time 26 days | Cost $ 1,093 /TEU<br>Time 35 days |
| **Current Market Share (more generally, Asia to US east coast)** | | | | **All data adapted from ACP estimates* |
| | **61%** | **38%** | **-** | **1%** |
| **Capacity Limitations** | | | | |
| | West coast port expansion limited<br>Rail capacity increase slow and not aggressive | Size limitations on vessels<br>Canal currently at 85% capacity<br>East coast port expansion limited | Size limitation only for largest vessels<br>Excess Canal capacity expected at least 'til 2025<br>East coast port expansion limited | Suez Canal capacity |

**Figure 10. Cost comparison among options**

*Source: Appendix A. Cost calculation amongst routes*

Figure 11 displays the average published freight rate for various trades. This is included as a benchmark for comparison of the accuracy of the cost data estimated in Figure 10. While freight rates are a function of the market price and not operator costs, shipping is generally not a very high-margin business, so it should be expected that freight rates should not exceed costs by more than 10-20%. Conversely, with intermodal transfers and some (but perhaps not all) surcharges applied, Figure 10 estimates the cost to be $745/TEU for service between Asia and the west coast. This is considerably less than the rate of $1,836 provided in Figure 11.

This discrepancy suggests that certain costs may have been overlooked. Most likely these costs are primarily additional surcharges and overhead. However, the accuracy of these calculations may be somewhat reasonable since often times the front-haul trip subsidizes the back-haul, which may provide significantly less profit (and, as Figure 11 suggests, also commands a much smaller freight rate at $818/TEU).

Whether the absolute values of Figure 10 are accurate or not may be in question, though it is really the *relative* values among the different modes that are of interest, and do seem reasonable. For this basic analysis, it will be assumed that any additional costs incurred will affect each option similarly.

Graph removed due to copyright restrictions.

## *Outlook conclusions*

Neither the expanded Canal nor the mini-landbridge option can sustain the entire market alone. It should therefore be little concern to Panamanians that the Panama Canal expansion project will have turned out to be a long-term failure (though it may take longer than expected to pay for itself).

Instead, it is likely that, with west coast US port capacity so tight, the market will drive most ships that *can* transit the new Canal to it. This transition will relieve the limited west coast ports by reserving them almost exclusively for the largest ships in the trade.

Focusing the largest ships on the landbridge route will make it more competitive by taking advantage of the vessel's economy of scale. It will also partially free up ports from the added congestion of turning around ships that can otherwise utilize the Canal. Since the new Canal should have excess capacity for quite some time, there remains little reason to operate Panamax vessels to west coast ports.

Placing these large ships in west coast ports, however, will require continued effort from the ports. Deeper harbors, stronger tugs, and larger cranes, which are all difficult sells to "environmentally-minded" west coast residents and municipalities, may have to be pursued. Port logistics must also improve to increase land-use efficiency and, ultimately, throughput. Should this occur, the landbridge option's reliability may, in-turn, improve, and command an even higher premium.

Ultimately, the true difference between the all-water and mini-landbridge routes is in the hands of the west coast ports and rail infrastructure. Panama has already decided to address rising demand. If the ports are up to the challenge,

then they may retain much of their current market share, which stands at 61% to the Canal's 38%. The current split in market share also suggests something about current liner service cargo. Despite the extra cost, port delays, and volatility associated with mini-landbridge transport, the time-value of most cargoes must be quite high to warrant the high premium paid by cargo owners and headaches experienced by operators associated with operating this service. This puts the ports and railroads at a strategic advantage that will require improved service to fully harness.

The problem for ports becomes even tougher since Canal service is now not only about to expand, but also improve. Costs will decrease with larger ships using the Canal and volatility will decrease for at least the next decade or so with the projected excess capacity. Depression of these costs may sway some cargo owners to accept longer lead times in exchange for cheaper rates.

Ultimately, it is highly likely that the Canal will both change the split of what ships cruise where. It will undoubtedly draw a larger market share. But, in the end, operators are the real winners. Ports will have to improve their operation to compete and the average size of ship calling at the ports will increase. This has the potential of decreasing volatility to the carriers. The Canal will also have excess capacity with which to relieve congestion, also improving service.

The next decade will be interesting to watch how carriers utilize the newfound capacity, and how the mini-landbridge players will respond.

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# Appendix A. Cost calculation amongst routes

**Container service from Japan to NYC**

| | Mini-Landbridge | Panama Canal (now) | Panama Canal (expanded) | Suez Canal |
|---|---|---|---|---|
| **Vessel Particulars** | | | | |
| Vessel size | 10,000 TEU | 4,800 TEU | 10,000 TEU | 10,000 TEU |
| Utilization | 85% | 85% | 85% | 85% |
| Effective TEU | 8500 TEU | 4080 TEU | 8500 TEU | 8500 TEU |
| Throughput | 442000 TEU/yr | 212160 TEU/yr | 442000 TEU/yr | 442000 TEU/yr |

**Opex to Operator**

| *Movement* | *Time day* | *Cost USD/TEU* | *Movement* | *Time day* | *Cost USD/TEU* | *Movement* | *Time day* | *Cost USD/TEU* | *Movement* | *Time day* | *Cost USD/TEU* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dock in Japan | 1 | $ 3 | Dock in Japan | 1 | $ 6 | Dock in Japan | 1 | $ 3 | Dock in Japan | 1 | $ 3 |
| Transfer to ship | | $ 200 | Transfer to ship | | $ 200 | Transfer to ship | | $ 200 | Transfer to ship | | $ 200 |
| Japan to POLA/POLB | 9 | $ 119 | Japan to Panama | 15 | $ 258 | Japan to Panama | 15 | $ 199 | Japan to Suez Canal | 18 | $ 239 |
| Dock in POLA/POLB | 1 | $ 3 | Panama Canal transit | 2 | $ 88 | Panama Canal transit | 2 | $ 81 | Suez Canal | 2 | $ 77 |
| Transfer to rail | | $ 200 | Panama to Elizabeth, NJ | 7 | $ 121 | Panama to Elizabeth, NJ | 7 | $ 93 | Suez to Elizabeth, NJ | 13 | $ 172 |
| Rail to NYC | 5 | $ 1,500 | Dock in Elizabeth | 1 | $ 6 | Dock in Elizabeth | 1 | $ 3 | Dock in Elizabeth | 1 | $ 3 |
| Ship to truck to dest | 1 | $ 200 | Ship to truck to dest | | $ 200 | Ship to truck to dest | | $ 200 | Ship to truck to dest | | $ 200 |
| Surcharge(s) | | $ 250 | Surcharge(s) | | $ 200 | Surcharge(s) | | $ 200 | Surcharge(s) | | $ 200 |
| | **17** | **$ 2,475** | | **26** | **$ 1,079** | | **26** | **$ 978** | | **35** | **$ 1,093** |
| | **Times modeled from APL's PCE route* | | **Times modeled from APL's APX route* | | | **Times modeled from APL's APX route* | | | **Times modeled from Maersk's AE2, TA2, and estimates* | | |

| Assumptions | | | *References (see Works Cited/Works Consulted)* |
|---|---|---|---|
| *Fuel cost (4 800TEU ship) =* | $ 47,633 | /day | *Containership-info website (45,000kW main for 4800TEU ship, 0.90 svc margin, SFOC 165g/kW-hr, 297$/MT fuel)* |
| *Fuel cost (10 000TEU ship) =* | $ 84,681 | /day | *Containership-info website (80,000kW main for 10000TEU ship, 0.90 svc margin, SFOC 165g/kW-hr, 297$/MT fuel)* |
| *Lease cost (4 800TEU ship) =* | $ 35,000 | /day | *Beddow, M., cost for operator ($35000/day lease rate, including crewing and maintenance, for a 5500TEU ship)* |
| *Lease cost (10 000TEU ship) =* | $ 48,000 | /day | *Beddow, M., cost for operator ($48000/day lease rate, including crewing and maintenance, for a 8500TEU ship)* |
| *Total cost (4 800TEU ship) =* | $ 17.22 | /TEU-day | *Fuel + lease cost* |
| *Total cost (10 000TEU ship) =* | $ 13.27 | /TEU-day | *Fuel + lease cost* |
| *Flat port fee =* | $ 24,000 | /vessel | *Estimated (Professor Marcus)* |
| *Intermodal transfer =* | $ 200 | /TEU | *Estimated (Professor Marcus)* |
| *Rail LA to NYC=* | $ 1,500 | /TEU | *Estimated (Professor Marcus)* |
| *Panama Canal fee =* | $ 54 | /TEU | *Thornby, C.* |
| *Suez Canal fee =* | $ 50 | /TEU | *R.K. Johns & Associates Inc.* |
| *TSA surcharge for Asia to US WC =* | $ 75 | /TEU | *Damas, P.* |
| *TSA surcharge for intermodal transfers =* | $ 175 | /TEU | *Damas, P.* |
| *TSA surcharge for Asia to US EC via Pan/Suez Canal =* | $ 200 | /TEU | *Damas, P.* |

***Note: These calculations are a rough estimate of operating expenses only, the fleet sizes must also be considered as a Capex***

| | Mini-Landbridge | Panama Canal (now) | Panama Canal (expanded) | Suez Canal |
|---|---|---|---|---|
| **Required Fleet Size for Weekly Service (based on cruising time)** | **5** | **8** | **8** | **10** |
| **Current Market Share (more generally, Asia to US east coast)** | **61%** | **38%** | **-** | **1%** |
| | | | | **All data adapted from ACP estimates* |
| **Capacity Limitations** | West coast port expansion limited<br>Rail capacity increase slow and not aggressive | Size limitations on vessels<br>Canal currently at 85% capacity<br>East coast port expansion limited | Size limitation only for largest vessels<br>Excess Canal capacity expected at least 'til 2025<br>East coast port expansion limited | Suez Canal capacity |

**Container service from Japan to NYC**

| | Mini-Landbridge | Panama Canal (now) | Panama Canal (expanded) | Suez Canal |
|---|---|---|---|---|
| **Vessel Particulars** | | | | |
| Vessel size | 10,000 TEU | 4,800 TEU | 10,000 TEU | 10,000 TEU |
| Utilization | 85% | 85% | 85% | 85% |
| Effective TEU | 8500 TEU | 4080 TEU | 8500 TEU | 8500 TEU |
| Throughput | 442000 TEU/yr | 212160 TEU/yr | 442000 TEU/yr | 442000 TEU/yr |

**Opex to Operator**

| *Movement* | *Time day* | *Cost USD/TEU* | *Movement* | *Time day* | *Cost USD/TEU* | *Movement* | *Time day* | *Cost USD/TEU* | *Movement* | *Time day* | *Cost USD/TEU* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dock in Japan | 1 | $ 3 | Dock in Japan | 1 | $ 6 | Dock in Japan | 1 | $ 3 | Dock in Japan | 1 | $ 3 |
| Transfer to ship | | $ 200 | Transfer to ship | | $ 200 | Transfer to ship | | $ 200 | Transfer to ship | | $ 200 |
| Japan to POLA/POLB | 9 | $ 119 | Japan to Panama | 15 | $ 258 | Japan to Panama | 15 | $ 199 | Japan to Suez Canal | 18 | $ 239 |
| Dock in POLA/POLB | 1 | $ 3 | Panama Canal transit | 2 | $ 88 | Panama Canal transit | 2 | $ 81 | Suez Canal | 2 | $ 77 |
| Transfer to rail | | $ 200 | Panama to Elizabeth, NJ | 7 | $ 121 | Panama to Elizabeth, NJ | 7 | $ 93 | Suez to Elizabeth, NJ | 13 | $ 172 |
| Rail to NYC | 5 | $ 1,500 | Dock in Elizabeth | 1 | $ 6 | Dock in Elizabeth | 1 | $ 3 | Dock in Elizabeth | 1 | $ 3 |
| Ship to truck to dest | 1 | $ 200 | Ship to truck to dest | | $ 200 | Ship to truck to dest | | $ 200 | Ship to truck to dest | | $ 200 |
| Surcharge(s) | | $ 250 | Surcharge(s) | | $ 200 | Surcharge(s) | | $ 200 | Surcharge(s) | | $ 200 |
| | **17** | **$ 2,475** | | **26** | **$ 1,079** | | **26** | **$ 978** | | **35** | **$ 1,093** |
| | **Times modeled from APL's PCE route* | | **Times modeled from APL's APX route* | | | **Times modeled from APL's APX route* | | | **Times modeled from Maersk's AE2, TA2, and estimates* | | |

| Assumptions | | | *References (see Works Cited/Works Consulted)* |
|---|---|---|---|
| *Fuel cost (4 800TEU ship) =* | $ 47,633 | /day | *Containership-info website (45,000kW main for 4800TEU ship, 0.90 svc margin, SFOC 165g/kW-hr, 297$/MT fuel)* |
| *Fuel cost (10 000TEU ship) =* | $ 84,681 | /day | *Containership-info website (80,000kW main for 10000TEU ship, 0.90 svc margin, SFOC 165g/kW-hr, 297$/MT fuel)* |
| *Lease cost (4 800TEU ship) =* | $ 35,000 | /day | *Beddow, M., cost for operator ($35000/day lease rate, including crewing and maintenance, for a 5500TEU ship)* |
| *Lease cost (10 000TEU ship) =* | $ 48,000 | /day | *Beddow, M., cost for operator ($48000/day lease rate, including crewing and maintenance, for a 8500TEU ship)* |
| *Total cost (4 800TEU ship) =* | $ 17.22 | /TEU-day | *Fuel + lease cost* |
| *Total cost (10 000TEU ship) =* | $ 13.27 | /TEU-day | *Fuel + lease cost* |
| *Flat port fee =* | $ 24,000 | /vessel | *Estimated (Professor Marcus)* |
| *Intermodal transfer =* | $ 200 | /TEU | *Estimated (Professor Marcus)* |
| *Rail LA to NYC=* | $ 1,500 | /TEU | *Estimated (Professor Marcus)* |
| *Panama Canal fee =* | $ 54 | /TEU | *Thornby, C.* |
| *Suez Canal fee =* | $ 50 | /TEU | *R.K. Johns & Associates Inc.* |
| *TSA surcharge for Asia to US WC =* | $ 75 | /TEU | *Damas, P.* |
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