The impact of ever larger vessels on terminals


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Introduction

Since the first fully cellular container vessels of the early 1970s commenced service, we have experienced container ship capacities increasing from 2,400 TEU (240m long) to the latest generation of 18,000 TEU (400m long). In time, ship capacities could even reach 24,000 TEU (456m long).

Container terminals have historically built berths to be anywhere between 300 and 360m, so it seems that the new generations of ships may have become too large for contemporary berths. This paper will consider the impact of larger vessels on terminals, analysing myth versus fact, as well as offer some ideas as to how lines and terminals can best operate moving forwards as more and more large ships characterise the appearance of the industry.

Dimensionally, how have ships evolved?

Until the mid-1990s, when lines decided to build container vessels which exceed Panama Canal (primarily width) limitations, a lot of the additional capacity created on new vessel classes was achieved through increasing the length. This resulted in long narrow ships which suffered major issues in terms of stability, bending and torsion; meaning that on some routes, for every 3 tonnes of cargo loaded, 1 tonne of ballast water was also required to be carried in addition to full fuel loads for vessel safety at sea.

Since the mid-1990s, we have seen the beam of vessels increase proportionately faster than the length, and that means that in terms of TEU capacity per metre of vessel length, we have experienced a doubling over the last 18 years, from 21 to 45 TEU capacity per metre. For the next generation, we are likely to see ship length increase dramatically, but these ships will still have a higher TEU per metre.

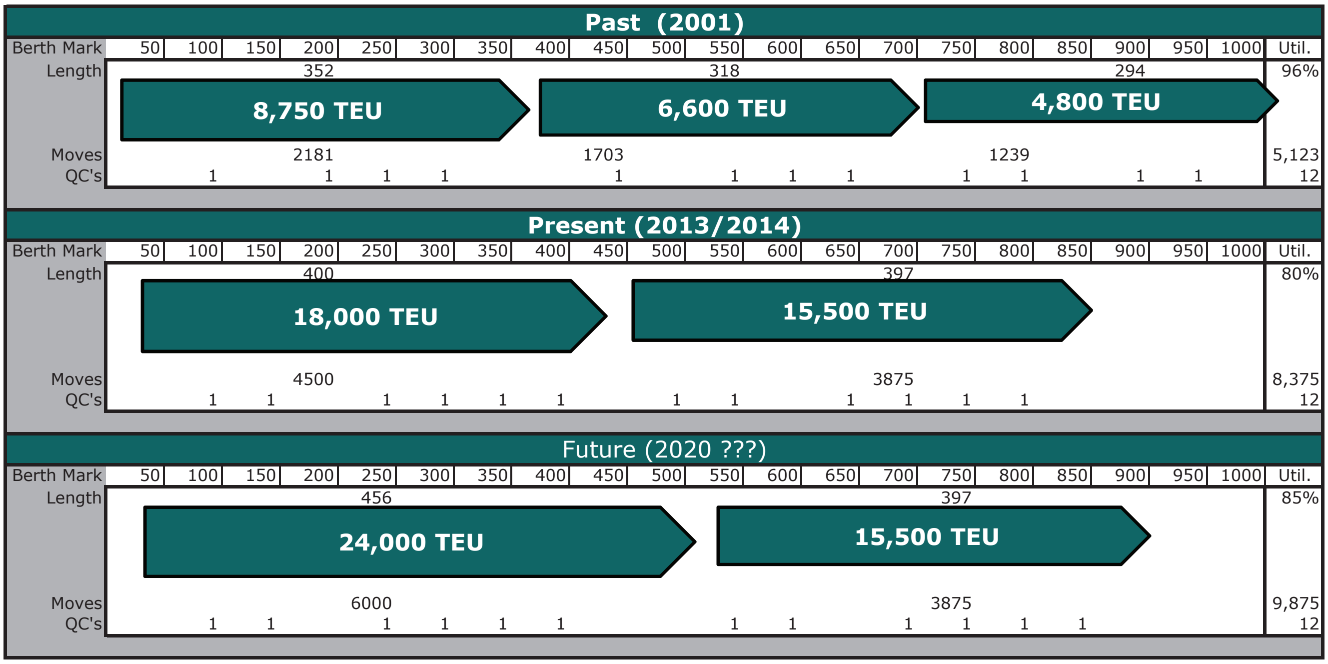
Vessel call size developments

As per figure 1, on the assumption that overall ship utilisation has not dramatically declined in recent years, on average, between all port calls, the moves per ship call will have proportionately increased. The largest ship in service in

Year	CAPACITY (TEU)	LOA (M)	BEAM (M)	TEU/M	GROWTH LOA	GROWTH BEAM
1974	2,400	239	30.0	10.0	-	-
1981	3,600	267	32.3	13.5	12%	8%
1988	4,800	294	32.3	16.3	10%	0%
1995	6,600	318	42.9	20.8	8%	33%
2001	8,724	352	42.9	24.8	11%	0%
2006	15,500	397	56.5	39.0	13%	32%
2013	18,000	400	59.0	45.0	1%	4%
2020	24,000	456	63.9	52.6	14%	8%

Top: Figure 1; Bottom: Figure 2

YEAR	TEU	LOA (M)	MOVES/ ROTATION	PORTS	MOVES /PORT	MOVES /METER	INCR-EASE	QC'S	MOVES /QC	METERS /QC	QC MPH	PORT DAYS	% IN PORT
1974	2,400	239	6,813	9	757	3.2	-	3.0	252	79.7	28	3.4	6%
1981	3,600	267	10,219	9	1,135	4.3	34%	3.5	324	76.3	28	4.3	8%
1988	4,800	294	13,626	11	1,239	4.2	-1%	3.8	326	77.4	28	5.3	10%
1995	6,600	318	18,735	11	1,703	5.4	27%	4.2	406	75.7	28	6.6	12%
2001	8,724	352	23,991	11	2,181	6.2	16%	4.5	485	78.2	28	7.9	10%
2006	15,500	397	42,625	11	3,875	9.8	58%	6.0	646	66.2	28	10.6	14%
2013	18,000	400	49,500	11	4,500	11.3	15%	6.5	692	61.5	28	11.3	15%
2020	24,000	456	66,000	11	6,000	13.2	17%	7.0	857	65.1	28	14.0	18%



Top: Figure 3; Middle right: Figure 4; Bottom right: Figure 5

2001 would generate an average of 2,200 moves per call, yet the largest ship in 2013 would generate an average of 3,850 moves per call - this marks an increase of 75%. As shown in figure 2, when these numbers are put into a moves per metre metric, the increase is 6.2 to 9.8, or 57%. This appears to be validated by a disclosure from PSA-Singapore recently that it had experienced an increase in average moves per call of 67% between 2001 and 2012.

More moves per call and more moves per ship metre create the opportunity to deploy additional quay cranes (QC) at potentially higher production speeds, which in turn increases the overall throughput capacity of a terminal, provided the stowage plans facilitate this.

In 2006, the 15,500 TEU ship arrived, and there was evidence of a step-jump in QC deployment. However, the increase in QC's was still not on-par with the increase in vessel capacity and moves per port, resulting in more days spent in port for vessels. The additional port time caused further issues such as the degrading of sea buffers and the jeopardising of schedule integrity, or potentially, additional vessels being required within a rotation; increasing both costs and transit times.

Despite the initial increase in QC deployment, over the last two and a half years we have actually seen productivity decreasing on the largest generation of container vessels by 6%, according to data from the Journal of Commerce.

Berth wastage

Figure 3 is a simulation of different berthing scenarios as they have developed over the years with increases in vessel size. This is simulated over a quay wall length of 1,000m and with 12 QC's available. This simulation demonstrates that berth occupancy can decrease as vessel sizes evolve, and therefore it is not unknown to see berth wastage has occurred in the contemporary era. In this particular simulation, when vessels get even larger by 2020, berth wastage will also diminish.

It is also important to understand what these various changes mean to container move volumes. We can calculate that the length of vessel is somewhat irrelevant when it comes to maximising container volumes handled over the quay, which will also represent 75% or more of a terminal's revenue stream. So, as calculated in figures 4 and 5 above, rather than berth occupancy or utilisation, the following method of calculation is more objective when measuring berth capacity:

Metric	Past	Present	Future
Berth Utilisation	96%	80%	85%
Quay Cranes	12	12	12
Moves	5,123	8,375	9,875
Moves/QC	427	698	823
QC MPH	28	28	28
Ops Hours	15.2	24.9	29.4
BERTH METERS	1,000	1,000	1,000
MOVES/M/HOUR	0.34	0.34	0.34

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QC MPH	28	31	34
Ops Hours	15.2	22.5	24.2
BERTH METERS	1,000	1,000	1,000
MOVES/M/HOUR	0.34	0.37	0.41

Quay cranes x moves per-crane per-hour = berth capacity

The below table shows how moves per berth metre per hour increase when the quantity of QC's remains the same, yet the efficiency of each QC improves. Where this is achieved through waste elimination and process improvement, it is a mutual win-win situation; the terminal can get more through the same footprint and a liner's vessels spend less time in port.

Cargo surge

There has been some suggestion that larger vessels create a cargo surge, negatively impacting both the yard and the gate. In light of the above scenarios and tables, this is not necessarily attributable entirely to vessel size, but again driven by how efficient the quay wall is in terms of assets deployed and the speed of each. With the quay wall and QC's typically being the most expensive assets in a terminal, the yard should not be the constraint to the entire enterprise. This needs to be more efficient and / or scaled to be in the right proportion to what it supports.

The gate, which is usually the lowest cost aspect of a terminal, also needs to be scaled up to deal with the more efficient quay side operation. When this hits its absolute physical maximum, then cargo flows need to be better managed, potentially through truck appointment systems.

Off-schedule vessels

As mentioned above, terminal efficiency is not keeping pace with vessel capacity and size developments and vessels are requiring more and more port time within a rotation which leads to the eroding of buffers. Delays caused by poor terminal efficiency and extreme weather will also have knock-on effects. With freight revenues depressed and costs high, profit margins are razor thin, running vessels at higher speeds to catch-up on time lost is a thing of the past. All of these dynamics have resulted in lower reliability levels. An off-schedule 18,000 TEU vessel will naturally be more difficult to squeeze into a berthing line-up than a far smaller one, and therefore the impact magnifies. Minimising the impact is a shared responsibility, and when achieved, it is mutually rewarding.

Lines need to obtain more accurate volume forecasts from their customers and make far better use of this data, then tactically plan much better. They need to protect the critical touch points (such as a few ports) in their networks for overall integrity. The optimisation of the network at design phase is critical; buffers need to be of appropriate size and placed in the right legs of a rotation to absorb delays and seasonal volume shifts. Forecasts, both pro-forma and operational, provided to terminals need to be more accurate and frequent.

Lines might consider buying contingency capacity at key terminals as an alternative to either speeding-up vessels or arriving late at subsequent ports or regions.

Terminals need to be far better at managing off-schedule vessels. These can be seen as a virus, and that virus must not be permitted to infect several other on-schedule vessels.

Home berth assignment needs to be adhered to as a top priority and strategy, as that matches what is operationally a static yard, and berthing several ships away from their planned berths will add a huge strain on the yard and therefore drag down overall terminal performance on all vessels and for all customers. It might be counter-intuitive, but an off-schedule vessel cannot be a top priority, it needs to wait for a suitable alternative window in which it can be quarantined.

Terminals need to change aspects of how they contract with their customers. Off-schedule vessels could have penalties assessed against them and their cargo, not be considered in productivity targets and merely handled on a best endeavours basis.

Lines and terminals need to cooperate much closer together in building trust, communicating, planning and better understanding each other's primary drivers and challenges. Key processes such as ship stowage plans, berth, yard and gate planning as well as exception handling need to come more into focus also.

The cost of handling new generation vessels

Whereas port authorities will generally levy costs based on vessel size, handling a container is still handling a container, almost regardless of vessel size. Terminals need larger QC's and stronger bollards, and the incremental capital cost is relatively small. This is likely off-set to some degree by more efficient operations and therefore some reductions in operating costs. 5 QC's for 12 hours is the same as 6 QC's for 10 hours, assuming that landside deployment ratios are the same for both scenarios.

Terminals need to get back to basics and improve processes to get to the next levels of efficiency, and this is largely cost-free. Lines are not likely to readily accept additional costs because terminals become less inefficient. Once these inefficiencies are removed, achieving the next level of performance is only possible by adding more yard assets, a cost compensatory model might be appropriate, we are however not close to that state presently.

Conclusion

Larger vessels will continue to be employed on all trade lanes. Dealing with larger vessels is not necessarily an insurmountable challenge, but changes to how we work are required for the supply chain to fully benefit from these.

This paper follows on directly from the CTI Consultancy study and article on "Ship Size Evolution", which is available to read at http://www.cticonsultancy.com/-Insight-

About the authors

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About the organisation

CONTAINER TRANSPORT INTERNATIONAL CONSULTANCY

CTI aims to constantly develop cutting-edge expertise surrounding port and vessel operations. CTI looks beyond the hardware and systems to analyse how an organisation can drive more value and growth from processes and people. CTI combines the toolbox of the international business consultant with extensive practical maritime experience. All CTI consultants have recently held leadership positions with leading carriers and port operators. The CTI service portfolio ranges from strategy development to operational and commercial specialism. The company's focus on organisational development and process optimisation offers an insight into the optimum practices in leading a modern business in the shipping and ports sector.

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