Container Terminal Productivity: Are we comparing apples with oranges?

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There are many figures quoted for container terminals in an attempt to compare productive efficiency in one region, port or terminal with another. Of course there are difficulties in objectively comparing two operations, given the different circumstances and conditions at work, but many of the figures quoted are just that – figures. If no context is provided they become meaningless; if there is no explanation of the physical effort that went into achieving that production, we may not be comparing the same things – we're probably comparing apples with oranges.

You cannot compare a terminal owned by a stevedore that handles any number of clients to a terminal owned by a shipping line that exists to service ships operated by that shipping line. The former stands or falls by the service it provides; its profitability is absolutely dependent upon the efficiency of its operation. The latter doesn't have to be particularly profitable because its primary function is to ensure the owner's ships get a berth on arrival, are worked as quickly as possible so that the ship can return to earning revenue as soon as possible.

Likewise, you cannot compare a terminal that handles an 18-20,000 teu ship where it can deploy 5-6 cranes (or more) to a terminal that only ever sees 4-6,000 teu ships where it can only ever effectively deploy 2-3 cranes for the duration of the ship's stay.

In terms of production, shipping lines only care about ship rates - how many containers are handled in a shift or in a day; they don't care about individual crane rates.

A far bigger problem is that shipping lines don't care about the cost to the terminal of achieving those ship rates. Maersk Line's attitude is typical; CEO Soren Skou's questions why terminal productivity hasn't risen at the same rate as container ship sizes (and resulting cargo exchanges); if ship sizes have doubled, why hasn't terminal productivity done the same? He is only focused upon the berth productivity when a Maersk Line ship is alongside; he wants the terminal to have more equipment, more people and to expend double the effort to minimise time in port for his bigger ships. He isn't concerned with what the terminal does with all of those resources after his ship has departed. However, the terminal is concerned – if the cost of the operation is not sustainable there can be only three outcomes; cost of the service increases, level of service provided is reduced, or the stevedoring operation goes out of business.

What is needed are objective, transparent KPIs that can be used to drive productivity up to the levels wanted by shipping lines but in a sustainable way, so we can compare the

In the following article I will make frequent reference to the Patrick (Asciano) AutoStrad terminal at Brisbane, partly because this terminal is clearly amongst the most efficient in the world when considered objectively and partly because it is, operationally, a very simple terminal (using quay cranes and straddles only) and provides an excellent reference point for other terminals. I have no commercial relationship with Asciano whatsoever.

Typical of the target measures provided, Drewry Shipping Consultants published their '*Container Terminal Capacity and Performance Benchmarks*' in November 2014 based upon an analysis of the actual performance of a sample of around 500 terminals worldwide for a three year period (2011-2013) – see http://www.drewry.co.uk/news.php?id=312. A summary of the global averages for 2013 is shown below (*© Drewry Shipping Consultants*):

- Teus per metre of quay p.a. - 1,072
- Teus per hectare p.a. - 24,791
- Teus per gantry crane p.a. - 123,489

When comparing such a large number of terminals across such a diverse number of regions it is sensible to use teus as a metric, but anyone using these metrics to gauge their own terminal's performance must be very wary.

Using 'teus' can mask all kinds of inefficiencies. To achieve the same "teus per metre of quay", a terminal that handles nothing but 20' containers would have to physically handle twice as many containers as a terminal that handles nothing but 40' containers. This means, for example that unless all 20' containers are twin-lifted at all times (highly unlikely) an Australian terminal (where significant numbers of 20' containers are in use) and a terminal in the U.S. (where 40' containers predominate) may have the same "teus per metre", but the Australian terminal is obviously more productive. However, this is not apparent from the metric.

Likewise, a terminal that handles nothing but 20' containers that has the same "teus per hectare" as a terminal that handles nothing but 40' containers is clearly moving more containers through the facility throughout the year. This means that its revenue earning capability is greater – remember, terminals charge by the container, not the teu. Unless all 20' containers are twin-lifted at all times it might also mean that its equipment and processes are more efficient and that its average container dwell time is lower. In the case of a gateway terminal this latter factor can only occur if the landside interface is also very efficient, meaning that local transport operators, communications and transport links (road and rail) must be efficient. None of this is obvious from the metric.

"Teus per gantry crane" should never be used. Australian terminals gave up measuring production in this way in the early nineties. A crane single-handling nothing but 40'

I undertook an analysis of an Australian stevedore's cranes at its four main ports for the period Jan-Dec 2008. There was considerable discrepancy between the volumes handled by each crane in each port but the *peak* volumes handled by a crane at each port were as follows:

Cntrs	**Teus**	**Utilisation (of crane in question)**	**Overall crane utilisation**
112,282	157,551	48.6%	32.7%
138,886	199,863	52.5%	37.0%
156,295	231,144	50.8%	34.2%
86,026	126,230	38.8%	27.3%

I understand that I am using *peak* volumes per terminal crane and comparing them to *global average* volumes quoted by Drewry but the point is this – if Australian terminals could achieve this production on even one crane throughout the year, then they clearly had drivers with the skills, the horizontal transport, the planning ability and process efficiencies to make it happen.

Australian terminals will never figure in any commentator's discussion of the world's most efficient terminals but these figures demonstrate that *as long ago as 2008* (5 years *before* the Drewry data) they were capable of achieving, at worst, the *current* global average and at best may be have been far in excess of it. Other terminals not considered amongst the 'world's best' may well be able to make the same point. Once again, a simple statement of numbers without context provides the reader with no indication of this.

The difficulty in knowing that we're comparing "apples with apples" is in being able to determine what lies behind the numbers being quoted. For example, the JOC Group released their report "*The Trends, Outlook and Market Forces Impacting Ship Turnaround Times*" in 2014. The report included two statements that together highlight the difficulty in establishing reality. In reference to ship productivity in general it stated that "Any crane downtime while the clock is ticking — during the nonexistent third shift at U.S. ports, for example — reduces productivity" but followed this by saying that crane productivity at Long Beach "is about 30 lifts per hour". If US terminals really don't work the third shift, what can you deduce from these two statements?

Rate per 24 hours = 30 cph, Rate per *working* hour = 45 cph?

1. Or does it mean that the cranes handle 30 containers per hour but only for 16 hours (480 containers) i.e.

Rate per 24 hours = 20 cph, Rate per *working* hour 30 cph?

Hence the need for targets that are transparent and objective. Following on from this, let us consider the Patrick AutoStrad terminal in Brisbane. The terminal doesn't bother to quote "average rate per crane"; it uses a simple KPI – containers handled per crane shift without any time deductions. Over an 8-hour shift the terminal expects 240 containers to be handled per crane - no deductions are made for rest breaks etc. This is the production rate it quotes. How do we know Patrick's claim is correct? Ask its shipping line customers. In other words, the terminal has taken out any subjective interpretations, calculations, local variations such as wage rates, labour rules etc and produced a very simple, objective target, easily measured by the customer.

Dividing 240 containers by 8 hours does result in an "average crane rate per quay crane" of 30 cph but that's not relevant to terminal planning. If the crane works for 24 hours then the terminal expects the crane to handle 720 containers. Two cranes will handle 1,440 containers; all five cranes working for 24 hours should handle 3,600 containers. Using the same container:teu ratio as in the Brisbane crane figures above, this means the five cranes could handle 5,282 teus per 24 hours.

These are world-class handling rates but you won't see Patrick Brisbane mentioned in any of the reports on the world's most productive terminals. Why is this?

In their report the JOC Group defined productivity "as the average of the gross moves per hour for each call recorded (during the) year. Gross moves per hour for a single vessel call is defined as the total container moves (on-load, off-load and repositioning) divided by the number of hours for which the vessel is at berth". It is therefore a very simple calculation, easily verifiable and not subject to any bias or skewing of the data. The top six terminals for berth productivity (cph) were as follows:

Terminal	Berth productivity (cph)
APM Terminals Yokohama, Japan	163
Tianjin Xingang Sinor Terminal, China	163
Ningbo Beilun Second Container Terminal, China	141

Qingdao Qianwan Container Terminal, China	132
Xiamen Songyu Container Terminal, China	132

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It is clear that Patrick Brisbane could achieve ship rates of 150 containers per hour if all five cranes worked one ship simultaneously, easily placing it third in the list above. However, it is extremely unlikely that any terminal in Brisbane will ever see a container ship that is large enough, with sufficient cargo stowed in a suitable manner to accommodate all five cranes working simultaneously for a prolonged period, let alone multiple such ships, so it is just as unlikely that we will ever see such high rates in Brisbane. The conclusion many people will draw is that Patrick Brisbane is not productive, but you cannot conclude this – you don't have sufficient data. And note that despite the berth productivity quoted, you cannot conclude that any of the terminals listed above are actually especially efficient.

The data above is for all vessel sizes. JOC report also provided berth productivity data for vessels less than 8,000 teus (more relevant to Australian terminals), as follows:

Terminal	**Berth productivity (cph)**
Qingdao Qianwan Container Terminal, China	116
Hyundai Pusan Newport Terminal, South Korea	114
Pusan Newport International Terminal, South Korea	112
Nhava Sheva Gateway Terminal, (Jawaharlal Nehru) India	111
APM Terminals Yokohama, Japan	105

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using 13 people?

To quote from the JOC Group report again, in discussing the improvement that U.S. ports had made from 2012 to 2013, the report stated “Basic measures such as adding more cranes and working more shifts helped to lift the numbers”. Herein lies the problem – berth handling rates improved but at what cost? Some terminals obviously just threw resources at the problem but was the cost sustainable?

When examining the terminals listed above, we know nothing about the following:

- What was the berth utilisation at each terminal?

Many terminals are owned by shipping lines; the terminal services only that shipping line’s vessels. This is the situation prevalent in the US especially on the west coast and which allowed the ILWU to accuse “a consortium of international corporations” of stopping ship-working on four of five days over a holiday weekend. Such a terminal can throw resources at the terminal owner’s ship(s) on the berth but there must be periods when there are no ships on the berth. The terminal has time to clear all the cargo but resources (cranes, yard equipment and people) are idle so resource utilisation is low. Berth productivity per individual vessel is high, but so are production costs.

- How many cranes were used simultaneously on average per ship?

Longer ships with large cargo volumes can have more cranes allocated to them than smaller vessels. Intensive use of resources can mask underlying process inefficiencies. Berth productivity per vessel is high but a smaller terminal servicing smaller vessels can actually be more productive, handling containers at a higher rate at a lower cost.

- How much yard equipment was used simultaneously on each ship?

The more cranes are used, the more equipment is required to support them. Unless that equipment is automated this means more people are required. Even where it is automated, some solutions appear to require more equipment; Patrick Brisbane uses between 2 and 4 straddles per crane, averaging around 3 whereas simulations produced for automated terminals using AGVs routinely assume 5-6 AGVs per crane.

- How many people were used per shift per ship?

Even if labour is cheap, it still has a cost. The Patrick Brisbane terminal uses 4 x people per crane gang, believed to be the lowest number in the world. As it uses AutoStrads, no other machines or people are directly involved in the crane operation. Resulting production (240 containers per 8-hour shift using 32 man-hours) is 7.5 containers per crane gang man-hour.

If 4 people per gang *is* the lowest gang size possible, then the only way this production rate can be improved upon is by handling more containers per crane shift. *In other*

The JOC Group report did make the point that it is not just a case of throwing resources at the ship; processes must be efficient as well. The difficulty in knowing what efficiency lies behind the production number being quoted was highlighted by a comment in the report in reference to the top position of APM Terminals Yokohama: "The collaboration effort extends beyond the terminal itself to include vessel operators. The shipping line, in advance of the vessel arrival, sends a detailed cargo-stowage plan that APM uses to pre-plan how it will work the vessel. By the time the ship docks, the equipment and manpower are in place to work the vessel without interruptions".

This practice has been in use in Australia since the mid-eighties! I know, as I used to be both a central ship planner and terminal planner. In fact, I cannot see how any terminal could efficiently work a ship or the wider terminal any other way – how else can it know how much yard space is required for exports and imports? Hence, where to berth the vessel? How to plan resource allocation (cranes, yard machines)? How much labour to allocate (sometimes 1-2 days before the ship's arrival)?

So how should we report production? There are three elements to service productivity:

1. Human – the number of people used to provide the service;

2. Mechanical – the amount of equipment used to provide the service;

3. Physical – the size of the terminal used to provide the service, including all area inside the perimeter fence.

In this paper, I shall only consider the first two elements – people and equipment.

Every terminal should be trying to achieve the best cargo handling rates using the minimum amount of land, equipment and people.

Firstly, there are some control parameters:

1. Container volumes - only consider revenue containers (using the JOC Group definition; on-load, off-load, re-positioning (vessel);

2. Crane shift production – use the duration of a full crane shift (no time deductions allowed).

3. Terminals - only consider terminals quoting 'containers per crane shift' equivalent to a crane rate of 30 containers per hour i.e. this is the minimum standard;

4. Man-hours worked – include all operational workers (workers engaged in the physical planning, handling, processing or monitoring of revenue containers) regardless of whether they are employed by the terminal or by contractors, or whether they are full-time, part-time or casuals. Basically, if any part of the operation could not take place without a particular employee being on shift, that employee must be counted;

considered as a 'weekend' is therefore not used.

KPIs

1. Crane production – Containers per crane shift per man-hour

KPI = Revenue containers per crane shift divided by crane gang man-hours worked (to be maximised).

The Patrick Brisbane rate of 7.5 containers per man-hour should be the standard.

2. Terminal production – Terminal 24-hours containers per man-hour

To work a crane continuously there must be people available to relieve the crane gang during breaks e.g. at Patrick Brisbane a relieving gang takes over the crane for the 45-minute rest break. What do they do for the rest of time? They fulfill a number of other duties; for example, they are brought in ahead of the crane gang(s) to moor/unmoor ships, they unlash sufficient containers to enable crane operations to begin and they lash where required. We can't assign their effort to a particular crane. And we know there are other people involved in enabling the terminal operation to continue e.g. Cargo Care personnel, clerical staff, gate security personnel etc.

How do we assign these people to any particular point of work? We can't, but the answer is to consider the full 24-hour production when all cranes are working for the duration and the land-side operation is in full swing and then consider all people the involved in the operation.

KPI = Revenue containers per 24-hour period divided by total operational man-hours worked (to be maximised).

Using manning similar to Patrick Brisbane:

240 containers handled per crane shift

5 cranes operating 24 hours

Manning - dayshift 53 people, evening shift 48 people, nightshift 43 people

(5 x cranes x 240 containers per crane shift x 3 shifts) = 3,600 containers

(53 x dayshift + 48 x evening shift + 43 x nightshift) = 144 x people working 8 hours

Current production = 3,600 / (144 x 8) = 3.13 containers per terminal shift man-hour

1. **Mechanical asset production – Mechanical asset cost per container**

The terminal may have been designed for a larger volume but if so, the terminal design should have taken into account the need to develop the terminal *as volumes grow* i.e. the design should be scaleable so that terminal expansion investment matches the revenue earning potential i.e. the terminal's ability to pay for it.

KPI = Asset $ cost of equipment (based on current prices) per container handled p.a. (to be minimised)

As a guide, use a terminal similar to Patrick Brisbane:

5 x quay cranes (assumed cost A$12m each = A$60m)

28 x AutoStrads (assumed cost A$2m each = A$56m)

Current annual volume 350,000 containers

Current production = A$116m / 350,000 containers = 331 asset $ per container

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Robert Hancock ··· 1y
Principal Consultant - Director at Port Mines Pty Ltd
Right on the money as usual.

Keep up the good posts.

Regards… See more
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Synergised and sharpened professional
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