The Importance of Benchmarking to Improving Container Terminal

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Abstract- The behavior of natural body simply considering is Benchmarking is a common activity for many people, in its simplest form comparison of Ideal performance against another similar activity, perhaps just to check that we are getting the best results or the best value for a particular item. In addition the reflect of benchmarking on several scopes such as:- High-quality results -Improving efficiency -Meeting or exceeding needs Adding value -Better tools for enhanced decision making. This happens in all walks of life. There are many different perspectives – here are two examples: "Benchmarking is a continuous systematic process for evaluating the products, services and work processes of organizations that are recognized as representing best practices for the purpose of organizational improvement." (Spendolini, J.M. The Benchmarking Book. American Management Association. New York 1992, p.2)Or "Benchmarking is a performance measurement tool used in conjunction with improvement initiatives; it measures comparative operating performance of companies and identifies the 'best practices. 'Benchmarking creates value by:· Focusing on key performance gaps;· Identifying ideas from other companies;- Creating a consensus to move an organization forward;· Making better decisions from a larger base of facts." (Mission Statement for The Procurement And Supply-chain Benchmarking Association (PASBA), Benchmarking is most effective where a large amount of data derived from practical experience, rather than theory, can be drawn together to identify best practice or establish a range of targets. Data accumulated by trade associations or organizations with international experience is often the best basis. But don't ignore data derived from your own experiences, benchmarking against historical performance of the same activity also has its uses. While direct comparison between identical activities is most straightforward, some lateral thinking can create benchmarks for particular operations or processes in one sector that can, to some extent, be applied to similar operations in different sectors.

Keywords:- benchmarking, Spendolini, PASBA, accumulated, straightforward.

I. CONTAINER TERMINAL BENCHMARKING

Handling of containers has very much become a numbers game with all-important throughput figures often featuring as benchmarks. However there is not, and there cannot be, a single holistic benchmark which can be applied to a whole container terminal. Patrick Fourgeaud of The World Bank in his note MEASURING PORT PERFORMANCE states that: *"…. in most cases, it is not possible to determine benchmarks which would be applicable for any port, and that all expressions of port performance do not address the same requirements. Therefore, carefully identifying problems to be monitored and taking into account the main characteristics of the commercial activity should lead to more accurate indicators and targets."*Whilst agreeing that ports are diverse and do not readily lend themselves to benchmarking, container terminals are generally less diverse and have sufficiently common themes to enable the use of benchmarking as a guide to relative performance against others of similar capacity and industry standards. Benchmarking requires values to be assigned against a series of factors so that when they are viewed in their entirety an overview of the terminal's performance is given and this can help to identify bottlenecks. The solution to alleviating these bottlenecks and improving performance may lie in identifying what the competitor ports with better benchmark scores are doing differently and then seek to emulate these activities in part or whole. Benchmarking is a very good tool to assess whether optimal use of existing labour and capital resources is being or can be attained, before the need to resort to major capital expenditure for new equipment or enlargement of infrastructure. The diverse nature of intermodal trade means that there are some sectors of the terminal operations where the improvement of efficiency and effectiveness are wholly within the control of the terminal operator. Some other sectors may be only partially within his control. There will also be other sectors with problems to the efficient running of the terminal that are wholly outside the terminal's control, however benchmarking can be used to highlight these problems and their solution to third parties. Much has been written on benchmarking for container terminals and useful background information upon use of benchmarking is provided in:

· International Benchmarking of the Australian Waterfront, 1998;

· OECD's Bench Marking of Intermodal Freight Terminals, 2002.

Good sources of data on terminals are also available in publications such as Container International Yearbook. Also, there are some commonly applied published benchmarking standards, such as:

· "World Container Terminals" Drewry, 1998;

· "Containerisation International Yearbook" 1998 and now;

· "Global Container Terminals" Drewry, 2002.

II. TYPE OF TRADE AND SIZE OF TERMINAL

The mega container terminals with high throughputs of transhipment cargoes have led the way and evolved state-of-the-art systems and equipment to meet their potential needs. Of course benchmarks set by Rotterdam or Singapore can be aspired to by the greater number of smaller terminals and with targets set to suit their

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business development, but benchmarking is best set against a range of terminals starting with direct local competitors of similar size and then moving up in size and wider geographical spread to encompass industry best practice. Most consideration of container terminals only covers Lo-Lo operations, but containers are also shipped on trailers using Ro-Ro facilities, sometimes with great efficiency. Aspects of yard and gate control benchmarking are equally applicable to all terminals.

III. LOCAL FACTORS

Every terminal is different with its own constraints whether these relate to its size, shape, navigation, linkage with the hinterland and many other factors. These local peculiarities need to be taken into account when benchmarking. For example the size of vessels and the percentage of containers offloaded and loaded in any one ship have a direct impact on crane productivity and vessel turn-around time. Benchmarking across the board does not accurately define this type of local factor. When compiling comparative benchmarking data it is important that local information providing background to exceptional figures is available.

IV. THE SCOPE OF MEASURE

Benchmarks need to be readily identifiable from published information usually from trade directories, annual reports and/or marketing information and can be focused on various aspects of the terminal business to report on one of three areas:

· Charges;
· Level of Service;
· Productivity of Labour and Capital.

This paper focuses on productivity issues. Of course all issues that improve productivity will ultimately reflect positively in improved levels of service and the charges that can be made for that service.

V. EVALUATING THROUGHPUT PRODUCTIVITY

5-1Terminal Size Benchmark

The throughput of a terminal can be set against the available quay length, the number of quayside cranes and the area of the terminal to provide a reasonable benchmark as to how well it is performing. This can also be used to assess the likelihood of being able to expand without immediate further major capital investment.

5-2Productivity Benchmarks

When assessing productivity within a terminal, operators will generally tend to look at issues such as the following:

Type Description
Number of lifts per crane operating hour
Average delay per vessel departure
Number of lifts per vessel hour
Vessel measurements
Number of lifts per quay labourer hour
Average truck cycle time
No. lifts per “yard crane” operating hour
Net container lifts per gross container lifts
TEUs stored per hectare of terminal
Mean storage dwell time
Mean stack height
Yard measurements
Number of lifts per yard labourer hour
Entry gate delay per arriving truck
Exit gate delay per departing truck
Trucks per gate per operating hour
Gate measurements
Trucks per gate labourer hour
Equipment availability – available/required
Mean time between failures
Equipment measurements
Mean time to repair per failure

It can be difficult to benchmark against these issues as industry standards do not necessarily exist and data for comparable ports is not usually available. However it is still useful to consider these parameters using information that can be derived from other relevant terminals. Perhaps just as important, through reference to historic records, these can be used to benchmark against previous performance of your own terminal, and that can be helpful in gauging the progress of development strategies. More commonly used benchmarks on productivity are:

· Workforce productivity (TEU/employee/year);
· Quay Crane Productivity (TEU/crane/hour);
· Berth Productivity (TEU/m of berth length);
· Yard Productivity (TEU/hectare of yard).

And suitable information is more readily generated using published information.

Some less commonly used benchmarks are:

· Yard Equipment Productivity (TEU/Unit/hour);
· Vessel Turnaround (hours);
· Berth Occupancy (% age);
· Dwell time in Yard (days);
· Vehicle turnaround time (minutes);
· Loss or damage (per 1000TEU).

These usually have to be set against industry standards or direct knowledge of other terminals.

VI. CALCULATING EFFICIENCY GROWTH POTENTIAL LABOUR

6-1Workforce Productivity

This can be measured as the number of TEU per annum divided by the total number of staff employed in the terminal. Drewry indicates figures for a medium sized terminal (210,000 TEU pa) of 900 TEU/man pa rising to 1,100 TEU/man pa in a large terminal (over 500,000 TEU pa). Clearly every terminal has differing manpower issues and in terminals where robotic equipment is used operational staffing levels are much lower than in a terminal operating a manual system of tracking containers. In general terms a low TEU/employee/year figure would indicate a need for implementation of better training, review of working practices and optimisation of staff utilisation. However, as the measure is based on a global figure, a further drill-down of performance against dockside, yard, gate and administration staff would be required to better define the specific problem areas.

VII. CONTAINER YARD

7-1Yard Productivity

This is broadly the number of TEU’s handled pa divided by the total area of the terminal.

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While dwell time and vehicle turn-around time is not generally available for other terminals, the area of the yard and the annual throughput generally is. Therefore this benchmark can be readily applied to assess competitor terminal yard productivity levels. The industry benchmark standard is generally taken as 20,000 TEU/ hectare/ year. For larger terminals an increase of up to 50% could be considered. Clearly terminals using straddle carrier operation with large areas and low stack heights will show a low utilisation. This does not necessarily mean that they are inefficient, but it could be that large areas of land are readily available and, in any event, there is a substantial potential for growth.On the other hand terminals such as those in Hong Kong and Singapore have restrictedspace for expansion and have focused on high density stacking techniques with advanced logistic systems before acquiring very expensive additional land for stacking areas.

7-2 Dwell Time

The dwell time for containers between delivery and dispatch in the terminal presents us with a good means of identifying poor clearance procedures. This can be due either to terminal or regulatory authority requirements and generally affects import cargoes. The average time aspired to in most terminals is 3 or 4 days with most terminals allowing importers this time until storage charges are triggered. In practice typical averages of between 5 and 7 days are usually considered reasonable. For terminals that have adequate or generous areas available for the container yard, the time profiles of container dwell time can accommodate a small proportion of longer term "storage of boxes". However as throughput increases and the yard comes under greater pressure the storage time that can be permitted inevitably has to be reduced. For any particular yard there is a limit beyond which logistics and system improvements cannot reasonably stretch the capacity. It will then be necessary to resort to capital expenditure for any or all of the following:

· Additional equipment to improve the existing stacking system;

· Increase the area of present terminal;

· Undertake improvements to the pavement to maximise stack utilisation and traffic flow;

· Transfer to a higher density stacking system with necessary adjustments to

pavement.It should be noted that taking the average dwell time for terminals that handle a high proportion of full exports may give misleading average dwell time figures because export dwell times are generally shorter. Detailed analysis of the terminal will require a full review of the dwell times for import/export, full/empty, standard/reefer and ratio of TEU/FEU/Non-standard containers. Dwell time is also distorted by local practice and custom. For instance in several African terminals high dwell times on imported full containers are persisting despite the introduction of incrementally increasing daily storage charges, simply because the importers cash flow cannot be stretched to pay the clearance charges when the container first arrives.

VIII. VEHICLE TURN-AROUND TIME

The time that vehicles spend within a terminal discharging or collecting their container is a good measure of the efficiency of the gatehouse and the yard procedures. Generally a period of between 25 and 30 minutes from entry to exit is considered acceptable but in high volume single user terminals this can reduce to 10 to 15 minutes for regular customers. However, the turn-around time in the terminal is of little concern to a customer if the truck becomes stuck in traffic outside the gates of the terminal causing delay and even missing pre-assigned collection delivery slots. Clearly this is a vital area of terminal business, although the terminal has little control of it.

IX. LOSS OR DAMAGE

This is measured as the number of TEU pa claimed to have been damaged, broken into or stolen divide by the total throughput. Although not strictly relating to productivity this can give a clear indicator of whether or not the container handling is sloppy (not complying with International Standards) and/or whether insufficient resources are being applied to the security of containers within the terminal and those being released from the terminal.

X. BERTH

10-1Berth Productivity

Berth productivity is given as the total TEU across the quay edge divided by the total length of the berthing quay in the terminal. The berth occupancy and crane productivity are less easily obtainable for other terminals unless these figures are quoted in marketing literature. However, the berth productivity benchmark is usually easy to assess from published port information. For example:

10-2 Port Actual TEUs per annum per 10-2 meter of quay

(from *Recent Developments and Prospects at UK Container Ports.* Department of Transport, Local Government and the Regions, July 2001 based on *Containerisation International Yearbook*). For the purposes of terminal planning an industry standard of about 1,000 TEU/m of Quay is suggested, but in Hong Kong HIT with 1,500 TEU/m/year has been achieved, although this is probably a special case. Other ports, such as Felixstowe, are believed to be seeking to achieve 1,400TEU/m per annum. The average in Europe is reportedly closer to 850TEU/m/year and in the USA 50TEU/m/year.

Berth productivity depends very much on the size of ship and the percentage of cargo exchanged. Also terminals with high volumes of transhipment cargoes will have a considerably higher value because of the inherent speed of this operation.

XI. QUAY CRANE PRODUCTIVITY

Between 20 and 25 moves per crane per ship operating hour is normal for a traditional container terminal with conventional single lift quayside cranes. An industry benchmark of about 115,000 TEU pa is set for modern gantry crane planning purposes, but this tends to reflect more on the systems operating around the crane rather than the crane itself. Obviously the type of quay crane used has a major bearing on the physical

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limitations of crane productivity, for example:
· Post Panamax gantry cranes 35 to 45 lifts/hour;
· Panamax gantry cranes 20 to 30 lifts/hour;
· Port Mobile 18 to 25 lifts/hour;
· Ship's Gear 8 to 15 lifts/hour.
The apparent disparity between the lifting equipment operational limits and the peak capability of the crane depends on many factors including the size of vessels, the percentage exchange of boxes, efficiency of trailer service crane to/from stack and reliability of the crane. Furthermore there are inevitably exceptions where these figures are exceeded.

XII. BERTH OCCUPANCY

Berth occupancy is the proportion of time that a vessel is occupying a berth. In practice this can become a balancing act between the shippers, who wish to avoid waiting time, and the terminal operator who wishes to maximise use of the facilities. It is generally held that occupancy levels of between 60% and 80% per berth is desirable to avoid vessel waiting time delays.

XIII. GROWTH POTENTIAL

The above benchmarks can be set up for the terminal being studied and a comparison can then be made against the industry standards, including those suggested above, in order to provide an overall indication of the terminal's productivity. The Berth Productivity, Yard Productivity, Crane Productivity and Workforce Productivity should also be assessed against a "basket" of similar and larger capacity terminals. The efficiency growth potential for particular aspects within the terminal can be measured using these benchmarks. The areas where the terminal is not performing to accepted industry norms should then be further reviewed and, wherever possible, compared with best practice in other similar sized or slightly larger terminals. It should be noted that, although benchmarking may be used to identify shortfalls at the terminal, these findings need to be linked with identification of what measures have been implemented at "best practice" terminals. Aspects at the terminal that do not show adequate growth potential have to be further examined and solutions found. The use of benchmarking provides operators and investors with more confidence that these productivity problem areas within the terminal are being correctly identified. Just as important, this tool can be used to provide support for investment business cases and justification for expansion during project planning permission and enquiry stages.

XIV. IDENTIFYING BOTTLENECKS AND IMPLEMENTING SOLUTIONS

It must be one of the aspirations of every terminal operator to have an efficient continuum of movement in which the location of each container and its onward path is known, with its dwell time at any point in the terminal minimised. In most modern terminals the location of containers is assigned in parcels to assist in vessel loading or discharge to land transport. Drop off/pick-up times are then pre-assigned together with appropriate terminal equipment. Most terminals also have specific external problems such as congestion on roads surrounding the terminal or restricted navigation channels that can play a major role in the efficiency of the terminal. This is all relevant to the customer when selecting which ports to use in delivering a container from factory to market. Some terminals, particularly in countries that are still developing container penetration, have major problems caused by inappropriate activities or practices such as:
· "De-stuffing" of containers permitted in the stacking yard or in undesignated areas in the port. This is largely because there is insufficient equipment outside the terminal to lift the container off of the trailer for emptying/filling and then returning it to the terminal.
· Maintenance of paper documentation and tracking systems to accompany every transaction, with all drivers having to leave their vehicles to have their papers scrutinised and stamped.
· Customs inspections are required for almost all containers with no alternative but to completely de-stuff and re-pack.
· Unreliability of handling equipment because of the absence of preventative
maintenance regimes and misuse by poorly trained staff.
· Insufficient linkage between the container yard and the berth leading to
congestion at the berth. In circumstances such as these it is fairly easy to identify the problems and advise on measures to mitigate and even cure the problems to levels at which the terminal can operate reasonably effectively. In many instances of this type there is often a need for some immediate capital expenditure in appropriate equipment and supporting infrastructure. In the case of terminals that are not suffering from this type of major problem, most weaknesses within the terminal operation systems will generally be obvious to the terminal operators, who will often be informally comparing their terminal's performance with that of their local rival terminals. In such cases a more formal benchmarking exercise can assist in making the business case for the necessary investment that will be needed to mitigate the effects of one or more of the bottlenecks which are preventing expansion of productivity and capacity. Sometimes there is no alternative but to invest in more equipment and infrastructure but in most cases investment in improved logistics will precede major capital expenditure.

XV. LABOUR

In most container terminals a high degree of training is required for all staff covering operating procedures, safety and security if optimum utilisation is to be achieved from the large investment in terminal equipment. It is now unusual to find terminals that have not yet taken steps to remove restrictive practices and indeed experience in Australia has shown that, following implementation of improvements in stevedoring productivity, the number of containers worked per hour of gangs on board has improved from 25.2boxes/hr in March 2000 to 29.6 boxes/hr in June 2002.In some terminals the night shifts are not worked or else worked as a skeleton shift. Clearly implementation of round the clock working will boost throughput but failure to invest in adequate illumination and safety procedures productivity may in fact fall.

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XVI. YARD AND GATE

In most container terminals, and especially those where space is at a premium, the minimisation of dwell time is the single most important issue causing bottlenecks by congesting the yard. The Terminal Operator is reliant on the importer arranging collection and the only means of redress is against a scale of increasing storage charges. In most terminals collection within 3 or 4 days will engender no storage charge. The charges then generally move through a series of incremental increases until the ceiling rate per day is reached. In the free market this might be US$200 at 10 days but in many terminals a regulatory framework has been imposed which increases the time and reduces the maximum tariff in order to take account of customs procedures and local business custom. The ease with which clients can pick-up or deliver the containers to the terminal is important in reducing congestion at the gate and optimising the traffic movement through the terminal. Many terminals are now operating with advanced logistic and communication systems such as pre-assigned collection and delivery windows for trucks and minimising or avoiding time that truck drivers have to leave their cabs to complete paperwork. The reliability of yard equipment is vital and most terminals have their own workshops. The practice of preventative maintenance and remote diagnostics is increasing the productivity in many terminals. In terminals where customs clearance is required for the majority of cargoes the introduction of both fixed and portable X-ray units means that the number of containers which have to be physically emptied for inspection is minimised without loosing security.

XVII. BERTH

The quay crane reliability is of vital importance to most terminals and, as for the yard equipment, preventative maintenance regimes and remote diagnostic have improved the reliability. The speed of operation of the crane is mostly controlled by factors in the yard or on the vessel, but there will come a time when the operational parameters of the crane need to be reviewed. In some terminals refurbishment and upgrading of existing cranes can work well and provide additional productivity until additional new craneage is required. The vessel turnaround time can be minimised by ensuring that bunkering and reprovisioning can be undertaken without interrupting the unloading. The pre-planning of loading using software links between the vessel and the terminal can ensure optimum efficiency of loading and unloading. In some ports heavily laden vessels can only enter the port during periods of high water and to widen this window they sometimes travel in light draft. In such terminals the use of Dynamic Underkeel Clearance can permit larger cargo volumes on vessels approaching and leaving the harbour.

XVIII. TERMINAL LOGISTIC SOLUTIONS

Before investing large amounts in capital investments the prudent terminal operator will wish to satisfy himself that all the elements of the terminal are working at close to peak capacity. The setting of realistic benchmarks for particular activities or sectors within the terminal will help to identify the activities and areas of the terminal operating at close to their peak efficiency. Assessments must then be made to identify whether the situation can be improved and made more cost effective by introducing improvements to terminal logistics before investing in new equipment or infrastructure. Substantial improvements in performance have been recorded in the introduction of the following systems:

· Radio and data links to all personnel to ensure yard equipment and resources is in the correct place at the correct time.

· Automated entry gate for regular clients using swipe card and truck recognition systems.

· Vehicle Booking System (VBS), which pre-assigns time slots for vehicles to arrive at the terminal for delivery/collection. Some of these systems include a return booking facility whereby the truck delivering a container can be routed within the terminal to collect a container.

· Electronic Data Interchange (EDI) systems allow container information to be shared to various organisations and minimise the need for manual transfer of data. · Container Tracking Software which allows information to be passed directly to the customer or his agent either by Direct Dial-up or via the Internet.

· CCTV container identification confirms the details and integrity of the container on entry to the terminal. (Claims for damaged containers were dramatically reduced at one terminal when this system was introduced).

· Yard Planning Software maximises the blocking of containers for the vessel and location of containers for release thereby reducing travel time for terminal equipment.

· Robotic control of terminal equipment; the use of this equipment can generally only be reasonably considered in high volume yards.

· Introduction of remote diagnostics in terminal equipment and computerised scheduling of preventative maintenance.

· Container X-ray facilities can dramatically cut the time required for customs clearance.

· Ship Planning Software improves the ability of the yard to deliver containers to the vessel in a sequence which minimises container crane movement. · Dynamic Under Keel Clearance is only possible in some ports with a moderate to high tidal range and provides the shipping line with the ability of loading the vessels to the maximum extent that the tidal conditions at their planned time of entry and exit will safely permit. Clearly not all of the logistic solutions described above will be economically viable to introduce in full or even in part at many terminals. However the use of appropriate technology and management systems can dramatically improve productivity levels and throughput in terminals. It is important that implementation of these systems is properly planned in advance and managed to focus on the specific requirements of the terminal in question.

XIX. CONCLUDING REMARKS

With increasing pressure on costs and efficiency of land utilisation benchmarking is a particularly useful tool for any container terminal. It is a formalised comparison technique

that can be used to identify bottlenecks in the current operations. It can also be used effectively in the planning process to help avoid the creation of bottlenecks during expansion and development of the terminal. A small number of the world's most sophisticated terminals may be well placed to use the findings of a benchmarking study to develop rigidly quantitative improvements. However it would be more realistic for the vast majority of terminals to consider benchmarking as a more qualitative exercise to enable identification of both real and potential weaknesses at the terminal, rather than to expect a detailed breakdown of the specific quantum involved. When one bottleneck to the smooth flow of containers is removed the opportunity is created for another bottleneck to crop up. An efficient terminal has to be well balanced with compatible capacity throughout all the diverse operations within the terminal. It must not be forgotten that a customer will assess door-to-door performance rather than that of the terminal alone. Operators need to consider the full picture and must not shut their eyes to bottlenecks beyond their gates when benchmarking the potential of their terminal. The author would like to thank Ian Netherstreet of Beckett Rankine Partnership for his valuable assistance in preparation of this paper.

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