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INDICATORS FOR PORT CONCESSION CONTRACTS AND REGULATION: THE COLOMBIAN CASE

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Abstract

Most countries that have privatized port operations are not yet prepared to regulate what have become oligopolistic settings in post-privatization environments. By definition, such settings heighten the risk of anticompetitive practices, yet many countries either lack port regulatory systems or the technical capacity to make such systems effective when they do have them. Regulators must be able to monitor for anticompetitive behaviour and ensure that private operators' services meet acceptable performance standards. Regulators may also impose minimum standards or, in the absence of regulators, standards can be incorporated into the terms of a concession contract, known as "regulation by contract." Governments and operators, however, may interpret performance standards in markedly different ways. Misinterpretation can be cause for government to unfairly terminate a concession contract or for an operator to claim performance is superior when in fact it is inferior. To prevent costly misinterpretation, governments need guidelines for indentifying and defining relevant, clear, and objectively measurable concession performance standards.

An effective regulatory system requires the use of performance indicators. In this paper we set forth six principles for defining performance indicators. Indicators must be (1) relevant to maintaining minimum performance standards; (2) pertinent to what is being measured; (3) objective, with no ambiguity about what is being measured; (4) auditable, to ensure reliability and verifiability; (5) unequivocal, with no opening for misinterpretation or re-interpretation; and (6) readily calculable, such that the information needed to judge performance is easy to access. In formulating these principles we have taken into account that most port regulators are new to the task and that terminal operators should not be unduly burdened by data collection and reporting requirements. We then define a set of indicators for operational efficiency and level of service that conform to these principles. We extend our port operations time accounting system, originally developed by the authors for auditing the operational efficiency of ports and later incorporated in the regulatory module of the World Bank's *Port Reform Toolkit*, to encompass the three main components of a terminal, including berth, container yard, and gate. For each indicator we provide the unit of measure and the information needed for their calculation.

Keywords:

port regulation, competition regulation, concessions, performance indicators, port productivity, port privatization

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INDICATORS FOR PORT CONCESSION CONTRACTS AND REGULATION: THE COLOMBIAN CASE

1. REGULATORY TRENDS AND PORT PERFORMANCE

In the 1980s, many countries turned to the private sector for services that had been provided by government agencies. More than 70 countries attempted some form of privatization, and nearly 7,000 state-owned enterprises were privatized. This trend continued through the 1990s, reaching its pinnacle in 1997 when the value of privatization transactions peaked at $157 billion.

This surge in privatization followed 100 years of attempted reform, the impetus for which depended on the perceived cause of economic problems: the market or government. In the late 1800s, for example, the government took over many businesses providing “essential public services” when those businesses became monopolistic and otherwise seemed to abuse their market power. In Argentina, the deteriorated condition of privately run railroads was cited as justification for the government’s purchase and management of them. In the United States, the Board of Commissioners of the Port of New Orleans was created to develop and operate port facilities after the private railroad companies that operated river terminals held local commerce “hostage” with inefficient and monopolistic behaviour. Similar conditions in the United Kingdom encouraged the state to take control and assume ownership of utilities, railroads, and ports. In fact, up to this point, the World Bank and other multilateral institutions encouraged governments to establish port operations in port authorities as a means for creating a buffer between port operations and government bureaucracy.

Eventually, however, port authorities behaved like their private sector predecessors and Adam Smith’s “invisible hand” became the rallying cry for reform. In the 1980s, the doctrine espoused by “neo-liberals” President Ronald Reagan and Prime Minister Margaret Thatcher encompassed the notion that the free market knows best and the private sector does best, and that the state’s main role is to reduce or eliminate impediments to market and private sector performance. Obvious public sector inefficiencies in many countries sustained the drive for reform. The World Bank, the International Monetary Fund, bilateral assistance agencies, and other international finance organizations re-oriented their policies to encourage private sector participation in public services. Indeed, in 1991 the World Bank encouraged governments to become “market friendly,” suggesting that government policies had become “unfriendly” (World Bank 1991).

Privatization was singled out as the means to liberate government-owned enterprises to go their own way and respond to market influences. Ports became a natural target for reform and privatization as they could either hinder or facilitate economic liberalization and global trade. Privatization was viewed as a cure-all for attracting investment, inducing efficiency, and lowering costs.

Following privatization, the vast majority of privatized port sectors operate in oligopolistic settings. Competition can be fierce in these settings, but the risk of anticompetitive behaviour, most notably collusion, is high. The pace of privatization has not been matched by the development of the necessary regulatory frameworks. Few countries have established regulatory systems to ensure that terminal operators behave competitively—one exception is Colombia.

Port Privatization and Regulation in Colombia

Colombia reformed its port sector when it became clear that structural impediments to trade put at risk all the gains from the country’s “apertura” economic reforms of the 1980s. The country’s ports were notorious for low productivity, inefficiency, inadequate security, and high costs. Carriers viewed the situation as untenable, and in 1990 imposed a penalty surcharge of $2.50 per ton in Colombian ports, in effect erecting a tariff barrier to free trade. Colombia's ports were thus obstacles to the achievements envisioned from the Apertura movement.

No surprise then that Colombia's very first law of 1991 liquidated the government's port agency, COLPUERTOS, and created a system of public–private partnerships for all port operations that still reigns as a model of port reform. In 1994, private entities (referred to as Regional Port Societies) were awarded concessions to operate the ports, unleashing a surge in investment and quantum leaps in efficiency such that today some, though not all, of Colombia's ports are operating at or above global performance standards.[2] In addition, Colombia is one of only a few countries instituting regulations to curb anticompetitive behaviour in the port sector.

Privatization, however well done, has not been a panacea for Colombia as competition, measures of competitiveness, and industry patterns are all evolving. First, while its Atlantic coast ports arguably are operating at acceptable global standards, Buenaventura is congested and not performing well. This has led to higher freight charges and even cargo diversions to Colombia's Atlantic Coast ports. Obviously, carriers are sensitive to delays. Though they incorporate expectations of delay in their itineraries, carriers still strive to reduce time in port throughout their itineraries. Notteboom (2006), in addressing the importance of time in designing liner service patterns, estimated the extra cost on goods from one day's delay for a post-Panamax vessel carrying 4,000 full TEUs between the Far East and Belgium to be about €57,000. Ashar (2009) in his analysis of the effects of the Panama Canal expansion estimates the average value of time at $75/TEU-day.[3]

The poor performance in Buenaventura is due in part to the failure to develop capacity but is rooted in the monopolistic setting enjoyed by the port operator. As a result, when the Regional Port Society of Buenaventura sought to extend its concession agreement, the regulator decided to impose minimum performance standards, in addition to investment mandates, in the concession agreement's terms. Rather than be perceived as unfairly imposing on Buenaventura, the regulator decided to impose minimum performance standards on all regional port society concessionaires. Once the Agua Dulce and TCBuen terminals come on line[4,5], however, the operator will have to change its management and operational practices. Thus, in the near term Buenaventura will likely become more efficient and lower its costs in order to retain and capture market share.

Second, competitiveness is increasingly measured less by the performance of ports and more by the performance of entire freight corridors. Hummels (2001), for example, estimates that each day of delay in the logistics chain carries an extra-ordinary inventory cost equivalent to 0.8 percent of the value of the goods carried in a container. Djankov, Freund, and Pham (2006) in measuring the time it takes for processing freight for shipment, transporting it, and moving it through the port, find that each additional day required for a freight shipment imposes an "extra" economic distance equivalent to 70 km per day, thereby effectively moving markets further away. And new "country competitiveness" indices, including *Doing*

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[2] The Regional Port Society of Cartagena was awarded the Global Institute of Logistics/Germanescher Lloyd's certification for achieving the standard Container Terminal Quality Indicators in November 2009.

[3] Note this is based on the choice between intermodal and all-water routings of Asian imports to North America assessing the trade-off between transit time and freight cost.

[4] The Agua Dulce terminal's development, initiated by local investors, is now spearheaded by ICTSI, a major global operator from the Philippines. The TCBuen development, also initiated by local interests and currently under construction, is now majority-owned by TCB of Spain.

[5] Note that Regional Port Societies operate public terminals that had been formerly operated by COLPUERTOS. Private terminals, some of which existed before port reform and handled only proprietary cargoes, are not subject to minimum performance standards. The regulator has the ability to regulate these terminals as well, both in terms of performance and pricing, but because Regional Society facilities are considered public assets the regulator felt compelled to impose minimum standards on them.

Business (World Bank 2010a) and the Logistics Performance Index (World Bank 2010b), report on the performance of entire logistics chains, and not just ports.

In this context, we note that Colombia's hinterland transport costs are among the world's highest. Some of the high cost is attributable to difficult terrain, long distances between ports and shipment origins and destinations (Guasch *et al* 2005), and the trucking regulatory structure.[6] With few options for improving freight corridor performance in the near term, Colombia has to focus on port performance, which can still have a substantial impact on trade competitiveness and economic growth. Clark, Dollar, and Micco (2001), for example, conclude that an inefficient port can have the effect of increasing the distance to a shipper's export market by 60 percent. Further, Kent and Fox (2005) show that eliminating port inefficiency can increase GDP by nearly 0.5 percent.

Third, as carriers deploy larger vessels and redeploy the vessels they supplant to other trades, Colombia's ports, particularly Cartagena and Buenaventura, will likely have to serve larger vessels in the near-to-mid term. Feeder and mainline vessels will increase in size as carriers continue rationalization, and the resulting higher peak load volumes per call, largely induced by free trade agreements, will require greater throughput efficiency. The recent experience of Rotterdam, New York, Los Angeles, and Mumbai, prior to the global financial crisis, provides evidence of peak-load congestion that we can expect even mid-size ports will eventually feel when the global economy recovers. In fact, many countries are at risk of a "congestion pandemic" as free trade agreements boost trade volumes (Kent 2005).

Thus, Colombia is wisely seeking to satisfy port customers by meeting standards rather than setting prices. The standards under consideration were originally contemplated as a precondition for approving concession extensions, but we believe regulators could apply these standards to continuously monitor for acceptable levels of performance. The intent is not to intervene in port operations, but to set reasonable minimum standards for operations. This "light touch" approach to regulation avoids the risk of imposing unreasonable expectations on operators while providing a reasonably wide margin to promote competition.

In Section 2 we set forth the selection principles for and technical issues encountered in establishing performance indicators to meet regulatory objectives. In Section 3 we precisely define six indicators, providing guidance on indicator calculation and where data necessary for calculation can be found.

2. PRINCIPLES AND TECHNICAL ISSUES IN SELECTING AND DETERMINING PERFORMANCE INDICATORS

In addressing performance indicators, the primary objective is to assess the relative competitiveness of one port or terminal over another. To monitor management, terminal operators use indicators ranging from cost per unit cargo (including labor inputs, maintenance, energy), revenue per unit cargo, and profit per unit cargo to equipment reliability/availability and safety and environmental incidents. These indicators are intended to show how well management is allocating resources and logically should be tied to their mission and objectives. Terminal operators also generate indicators to reflect customers' concerns. Crane productivity, or more importantly, time at berth, is relevant for their carrier customers. So performance indicators are already commonly used by terminal operators around the world, but not so by regulators.

The academic community has shown a strong interest in measuring the performance of ports, but very little research has been done to provide guidance as to what should be measured to assure reasonable performance. In the context of port competition regulation,

[6] Though there are hundreds of trucking companies in Colombia, trucking prices are set via negotiations between the regulator and the trucking industry.

Kent and Ashar (2001) incorporated berth utilization rates as one of five criteria in a model they developed for regulators to assess the risk of anticompetitive behaviour, which was later adopted by the World Bank in the regulatory module of the *Port Reform Toolkit* (World Bank 2001). The research, however, has been predominated by interest in data envelopment analysis (DEA) techniques. Rios and Maçada (2006) identify seven studies using DEA since 2000, all intent on testing the efficacy of DEA in measuring port efficiency. Barros (2003) sought to expand the basis on which Portuguese regulators monitor port efficiency, which is based purely on financial reports. Barros applies a DEA approach to generate an efficiency "score," which is explained as a surrogate for a port's "overall competence and capability." Barros (2006) took a similar approach in assessing the efficiency of Italian ports. García-Alonso and Martin-Bofarull (2007) applied a DEA approach to assess the impact of investment on the efficiency of the ports of Bilbao and Valencia.

The difficulty in using the indices generated by the DEA approach lies in making the results meaningful for operators and their customers. The literature seems to be focused on how port operators and regulators might use DEA results to define strategies for improving port performance, but customers must understand the results as well in formulating their service patterns.

Rios and Maçada attempted to consider this industry perspective. They surveyed industry executives to validate the inputs for and outputs of their DEA model. Executives identified an additional output (moves/ship hour), which coincides with the customer focus of terminal operators. However, moves/ship hour addresses efficiency only at the level of berth operation and not at the level of other terminal components, such as yard and gate operation, which are of great significance to shippers and the trucking industry. Wang and Cullinane (2006) seem to recognize the problem of how industry can interpret DEA results. Indeed, in a groundbreaking study consisting of the largest number of ports covered by a DEA analysis, Wang and Cullinane state that further analysis is needed to uncover the relationship between DEA efficiency scores and the common efficiency or performance indicators used by the industry. Moreover, they seem to suggest that even the causes for inefficiency are not fully understood from DEA analysis. The usefulness of the DEA approach is in question until further research suggested by Wang and Cullinane clarifies this point.

Principles

The following principles have guided our selection of performance indicators. They take into account that institutional capacity for regulatory enforcement varies, that terminal operators should not be unduly burdened with calculation and reporting requirements, and that the ultimate goal is the achievement of acceptable operational efficiency and level of service. To wit, performance indicators must be

1) Relevant to ensuring minimum performance standards;
2) Pertinent to what is being measured;
3) Objective, with no ambiguity regarding what is being measured;
4) Auditable, to ensure reliability;
5) Unequivocal, with no room for misinterpretation or re-interpretation; and
6) Readily calculable, such that the information needed to judge performance is easy to access.

Technical Issues

Performance indicators should be incorporated into concession contracts to help ensure operational efficiency and level of service (LOS). Operational efficiency relates to the actual utilization of public facilities; LOS refers to the quality of service provided to users of these facilities, mainly cargo and ship owners and their representatives. These objectives, however, have an inherent conflict: higher utilization may result in congestion and deteriorating LOS. Hence, the desirable values assigned to an indicator are usually referred to as *optimum* levels. Determining optimum levels poses some difficulty and usually requires detailed study.

Defining and measuring a manageable set of indicators with a minimal data collection and calculation burden also presents some challenges. First, utilization and LOS can be measured many different ways and any representative set is unlikely to be applicable to all types of cargo and all facilities.

Second, terminal operators manage facilities and operations in keeping with their own managerial philosophy and policies and do not define, collect, or process data necessary to calculate an indicator using a system applicable to all operators. Still, each operator can easily accommodate a uniform and reliable data collection system according to a set of indicators defined by the regulator. Ideally, this system is integrated with the port's management information system (MIS).

Third, ports subject to a system of performance indicators are themselves not uniform. Each has its own unique layout, facility size and configuration, and type and amount of handling equipment. Likewise, each may serve customers with different technical characteristics and service expectations.

3. SUGGESTED PERFORMANCE INDICATORS FOR REGULATORS

In the following subsections we describe three performance indicators for operational efficiency and three for level of service. The values suggested for indicators should be adjusted periodically based on discussions with operators to reflect changes in technology and operating practices introduced into port operations (e.g., twin-lift, tandem lift, multiple empty lift) as well as LOS expectations.

3.1. Operational Efficiency Indicators

Time Accounting

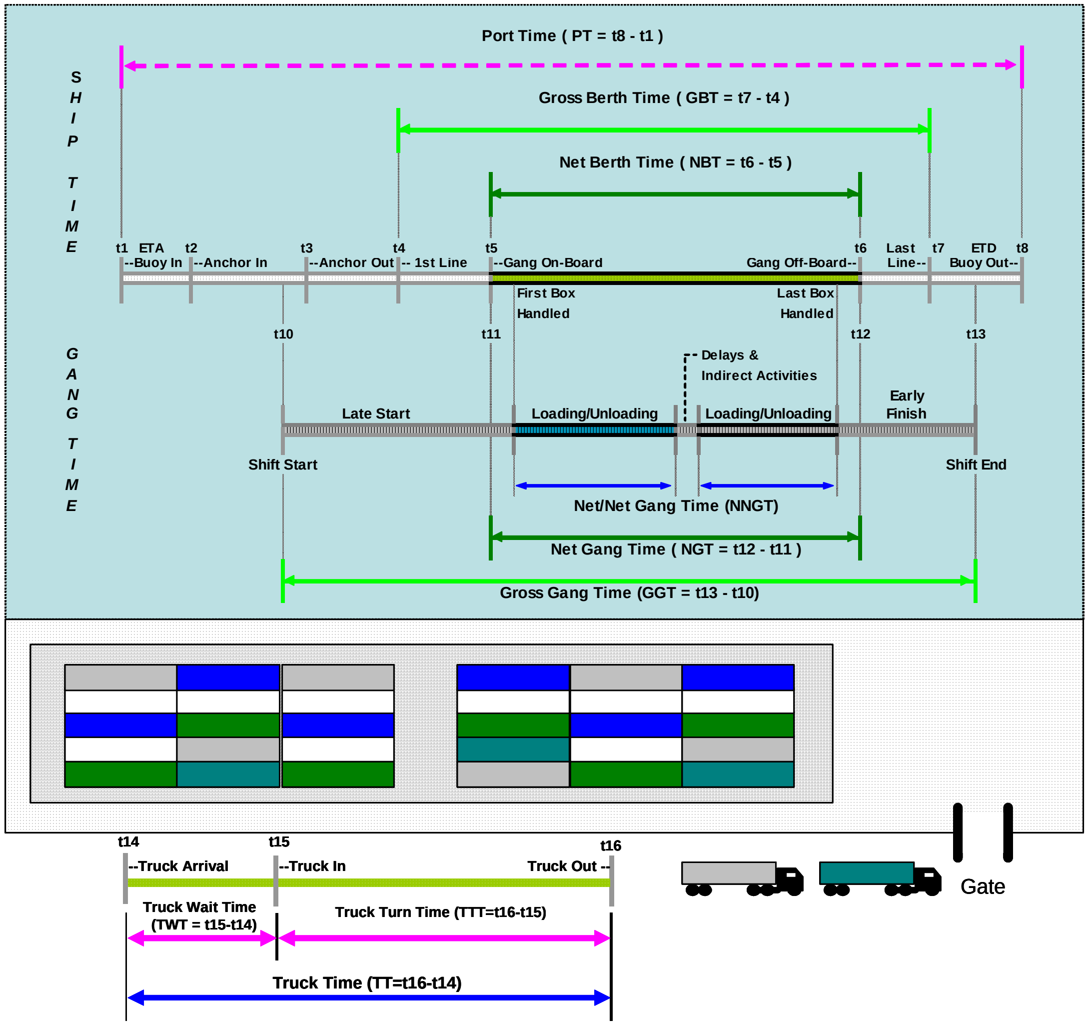
All measures of operational efficiency are related to time. Our system of "time accounting," presented in the regulatory module of the World Bank's *Port Reform Toolkit* (World Bank 2001) is based on the principles of industrial engineering. The system defines and records a series of events during the handling process along with respective elapsed times between these events. Most ports use this or a similar system as a basis for operational control and have made it an essential part of their MIS reporting.

Figure 1 illustrates the three main components of a terminal (berth, yard, and gate) and the events and elapsed times for each. The figure shows two parallel time lines. The upper one applies to the ship (berth) operation and the lower one to the gangs (cranes) involved in this operation. The intent is to illustrate the functional relationships between the two. The figure shows that overlapping time occurs only with Net Berth and Net Gang Times. Indeed, Net Berth Time equals Net Gang Time only where one gang is employed. A similar depiction of time accounting is also included for the gate operation.

Performance indicators for ship and crane operations could consist of numerous measures, each addressing a different aspect of operations; however, we recommend using only those essential to ensuring that regulatory objectives have been met. These indicators should address the main events in ship handling as follows:

- ***Ship Arrival Time*** – Actual time of arriving at the port's entrance buoy, which is the meeting point with the port pilot.
- ***Ship Ready to Work Time*** – Actual time when ship is moored at the berth, cleared, and ready for the gangs to begin work.

Figure 1: Time Accounting System for Port Operations

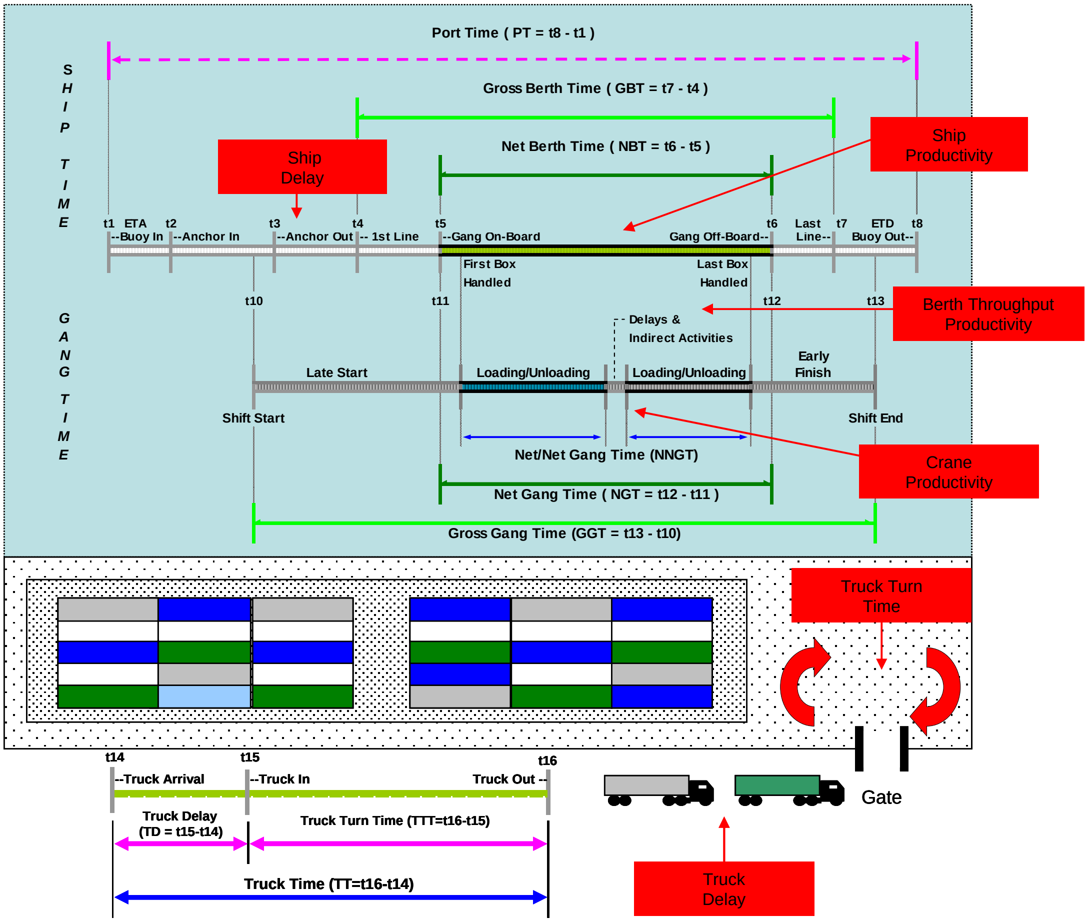


Source: Adapted from Paul Kent, *et al*, *Port Reform Toolkit*, Module 6, Port Regulation: Overseeing the Economic Public Interest in Ports, World Bank, Second Edition, 2007.

- ***Ship Net Berth Time*** – The elapsed time for the ship from the time the gang is ready to work until handling is finished, which is roughly equal to first-to-last box.
- ***Gang Net Work Time*** – Similar to Net Berth Time, but for each gang.
- ***Moves*** – The number of boxes ("lifts") transferred between ship and dock during Net Berth Time, including re-handles, but excluding cell-cell and hatch covers handling.

Likewise, similar events should be defined for gate handling. All of these events are shown in Figure 1. Where all indicators—for operational efficiency or LOS—manifest themselves in these events is shown in Figure 2.

Figure 2: Recommended Port Performance Indicators for Regulators



Source: Adapted from Paul Kent, *et al*, *Port Reform Toolkit*, Module 6, Port Regulation: Overseeing the Economic Public Interest in Ports, World Bank, Second Edition, 2007.

Selection of Indicators

Our suggested set of indicators for operational efficiency pertains to ship productivity, crane productivity, and berth utilization. In most container terminals the yard or waterfront area determines the entire terminal's capacity. We have not included indicators of yard or storage productivity and related dwell time (e.g., TEU/yard hectare) for two reasons.

First, yard productivity is a direct function of container dwell time; a shorter dwell time provides for more turnovers per yard slot and hence higher utilization. As long as the yard is not congested, terminal operators intent on generating revenue from container storage fees will pursue longer dwell times, encouraging lines and shippers to keep boxes in the terminal. Moreover, in some cases, terminal operators with large underutilized yard areas attempt to lure lines by providing them with free storage for empty boxes. Thus, a high cargo dwell time may not necessarily indicate poor performance.

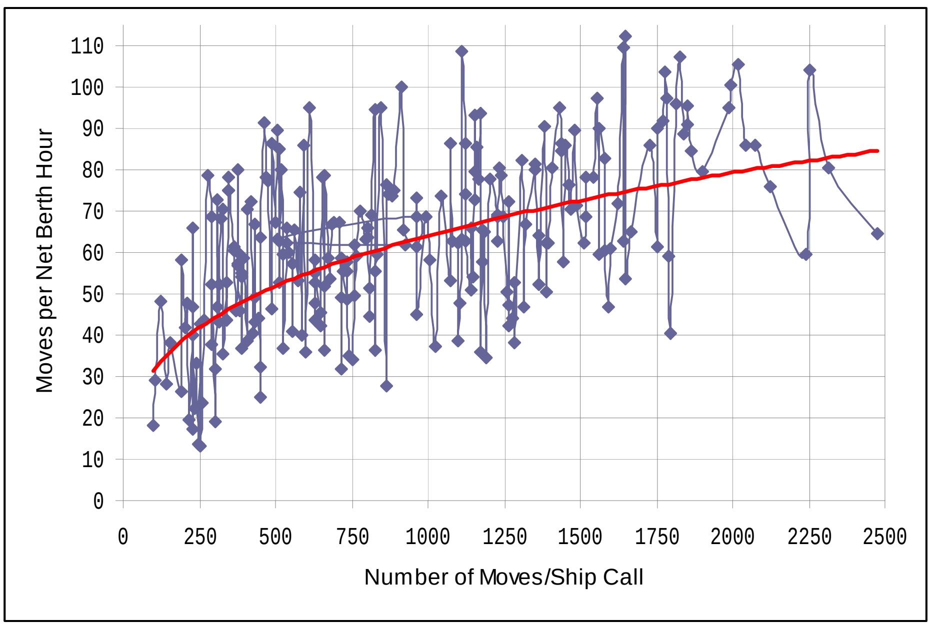
Second, offshore yards can be used to boost terminal throughput and shorten the dwell time of the on-dock yard, which is the yard subject to the performance monitoring. Third, terminal operators are at the mercy of Customs clearance times, while others are subject to government directives that containers be allowed to remain in the terminal well beyond the time required for Customs clearance.[7]

Finally, and perhaps most important, indicators related to berth and gate performance and LOS indirectly reflect yard performance. If the yard is congested, ships and trucks have to wait, adversely affecting their performance indicators. Accordingly, cargo dwell time, although considered pivotal to port performance, is subject to too many variables to be a reliable or meaningful indicator.

Indicator 1. Ship Productivity

Ship (or berth) productivity is the most important measure of container terminal performance. It is calculated by dividing the number of moves by Net Berth Time measured in hours (moves/hour). The number or score is affected by factors that may or may not be within the control of the terminal operator. For example, ship-handling productivity is directly related to the number of gangs assigned to this ship. This in turn is affected by the number of gangs (or shore cranes) available at the terminal, the demand for gangs by other ships at the terminal, the size of ships and stowage plan, and the number of total moves per ship. For example, there is no point in assigning more than one crane to a ship if the total number of moves is small. Because of these factors, we can expect a wide variation in productivity even at the same terminal. Figure 3 illustrates the wide variation of productivity performance based on a year's worth of vessel calls at a container terminal in Chile and the difficulty in determining productivity standards.

Figure 3. Distribution of Net Berth Productivity (Moves/Hour) as a Function of Moves/Call



Source: Asaf Ashar, "Alternative Development Plans for Central Chile's Ports," presentation at the TOC America's Conference, Buenos Aires, Argentina, 2009 (available at www.asafashar.com).

[7] In Nigeria, Customs inspects 80 percent of containers at the ports of Apapa and Tin Can Island and shippers are permitted to store containers up to 90 days. The government sets the rate for container storage even in privately operated terminals, and these rates are far below standard rates, which encourages shippers to use the terminal for cheap storage.

Ship-handling productivity is also related to crane (or gang) productivity, with higher gang productivity boosting ship productivity. As explained below, crane productivity is also affected by ship characteristics and the ship stowage plan. We divide the ship productivity indicator into three categories according to the number of moves, which usually correlates with a ship's TEU capacity (Table 1). Table 2 identifies data required to calculate each indicator as well as the data source.

Table 1: Proposed Indicators for Operational Efficiency and Level of Service

Indicator	Additional sub-division	Unit	Optimal	Acceptable	Unacceptable
I. Operational Efficiency					
Ship Productivity	> 1,000 moves/call	Moves/Hour	> 80	60 - 80	< 60
	500 - 1,000 moves/call	Moves/Hour	> 50	35 - 50	< 35
	< 500 moves/call	Moves/Hour	> 25	20 - 25	< 20
Crane Productivity	STC	Moves/Hour	> 30	25 - 30	< 25
	MHC	Moves/Hour	> 25	20 - 25	< 20
	Ship's Gear	Moves/Hour	> 15	10 - 15	< 10
Berth Throughput Productivity	Measured annually	TEU/Berth-m	> 1,250	1,250 - 750	< 750
II. Level of Service					
Ship Delay	Containers	Hour	< 2	2 - 4	> 4
	Bulk	Hour	< 4	4 - 12	>12
Truck Delay	Containers	Hour	< 0.5	0.5 - 1	> 1
	Bulk	Hour	< 2	2 - 4	> 4
Truck Turn Time	Containers	Hour	< 0.5	0.5 - 1	> 1
	Bulk	Hour	< 1	1 - 2	> 2

Source: Authors

Table 2: Information and Data Sources Required to Calculate Recommended Port Performance Indicators

Indicator	Unit	Information Required for Measurement	Source of Data
I. Operational Efficiency			
Ship Productivity	Moves/Hour	Number of moves during operations (per ship type)	Port Operator
		Net berth time	Port Operator
Crane Productivity	Moves/Crane Hour	Number of moves per operation (per crane)	Port Operator
		Net crane time	Port Operator
Berth Throughput Productivity	TEU/ Berth-m	Annual throughput (TEU)	Port Operator
		Workable length of berth (meters)	Port Society
II. Level of Service			
Ship Delay	Hour	Ship arrival time to bouy	Port Captain
		Time when ship is ready to work	Port Operator
		Window's starting time	Port Operator
Truck Delay	Hour	Truck arrival time	Port Operator
		Truck in time	Port Operator
		Truck schedule time	Port Operator
Truck Turn Time	Hour	Truck in time	Port Operator
		Truck out time	Port Operator

Source: Authors

Indicator 2. Crane Productivity

Gang productivity is affected first and foremost by labor proficiency and to a lesser extent by the crane's technical characteristics, proper planning for handling, and yard particulars. A common constraint on shore-crane productivity is the ability of a yard to "absorb" the flow of containers from a ship during discharge and "generate" flow during loading. Hence, as the throughput of a port increases and its yard becomes more occupied, crane productivity may decrease. Crane and gang productivity differ according to the type of equipment used, typically Ship-to-Shore Crane (STC) or gantry cranes, Mobile Harbour Crane (MHC), an elevated swinging crane, or ship's gear. Even within each type of crane there are variations according to technical characteristics. For example, the latest models of STC provide for "tandem lift" or the possibility of handling 4 TEUs in a single lift. Table 1 provides illustrative values for each type of crane.

Indicator 3. Berth Utilization

The two common measures of berth performance are the percentage of occupancy (the percent of time in which the berth is occupied) and the throughput per berth. In keeping with our selection principles, we prefer throughput per berth, but with some adjustments. "Berth," for example, is not necessarily uniform given the substantial variance in ships' lengths. The length overall (LOA) of ships employed by an intra-Caribbean feeder service might be half that of deep-sea mainline vessels. Hence, the proposed measure relates to the throughput per *berth-meter*. And, since throughput is usually measured in TEUs and not in moves, we further adjust to TEU per berth-meter.[8] We also recommend the term "berth throughput," which better reflects what is being measured and calculated.

As was the case with ship productivity, there can be a high degree of variance for berth throughput. Table 3 presents a set of reference berth throughput indicators prepared for the assessment of terminal capacity as part of a recent master plan of the Central Chilean ports of San Antonio and Valparaiso (Ashar 2009b). The table includes indicators for berth capacity per berth and per berth-meter; as shown, berth-meter capacity can range from 1,400 to 2,500 TEUs per berth-meter.

Table 3. Reference Berth Throughput Indicators

Year	Berth Type	Berth Length (m)	Depth Alongside (m)	Berths per Terminal	Design Ship	Berth Capacity (TEUs)	Berth-m Capacity (TEUs/m)
2009	Sub Panamax	250	12	3	3,000	350,000	1,400
2012	Panamax	280	14	3	4,500	450,000	1,607
2012	Panamax	280	14	4	4,500	495,000	1,768
2014	Post Panamax I	300	15	3	5,700	500,000	1,667
2014	Post Panamax I	300	15	4	5,700	550,000	1,833
2017	Post Panamax II	350	16	4	8,000	700,000	2,000
2025	Post Panamax III	400	16-18	4	12,000	1,000,000	2,500
2009	Multipurpose	150	10-11	2	1,000	100,000	667

Source: Asaf Ashar, "Alternative Development Plans for Central Chile's Ports," presentation at the TOC America's Conference, Buenos Aires, Argentina, 2009 (available at www.asafashar.com).

The indicators in the table relate to full capacity. Terminals obviously are not expected to operate at full capacity. Therefore, for our proposed regulatory system, we suggest that a level of about 50% of these capacity indicators be used to establish minimum guidelines. For example, a terminal with 3 berths handling Panamax vessels would have, according to Table 3, capacity per berth of 450,000 TEUs per berth, and 1,607 TEUs per berth-meter. Our regulatory system would indicate a performance measure of 50% of these figures, which means a minimum of 225,000 TEUs berth capacity and about 800 TEUs per berth-meter.

[8] Our recent studies of Colombian, Chilean, and Brazilian ports indicated a stable ratio of about 1.5 TEUs/move.

3.2 Performance Indicators: Level of Service

Indicator 4. Ship Delay

Ship delay is a straightforward measure reflecting the availability of berth and gangs. It is calculated by subtracting the original scheduled time for the vessel's arrival at the port from the time the vessel arrives at the berth (second line tied) and is ready to work. A situation where there is no delay is ideal; a delay of up to four hours is considered acceptable as it can be absorbed in the vessel's itinerary. A delay exceeding four hours is unacceptable and can lead carriers to impose congestion surcharges. The calculation assumes that the ship arrives on time and it incorporates a provision for sailing time between buoy and berth, mooring, and clearances. For example, ships are expected to arrive at the pilot station at least two hours prior to the planned Ready to Work time. Any late arrival of ships should not be considered when calculating ship delay. Consistently late arrivals, however, suggest that berthing plans need to be adjusted.

Indicator 5.Truck Delay

Truck delay is calculated as the difference between the appointment time and when gate processing began, assuming a truck appointment system has been implemented. As with ship delay, the calculation assumes that the truck arrives (pre-gate) prior to the appointment time. The suggested optimal value is less than 30 minutes (i.e., a truck with an appointment time of 8:00–8:30 am will be accepted no later than 9:00 am if it arrived before 8:30 am).

Indicator 6. Truck Turn Time

This measure involves gate processing, travelling to the stack, waiting for yard equipment, loading/unloading, travelling back to the gate, and gate processing on the way out. It is calculated by subtracting the in-gate time from the out-gate time. The optimal value suggested here is one hour.[9]

3.3 Bulk Terminals

Our performance indicators recommended for container handling could be applied to bulk terminals except that no standard values are available. Bulk handling involves a wide range of technologies and handling capacities, making terminal performance very dependent on equipment specifications. In this context, prescribing productivity standards is difficult. The performance of vessel window and truck appointment systems may serve as proxies.

Gauging the performance of the window system involves measuring the extent to which vessels honour their window periods. Terminal operators may not have full control over the various causes of vessels not meeting window obligations, but they must still enforce obligations or modify window periods to reflect the variable conditions of bulk vessels. Likewise, if there are long queues at the gate where a terminal operator has a truck appointment system, then the system is not properly managed. We recommend that regulators require terminals providing bulk handling services to install vessel window and truck appointment systems, both of which we describe next.

3.4 Performance-Enhancing Systems

We have recommended and described indicators that can be imposed on terminal operators to ensure acceptable performance. Two other requirements can help ensure acceptable performance: vessel window systems and truck appointment systems.

[9] If the truck entering the gate involves more than one activity (e.g., dropping an import box and picking up an export box), the suggested time should be increased by 50%.

Vessel Window System

Liner shipping services are based on fixed port rotations and schedules that ensure utilization of ships' time and reliable transit times. To meet their schedules, lines must secure "berthing windows" or fixed intervals of times for berthing and ship handling. The window system is essential to operational efficiency, allowing ports to allocate labor, facilities, and equipment in advance of a vessel's arrival and making the vessel handling process more reliable, predictable, and timely. Window length is calculated according to the number of moves required of the vessel as well as berth productivity. Most ports have at least a rudimentary berthing window system.[10]

Allocating berthing windows among lines and services can be complex as two or more lines often vie for the same window. Berthing plans must be negotiated and include provisions for contingencies for unexpected interruptions. Once a plan is agreed on it binds the terminal operator and the shipping line. Both sides are expected to fulfil their obligations: the shipping lines commit to arriving and departing within the agreed-on window, and the port commits to have a berth and gangs available throughout the entire window period. As a matter of policy, regulators should consider requiring terminal operators to have a vessel window system.

Truck Appointment System

Until recently, port operators were more concerned with ensuring quick vessel turnaround than with truck turnaround time. But as even the most efficient ports have become increasingly challenged by problems outside the gates, some regulators have imposed standards for truck turn times. These standards sometimes stem from concerns about air pollution. In Los Angeles, for example, the terminal operator is fined $250 for each truck that waits more than 30 minutes at the gate. Charges can escalate if operators corral trucks inside the terminal to avoid the queuing fine.

A truck appointment plan is similar to a ship's berthing plan, except that it relates to much shorter time intervals (e.g., half-hour increments). The system is relatively simple. The terminal operator publishes truck appointment availability for each day according to the expected load on yard equipment (which also serves ships) and the processing capability of the gate lanes. Appointment availability can be published on the port's website in hourly or half-hourly periods. Truckers can make an appointment on the website and print a ticket showing the time interval and reservation number. This ticket comprises a mutual obligation; the terminal is committed to accommodating the truck upon arrival, and the truck is committed to showing up on time. If the operator charges for the appointment ticket, the charge can be reimbursed if the truck is not accommodated as scheduled.

By aligning demand relative to supply, the appointment system alleviates gate congestion, increases the terminal's capacity to handle trucks, and reduces the time trucks spend inside the terminal. Again, as a matter of policy, regulators should consider making a truck appointment system a requirement where terminals are highly congested at the gates.

4. CONCLUSION

We have identified six basic indicators for ship handling and truck handling that a regulator can apply or that can be inserted in concession contracts to ensure terminals meet minimal standards of performance. Additionally, all terminal operators should be required to implement vessel window and truck appointment systems to ensure acceptable levels of performance.

Terminal operators may resist the introduction of performance indicators and/or the values assigned to these indicators. Holding discussions with them to reach consensus on the

[10] The common alternative to a window system is first in-first served.

indicators will at the very least reduce this resistance, as our experience in Colombia indicates. One major concern will be how data for calculating indicators are collected. The usual approach is to assess data flow in the terminal and identify points at which data are or can be captured. In most terminals, the data are already collected for key performance indicator systems that the operators use to monitor their own performance; hence, the proposed indicators will not create an undue reporting burden on the operator. Indicators should also be based in part on the dynamics of the market in which operators compete, such as vessel size trends and loading/discharge volumes. It is also important that the performance criteria in concession agreements be adjusted periodically to reflect changes in technology and expansion at the terminals.

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