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DRAFT ASSESSMENT REPORT

Private Sector Participation in an Integrated Transport System in Lagos, Nigeria – Truck Parking and Port Access Facility Project

Prepared for:

World Bank

Prepared by:

CPCS

In association with:

Benchmac & Ince

Osot Associates

Solutions for growing economies

CPCS 17447

December 28, 2018

Quality Assurance

Private Sector Participation in an Integrated Transport System in Lagos, Nigeria

CPCS Ref: 17447

Final Assessment Report

Version	Date	Responsible	Approval
1.0	August 6, 2018	Devyani Singh	Philip Asante
1.2	September 4, 2018	Vivek Sakhrani	Philip Asante
1.3	November 20, 2018	Vivek Sakhrani	Jean-Francois Arsenault
1.4	December 28, 2018	Vivek Sakhrani	Jean-Francois Arsenault

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December 28, 2018 CPCS Ref: 17447

To:
The World Bank Group
1818 H Street, NW
Washington, DC 20433 USA

Dear Sir/Madam,

Re: Private Sector Participation in an Integrated Transport System in Lagos, Nigeria Truck Parking and Port Access Facility Project - Submission of Draft Assessment Report

We are pleased to submit this final assessment report for the above-referenced Project.

We would be happy to address any comments or questions that you may have.

Yours very truly,

CPCS Transcom Limited

Vidhi Mohan
Project Manager

Acknowledgements

CPCS would like to acknowledge the kind assistance granted to them by the World Bank Group, the Lagos State Government, including its agencies LAMATA, LASWA, and the Nigerian Ports Authority. We also wish to thank all other stakeholders consulted during the project mission. Any errors of fact or interpretation are ours.

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Acronyms/Abbreviations

ALBON	Association of Luxury Bus Owners of Nigeria
BOT	Build Operate Transfer
BPP	Bureau of Public Procurement
BRT	Bus Rapid Transit
CA	Concession Agreement
CMS	Christian Missionary Society
CPCS	CPCS Transcom Limited
DTIDCL	Delhi Transport Infrastructure Development Corporation Limited
FAAN	Federal Airports Authority of Nigeria
EBITDA	Earnings before Interest, Taxes, Depreciation and Amortization
EBIT	Earnings before Interest and Taxes
FGN	Federal Government of Nigeria
FMEnv	Federal Ministry of Environment
FMOT	Federal Ministry of Transport
FMPWH	Federal Ministry of Power, Works and Housing
GIF	Global Investment Facility
GIS	Geographic Information System
Ha/hA	Hectares
HSV	Hourly Service Volume
IA	Implementing Agencies
ICD	Inland Container Depot
ICRC	Infrastructure Concession Regulatory Commission
IR	Inception Report
ISBT	Interstate Bus Terminals Project (Mega Terminals Project)
IoT	Internet of Things
KL1	Kirikiri Lighter Terminal Phase I
KL2	Kirikiri Lighter Terminal Phase 2
Km	Kilometer
LAGBUS	LAGBUS Assets Management Company Limited
LAMATA	Lagos Metropolitan Area Transport Authority
LASTMA	Lagos State Traffic Management Authority
LASWA	Lagos State Waterways Authority
LASG	Lagos State Government
LBSL	Lagos Bus Services Ltd
LMA	Lagos Metropolitan Area
LOS	Level of Service
LSPPA	Lagos State Public Procurement Agency
LSPPP	Lagos State Public Private Partnership
LSSC	Lagos State Safety Commission
LSWTP	Lagos State Water Transport Program
MU	Management Unit of Global Investment Facility
N4P	National Policy on Public Private Partnerships
NPA	Nigerian Ports Authority

NRC	Nigerian Railway Corporation
NSC	Nigerian Shippers Council
O&M	Operation and Maintenance
OD	Origin Destination
Pphpd	Persons per hour per direction
PPIAF	Public Private Infrastructure Advisory Facility
PPP	Public Private Partnership
PSP	Private Sector Participation
PT	Public Transport
RfP	Request for Proposals
RoW	Right of Way
Sqm	Square meters
STMP	Strategic Transport Master Plan
TEU	Twenty Foot Equivalent Unit
TPPAF	Truck Parking and Port Access Facility
WP	Working Paper
WB	World Bank

Key Takeaways

The port-truck interface is a set of activities that includes the queuing behavior and local dray movement of trucks between port gates and landside freight facilities. The main metric and key performance indicator for efficiency at the port-truck interface is the "**truck turn time**" – the time it takes for a dray truck to leave an origin, complete a loading / unloading transaction at the port, and arrive at a destination. While turn times are on the order of hours at most ports worldwide, the time that dray trucks spend at Lagos area ports for a single container move stretches into days with thousands of trucks queued outside port facilities. An ideal reduction of 5 days in turn time in Lagos translates to cost savings of USD 1,200 per truck turn, of which USD 250 per turn can be captured by reducing congestion and improving dray efficiency.

In recent work, the World Bank has recommended truck parking outside city limits, buffering lots near ports, and the use of truck appointment systems to mitigate congestion.[1] Truck Appointment Systems (TAS) are seen as essential for giving the port and terminal operators the ability to control or influence behavior of trucks at the interface with ports. Buffering lots near ports (also known as marshalling yards, or waiting zones) are seen as a way to strengthen the power of the TAS mechanism. These are advanced schemes requiring a high level of coordination between public agencies and private actors. In this study, we investigated the potential of moving towards the advanced coordination scheme of the Truck Parking and Port Access Facility (TPPAF) using Information and Communications Technology (ICT).

The TPPAF concept entails a **scheduling** logic in which trucks arrive at port gates only when they have confirmed appointments to perform a dray move at the ports. Under realistic conditions, trucks might arrive early to avoid missing appointments or may need to wait while their transaction and load is being processed within the port. To allow for these deviations, the arrival process of trucks can be staged using marshalling yards, i.e. **buffering** lots. The role of ICT is to streamline communication between trucks, port gates, and terminals, and to improve processes through digitized transaction handling by using a Truck Appointment System (TAS). Even the simplest ICT components can deliver significant benefits, when implemented correctly and used by stakeholders as intended.

The precedent of the Port of Manila, with a context similar to that of Lagos area ports, shows that the Truck Appointment System by itself can mitigate port area congestion, and unlock economic benefits. The TAS solution in Manila is reported to have reduced truck turn times so that 72% of trucks are served within 2 hours, at appointment fee levels of USD 5 to USD 20 per TEU depending on time of day.

Our analysis of all available land zoned for commercial and industrial use (both open and brownfield) showed there are only about eleven available sites across the LMA that are suitable for truck parking. Four prime sites that lie within a twenty to thirty-minute travel time radius along main port access routes can accommodate a total of about 3,100 trucks. Of these, the federally-owned truck parking site on Tin Can Island is at 90% completion, but not yet operational. Repurposing the other three sites would entail site acquisition and civil works.

[1] World Bank (2018). *West and Central Africa Trucking Competitiveness*

Three other large sites are about two hours' travel time away under current traffic conditions, whereas others are too small or not near main corridors.

A study of different project structure options for Private Sector Participation shows that a TPPAF project focused on scheduling has healthy returns at low fee levels of USD 5 – 10 / TEU, while the necessary fees to support buffering lots are unlikely to be sustainable in Nigeria (up to $20 / TEU excluding land acquisition). The buffering lot aspect should be seen as a supporting component, and decoupled into an optional module.

A scheduling approach (Truck Appointment System) is the most essential component of the solution envisioned, and can be pursued by the private sector under a PPP, with no cost to the government (similar to the Port of Manila).

Under this recommended scheduling solution, what truck drivers are paying for is the service of unambiguous appointment times and streamlined transaction handling by the port and facilities. The fee for use of the TAS can thus be incorporated as one line item in the bundle of fees and charges that trucks are already responsible for, as part of the requirements for accessing the port and providing dray services.

The scheduling system could quickly generate positive returns, and these returns could be reinvested into buffering lots and/or to decrease the appointment fee payable. The federally-owned truck parking site (90% complete) on Tin Can Island, or part of it, should be the first choice for a buffering lot, if this optional buffering component is also included.

Either of these approaches, i.e. a scheduling system with or without buffering lots, is only likely to be successful if some other fundamental mechanisms and complementary strategies are in place and working. As such, our proposed **phased approach** for the project is as follows:

Phase 1: Setting the Stage

1. **Registration**: Begin requiring drivers and fleets to register their trucks in an electronic Lagos State Parking Authority (LSPA) database, and then enforce port-area and terminal access only for those with the recognized authority to operate. The Nigerian Ports Authority (NPA) must be able to access the database for port-area checks.

2. **Implementation Charter**: LASG and the Federal Government (represented by the Federal Ministry of Transport - FMOT, the Nigerian Ports Authority and the Federal Ministry of Power, Works and Housing – FMPWH) come to an agreement with the objective of decongesting the ports and improving traffic flow in/around the Lagos ports area. The charter would impose obligations on each party with LASG assuming responsibility for enforcing parking restrictions (#3 below), FMOT and NPA granting access to the port gate (#6 below) and FMPWH providing the Tin Can Island site, or part of, as the buffering lot staging platform (#5 below).

3. **Port Traffic Management**: LASG to ensure that Lagos State Traffic Management Authority (LASTMA) develops, implements and enforces regulations restricting arbitrary parking in the port environment, creating an environment conducive to a scheduling system.

4. **Special Purpose Vehicle**: NPA to convene stakeholders and oversee an arrangement leading to the formation of a Special Purpose Vehicle (SPV), which would later be granted

status as the Authorized Economic Operator (AEO) in a PPP for implementing and operating the Truck Appointment System and the buffering site. It is envisioned that a competitive process (transaction) would be undertaken (see Phase 2a below) to identify a private foreign entity who would enter into a Joint Venture with a local firm to form a majority group (51% equity stake) in the SPV. This approach would bring both the needed international expertise and also ensure capacity building for the local participants. NPA to hold discussions with terminal operators under the umbrella of the Seaport Terminal Operators Association of Nigeria (STOAN) to ensure fairness and transparency in dealings, with terminal operators on Tin Can Island and Lagos port complexes forming a minority group (49% equity stake) in the SPV. As terminal concessions expire and new concessionaires are identified, the equity stake can be transitioned to them to maintain the 49% among active concessionaires.

5. **Buffering / Staging**: FMWPH, via the Implementation Charter, commit to leasing its truck holding site (currently at 90% completion) to the AEO / SPV to manage as a buffering lot staging area for trucks destined to either of the Lagos area ports. The objective of this optional component of the approach is to strengthen the TAS as a solution and extract value from it.

6. **Port Access Governance**: NPA to provide firm commitment in Implementation Charter on port access, and their interest in implementing a scheduling system. Such systems always face some level of opposition from vested interests, and commitments from key stakeholders are a must. This commitment must include unequivocal declaration to allow gate access to only vehicles with valid registration and documentation. The updated provisions to also include a separate line item for the inclusion of the service fee for the use of the TAS, as one of the business rules for the AEO.

7. **Awareness**: Sensitize key stakeholders (particularly road transport unions) about the benefits of the truck scheduling scheme, emphasizing successes in other jurisdiction such as Manila and other congestion management efforts at other African and global ports.

Phase 2a: Operationalize Pilot Phase of Scheduling System

The first step of this phase would be to implement a transaction to identify and select a private group acting as an Authorized Economic Operator to manage the Tin Can Island staging area. This private group would hold a controlling stake (51%) in the SPV assigned the lease to operate and manage the Tin Can Island truck staging area. The SPV would include terminal operators as minority members (holding 49% stake) of this SPV. The Authorized Economic Operator would be responsible for stewarding linkages between Terminal Operating Systems and port-truck interface / landside operations. Specific steps would involve:

1. **Business Rules**: Engage a Transaction Advisor to develop an Outline Business Case (OBC) identifying the business rules that will govern transactions between the terminals, trucks / carriers, and the NPA. Harmonize the various fees, charges, and requirements holistically.

2. **Truck Appointment System**: Implement a competitive tender process to identify a private group that will assume a majority stake in the Authorized Economic Operator

and be responsible for procuring / integrating a common Truck Appointment System across participating terminals. The entity is likely to be foreign, given the specialized technical and operational experience required, but could enter into a Joint Venture with a Nigerian firm to ensure that the local context is respected, international technological expertise is brought in, and local capacity building is fostered over time. The initial focus for TAS implementation could be on TCI terminals.

3. **Tin Can Island Buffering Lot**: Leverage the almost-operational truck holding lot on Tin Can Island as the first buffering lot to test the scheduling and buffering concept, and refine operating rules. Very little ICT investment is deemed necessary at this stage, with the minimum requirements being a computer system to validate truck identities, transaction statuses, and registrations. Radio communications with the terminal operators will also streamline information flow.

4. **Assessment**: Evaluate the changes / impacts to throughput from the use of the scheduling system and the pilot buffering lot.

In parallel to Phase 2a related directly to the project, other reinforcing measures must be put in place to maximize the likelihood of success.

Phase 2b: Reinforcing Measures

Without supporting measures, there is a likelihood that a scheduling system will not bear the anticipated fruits. By far the most important measure is the enforcement of port-area access and parking restrictions, which would also be a strong indicator of the authorities' commitment to deal with the congestion issue. As such, key measures would be as follows:

5. **Port Access**: Enforce the requirement for valid truck registration (license to operate), and consignment notes / bills of lading for access beyond a security cordon in the vicinity of the ports, in line with the new LASTMA legislation and regulations for implementation noted above. There are no additional fees or charges beyond what trucks are already responsible for today.

6. **Parking**: Enforce restrictions of truck parking on port-area access roads beyond that security cordon.

Phase 3: System Build-Out

Once the system is working at TCI terminals, and the supporting measures are well in place, the financial balance of the project should be quite positive. If the staging area has been successful, the TPPAF area of operation can be extended to the Lagos port complex terminals, this should allow for a significant fee, which could be reinvested to build up additional buffering zones and other supporting infrastructure. As such, key steps would be:

1. **Scale Expansion**: Expand scheduling to all terminals, renegotiating a concession fee to be used for initiatives related to port congestion management initiatives.

2. **Buffering Capacity Expansion**: Pursue site acquisition for St. Mathew Daniel and Kirikiri sites as optional buffering lots, using some of these funds. Alternatively, develop and implement a small-scale buffering lots licensing program.

3. **Long-term Parking**: Develop long-term parking zones further away from the port outside the LMA and near major freight corridors, as a feeder to the port area facilities and buffering lots.

In particular, long-term parking zones with suitable pricing will become interesting to truckers if they have some level of confidence that *when granted an appointment* they can move from a long-term parking lot to the port access are, and a buffering zone if needed and wait for their scheduled appointment with limited to no risk of missing it. The choice of staging in long-term parking and then in buffering zones near the port will be reinforced significantly by a strict enforcement of the use of the Truck Appointment System and parking rules near the port, and the requirement to have the necessary registration, consignment notes, and confirmed appointments.

This study also identified other initiatives and opportunities that would contribute to alleviating truck congestion and reinforce the proposed initiative, which we document in our report.

Executive Summary

This assignment "Private Sector Participation (PSP) in an Integrated Transport System in Lagos" is intended to assist the Lagos State Government (LASG) with three transport sector initiatives that may have the potential for Private Sector Participation (PSP):

- the Interstate Bus Terminals Project (Mega Terminals/ISBT Project),
- the Lagos State Water Transport Program (LSWTP), and
- the Truck Parking and Port Access Facility (TPPAF) using Information and Communication Technologies.

The overall objective of these three projects is to reduce road congestion and associated externalities in the Lagos Metropolitan Area (LMA).

The "Truck Parking and Ports Access Facility using Information and Communication Technologies" workstream (hereafter TPPAF workstream) is an important element of the overall vision to address the road congestion in LMA. The TPPAF workstream is about improving operations in a key stage of the of the Lagos Metropolitan Area (LMA) transportation supply chain: **the port-truck interface**. This report documents the results of the TPPAF workstream.

Before documenting the specific findings of this workstream for Lagos-area ports, we introduce the project context and rationale in the context of both local and global attributes of metropolitan ports.

Project Context and Rationale

The port facilities in Lagos – Apapa and Tin Can Island port complexes – constitute a metropolitan port, because of their location within the larger Lagos Metropolitan Area (LMA). Like many other metropolitan ports all over the world, the LMA ports suffer from truck congestion and related externalities, for the following reasons:

- **Location**: Lagos, like many metropolitan cities, has grown and developed around its major port facilities, leaving them landlocked. This leaves little to no flexibility for greenfield development, and only discrete possibilities for brownfield development. As a result, Lagos (and indeed all metropolitan ports) cannot "build its way out" of most problems without concerted and coordinated long-term planning to increase capacity.
- **Agglomeration**: the co-dependent sectors of the economy (processing, manufacturing, distribution) that rely on efficient port activities are typically located in the vicinity of ports, or occur in clusters within a distance of about 25 – 30 km from the port envelope. This requires trips to and from the clusters to the port facilities across a network of roads traversing the LMA, for the movement of containers as well as other types of goods.

→ **"Last Mile" Access:** The features of Lagos as a metropolitan port above require that trucks frequently enter and exit high-volume roads such as connectors and highways, and rely on local roads to access facilities. The LMA ports have only a few access routes between port facilities and other regional connectors, creating the potential for chokepoints in the transportation network. Distribution warehouses, and other industrial clusters are distributed in different parts of the LMA, requiring trucks to traverse Lagos arteries and connectors as they deliver loads and pick up containers.

→ **Truck Behavior:** As heavy good vehicles, trucks typically have different operating characteristics than passenger vehicles. Trucks have longer start/ stop times, slow pick up speeds, longer braking times, differential idling characteristics, and significantly higher wear and tear on infrastructure than passenger vehicles. When mixing with other types of traffic, trucks in the LMA are therefore not only affected by existing congestion, but can also exacerbate congestion. Overloaded trucks and those in a state of disrepair are likely to break down and block lanes on the LMA port access roads or on major arteries, thereby slowing down traffic for all road users. Pavement wear and tear is a compounding factor on last mile roads frequented by trucks, further affecting all traffic, and also increasing the risk of truck damage.

→ **Terminal and Quay-side Operations**: Truck flow into and out the LMA port facilities is a "throughput" phenomenon. In other words, the efficiency of processes such as container stacking / unstacking, loading on to and off trucks, routing of trucks through the terminals, administrative and clearance steps, all affect the rate at which trucks can complete their business at the ports and leave the vicinity. Chief among these processes is the manner in which the large number of empty containers are handled, as the uncoordinated return of "empties" at terminals can create logjams. Moving empty containers also implies an increase in the number of truck trips on average, as there are only very specialized cases in which a truck can both pick up a loaded container and drop an empty (or vice versa) in one round trip. The more the trips, the greater the likelihood of trucks either experiencing or exacerbating congestion in an already congested area.

There are thus three zones of activity which can either contribute to or be used to mitigate truck-related congestion. These are:

(1) **Quayside** – activities inside the port terminal boundary, which are primarily under the jurisdiction and governance of the terminals and the port authority

(2) **Landside** - activities at freight facilities, warehouses, etc. and on local roads and highways, which fall under the purview of the private shippers, consignees, and beneficial cargo owners on the one hand, and the local and state transportation agency and other public sector authorities on the other.

(3) **Port-Truck Interface** – the activities that link the prior two, including processing and checks, guiding trucks to and from the ports, routing, etc. The movement of trucks at this interface is known as dray operations (as opposed to line-haul or long-haul operations) and the trucks are called dray trucks.

Many of the world's metropolitan ports, including the Lagos area ports of Apapa and Tin Can Island, have tried to come to terms with truck-related congestion. Solution mechanisms are typically many-fold (see detailed case studies) and need to be coordinated across stakeholders in the three zones of activity described above. When executed well, these solutions come together to reduce **truck turn times**, as the ultimate measure of efficiency.

The overall objective of congestion alleviation measures is to reduce truck 'turn times' – the time it takes for a truck to complete a trip from an origin, into the port, turn around and move onto a destination, while balancing other social interests.

The figure below summarizes specific mechanisms by zone of activity. Most mechanisms are operationally focused, whereas a few entail infrastructure upgrades, maintenance, or capacity addition. Other advanced mechanisms may call for investments in automation or communications technologies.

Figure ES-1. Operations and Capacity Measures to alleviate congestion, by Zone of Activity

Zone of Activity	Measures to Alleviate Congestion and Improve Efficiency (* indicates infrastructure / technology-related investment)
Quayside The objective of quayside mechanisms is to reduce truck 'dwell times' as the main key performance indicator of efficiency	→ Streamline inspections, administrative, and clearance checks → Optimize routing and staging of trucks within yards → Improve container loading, stacking, flipping operations → Use automated equipment and electronic communications* → Truck and driver registrations and transaction databases* → Track truck movements within yard → Separate processes for empties from loaded containers → Coordinate yard hours of operation with Landside and Interface
Landside The objective of landside mechanisms is to maintain travel time reliability between landside facilities and the port-interface, while balancing other public interest objectives such as safety, emissions pollution, noise, and community quality of life.	→ Improve signage and route directions → Set and enforce truck weight restrictions → Design and maintain roads for chosen weight parameters* → Improve road and infrastructure designs to avoid rapid stops, starts, sharp turns, and slow downs* → Develop long-term parking facilities outside the dense urban core* → Develop dedicated depots / zone for storing containers* → Design truck routes and enforce routing restrictions from parking and staging locations to port and other freight facilities, container depots, or intermodal yards → Set and enforce time / hour restrictions for truck travel within urban core → Set and enforce parking restrictions on where trucks can park publicly → Regulate and inspect trucks for emissions and safety requirements
Port-Truck Interface The objective of interface mechanisms is to reduce idle time and dwell times	→ Require driver licensing, tractor / truck registration as eligibility requirement for port operations → Institute single-gate / window processes

Zone of Activity	Measures to Alleviate Congestion and Improve Efficiency (* indicates infrastructure / technology-related investment)
and the occurrence of queues between the Landside and Quayside.	→ Supplement with a two-stage gate to identify and separate exceptions from main queue → Develop extended hour gate entry policies, coordinated with yard operations → Admit trucks based on appointment windows → Develop marshalling yards / buffering zones near port facilities* → Supplement marshalling yards with electronic appointment systems → Detect and track trucks within a geo-fenced region extending beyond port gates to detect truck presence

Source: CPCS research and analysis

The mechanisms documented above by zones of activity need concerted policies and actions by either the public sector, private actors, or coordination by both. Many of these address fundamental structural issues on the public sector-side such as driver licensing or enforcement issues such as traffic management measures. At a different end of the spectrum, there are pure private mechanisms that shipping lines, terminal operators, and fleet owners must undertake in the course of accomplishing their business interests.

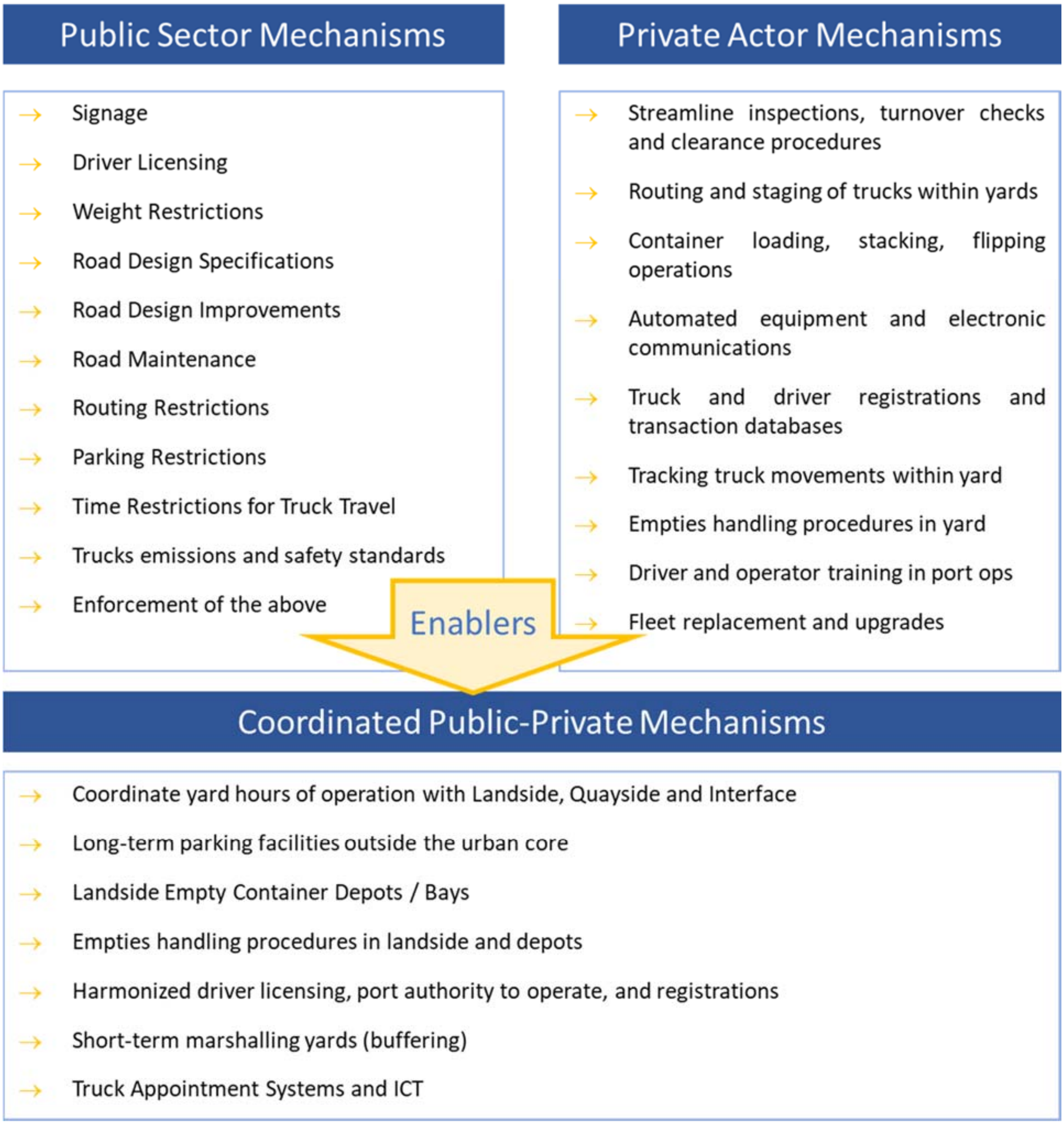
In the last decade, a number of World Bank and development assistance studies on trucking performance and the metropolitan port-city interface have pointed to the need for coordinated mechanisms between the public sector and private actors. The motives are to support sustainable urban development as well as promote trade and logistics efficiency for economic growth. These include investments in truck parking facilities outside the cities, close buffering lots as a waiting zone for trucks planning to enter the port area, and truck appointment schemes to schedule the pick-up and delivery of goods. However, these are advanced schemes – they assume that fundamental trucking sector structures, policies, and mechanisms are in place and functioning.[2]

As the figure below shows, the hybrid mechanisms relying on public-private coordination need as their pre-requisites the mechanisms traditionally associated with either the public sector or private actors.

Advanced schemes such as buffering and truck parking coordinated with ICT-based automation such as truck appointment systems can only realize their full potential once other fundamental structures are in place and functioning.

[2] World Bank (2018). *West and Central Africa Trucking Competitiveness*

Figure ES-2. Enabling and advanced mechanisms for efficiency, by actor type



Source: CPCS literature review and analysis of port case studies

It becomes clear that any solution proposed that requires significant coordination between public and private sectors will also need to be accompanied by measures to improve the fundamental public and private mechanism onto which such solutions are built. With this backdrop, we addressed the project terms of reference and explored the scope for PSP in leveraging Information and Communication Technologies (ICT) to address truck congestion and related externalities in the vicinity of the Lagos port complex.

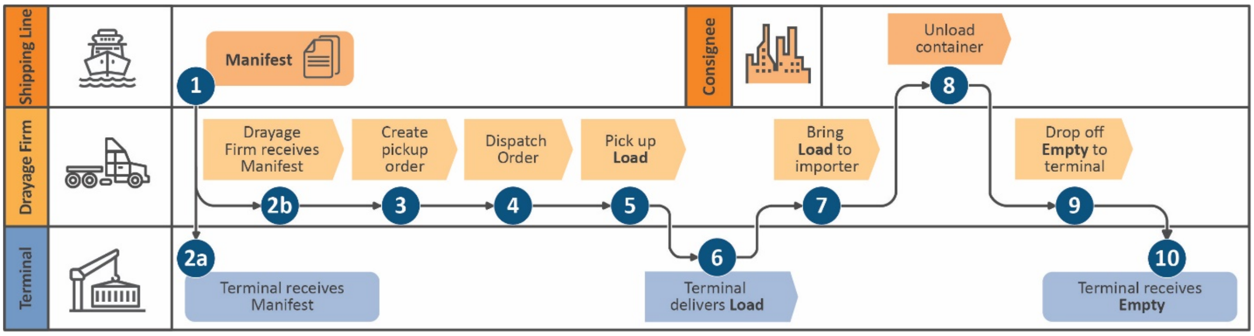
Technical Concepts- The Port-Truck Interface and Dray Operations

The port-truck interface is the point at which load (i.e. containers) changes modes from marine to road, or the converse. Dray trucking operations in the Port of Lagos or Tin Can Island complexes, and the related cargo handling steps before and after drayage are the activities that comprise the interface.

Dray Operation Overview

Figure ES-3 depicts the sequential port-side and land-side activities that are integral to a dray operation, arranged by actor and timing. The complete cycle between manifest creation (step 1) to load transfer (step 6) to the return of an empty container (step 10) is commonly called a **truck turn**.

Figure ES-3. Sequential Logic of a Dray Operation, which defines the Port-Truck Interface



Source: CPCS synthesis of port operations literature and practice

Shipping lines (i.e. vessel operator), consignees, drayage firms (or individual drivers) and the terminal operators are the principal actors engaged in a dray operation. Each actor "touches" the dray load (container or bulk shipment) multiple times between origin and destination, with the dray truck as the critical link between port- and land-side actors. Coordination between actors ensures that dray operations are streamlined.

Dray Efficiency and Performance

Delays or inefficiencies can occur at any stage of the dray operation. The key metric of an efficient dray operation is **truck turn time** – typically measured as the time between when the dray truck is dispatched to the port (step 4) to when it leaves the port (between step 6 and 7), either for moving a loaded or empty container. In some cases, truck turn time is measured as a "round trip", i.e. including the return of an empty or full container (step 10). While the dray truck is the critical link between the port-side and land-side, the other principal actors must coordinate operations to accomplish the truck turn and minimize truck turn time. The implication of efficient truck turns and low turn times is increased throughput at the port.

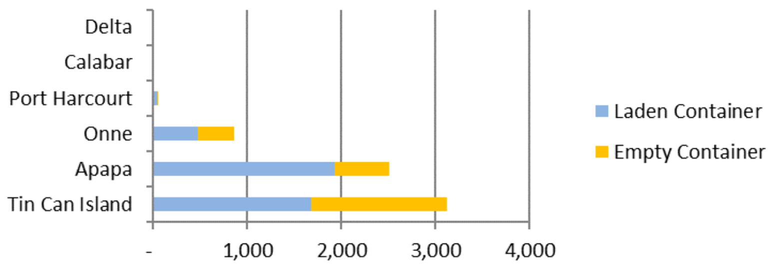
The quicker the truck turn, the higher is port throughput and the more positive is the overall contribution of the Lagos area supply chain to Nigeria's economy.

The TPPAF workstream thus ultimately envisions a solution to addressing the inefficiencies plaguing Lagos' dray operations via reducing truck turn times. Congestion, queues and related externalities are the foremost among these challenges.

Diagnostic – Current Port-Truck Interface Conditions in Lagos

The Nigerian Ports Authority (NPA) estimates that the ports of Tin Can Island and Apapa (collectively the Lagos Ports complex) accounted for above 85% of Nigerian container trade (between 5,000 – 6,000 containers a day) in the first half of 2017[3] (Figure ES-4). The Port Complex is thus the largest freight generator, and operating conditions have cascading implications for Nigerian trade and the economy.

Figure ES-4. Average daily container handling estimates at Nigeria ports in 2017, with over 85% in Lagos ports



Source: CPCS analysis of NPA data

When trucks depart the port area, they not only encounter **congestion** but also exacerbate it, with average travel speeds during peak morning and peak evening being less than 30 kilometers per hour (19 miles per hour) in most parts of the LMA[4], and especially within the Lagos logistics ring. The congestion in the "first / last mile" -- the short segment from the ports to Lagos warehouses -- is so acute that it costs shippers USD 434, representing 22% of the total land transport price of shipping along the entire 1,225 km north-south Lagos-Kano-Jibiya (LAKAJI) corridor[5]. About 94% (USD 408) of this local transportation cost is deemed an "extra cost" attributable to congestion, poor road conditions, handling charges and delays, and other inefficiencies such as long cargo dwell times.

On the land-side, **extensive truck queues** are a primary reason for inefficient dray operations and long turn times at the Lagos Ports Complex and the Tin Can Island Ports Complex. These queues in turn impose significant negative externalities by compounding congestion in the Lagos Metropolitan area (LMA), generating higher concentrations of pollutants and Greenhouse Gas (GHG) emissions from idling trucks, noise, and driving up the cost of doing business.

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[3] Nigerian Port Authority, 2018. Ports Statistics; Container Traffic (TEUs). www.nigerianports.gov.ng/ports-statistics/.

[4] Frederic Oladeinde. Presentation on the Lagos Strategic Transport Master Plan. Lagos Metropolitan Area Transport Authority (LAMATA). 2017

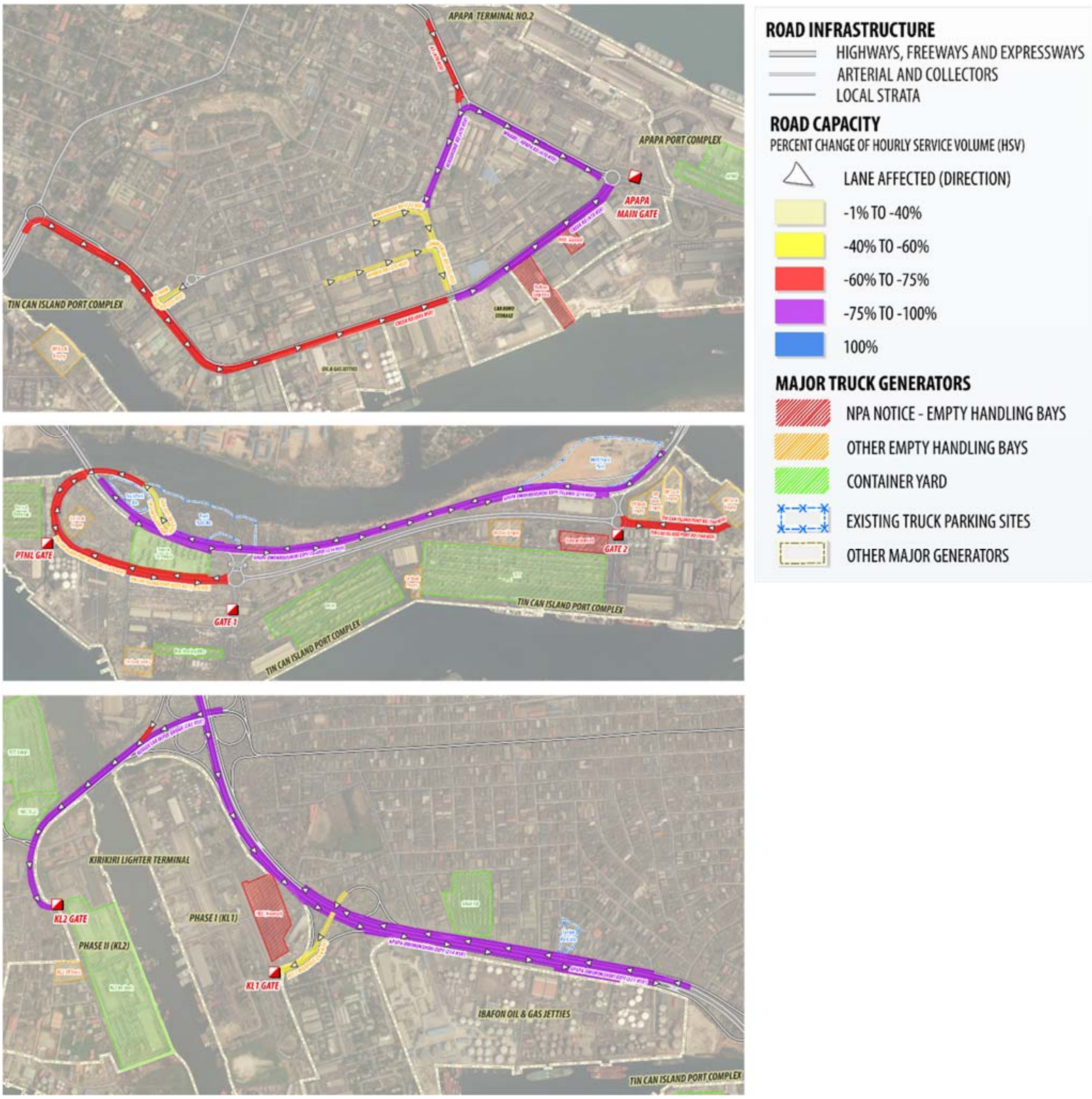
[5] Nigeria Expanded Trade and Transport Program (NEXTT) Lagos-Kano-Jibiya (Lakaji) Corridor Performance: Baseline Assessment Report On The Time And Cost To Transport Goods, 2015

Congestion Analysis

Truck queues and associated congestion tends to occur in clusters associated with an identifiable freight generator – Tin Can Island and Lagos Ports Complexes in particular. Figure ES-5 shows maps of the port facilities with truck queues along the main access and egress roads. Congestion, as measured by *reduced* Hourly Service Volume (HSV), on these roads can exceed decreases of 75% for significant stretches, i.e. decreasing road capacity by over three quarters. In other words, blocked lanes and occupied shoulders prevent trucks from easily entering or exiting the ports complex, which increases truck turn times.

Section 2.2 contains a detailed congestion analysis.

Figure ES-5. Truck queues and congestion in the vicinity of Lagos area ports



Source: CPCS analysis

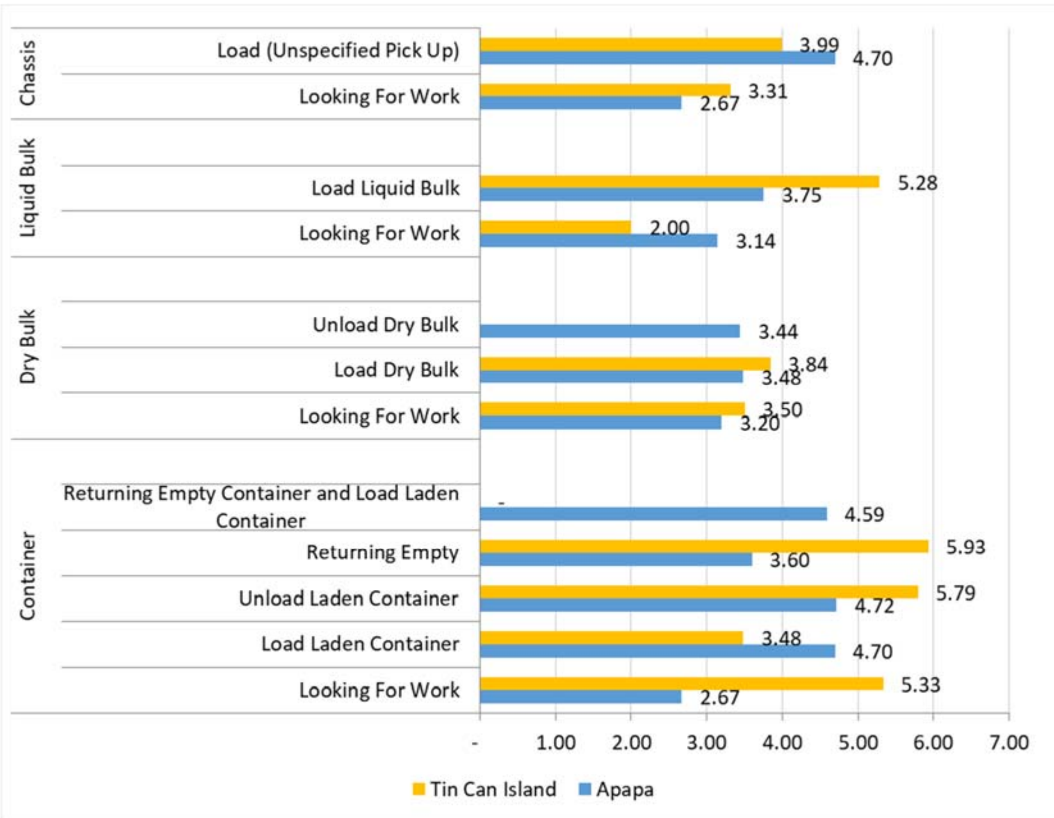
Queue Composition Analysis

Our independent survey of truck queues for this project indicated queue lengths of about 2,800 and 3,200 trucks near the Tin Can Island and Apapa complexes respectively, for a total of about 6,000 trucks on a single day. Consultations with NPA and others suggest that queue lengths can exceed 10,000 trucks on busy days, depending on vessel call schedules and status of port operations. The analysis of the truck trip purpose and dwell times in queues is illustrative of daily and weekly patterns (Figure ES-6 and Figure ES-7). However, there is considerable variance in queue lengths and conditions can be much more severe.

Most trucks in the queues tend to be container trucks or chassis. Over 2,100 trucks out of 6,000 were returning empties. Apapa and TCI (Nigeria for that matter) are import driven, 80% of the goods seen are unloaded at the ports and sent inland and account for such a large share of trucks attempting to return its empties.

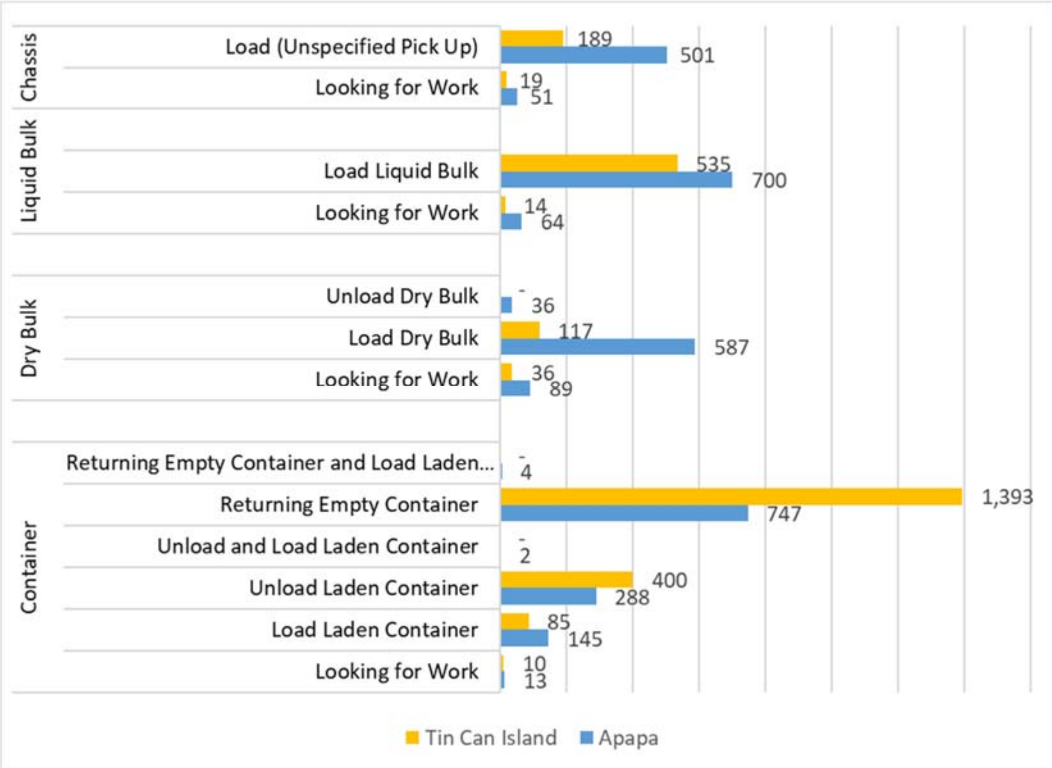
An additional 700 trucks were holding spots opportunistically, vying for their next transaction or awaiting dispatch. About 1,200 trucks were in queues to handle liquid bulk. The rest had specific appointments for loading or unloading either bulk or laden containers. The return of empties and their management is thus a significant factor contributing to congestion and queues, followed by the co-mingling of container and bulk trucks.

Figure ES-6. Average queue dwell time of trucks in survey sample by type and trip purpose



Source: CPCS survey and analysis of truck queues (2018)

Figure ES-7. Number of trucks in survey sample by type and trip purpose



Source: CPCS survey and analysis of truck queues (2018)

Dwell times for trucks tend to correspond to trip purpose, but on average can range from two to six days. Trucks can often wait to unload laden containers for five to six days, and look for work or wait for dispatch for up to 10 days or more. These long dwell times add to the high indirect cost of transporting goods in the last mile, while blocking or delaying scheduled transactions that could otherwise be executed promptly. The trade-off for truck drivers is to remain in the port area, or deal with the high degree of travel time unreliability in going back and forth from other locations in the LMA which can take up to a day of travel time.

On average, only one in five trucks in a queue (20% of queue length) transacts business with the terminal yards on any given day.

Our analysis of the NPA gate operational return summaries for Apapa and Tin Can Island and consultations with NPA suggest that only a small fraction of trucks in these queues actually perform a dray operation at a snapshot in time. The daily number of gate transits was 500 trucks at Apapa and 700 trucks at Tin Can Island, for a total of about 1,200 trucks.

Limitations of Current Measures to address Congestion

While both congestion and queues are the fundamental challenges that need to be addressed to improve dray operations, they are in fact symptoms and not the causal driver. One of the fundamental blind spot driving queues, congestion, and other negative externalities in Lagos dray operations is the lack of **truck and asset observability** – the ability to know where trucks and containers are, relative to where they should be, or to influence their movements and presence. This makes operational coordination difficult.

Key actors involved in drayage are currently unable to coordinate their operations to ensure that trucks are in the right place at the right time, and the lack of a means to influence truck movements.

The legal measures currently in place (see Appendix G) to address queues and congestion have not borne fruit, partially because they do not address the fundamental blind spot or assist with coordination. Figure ES-8 summarizes measures that have been attempted and their limitations / shortcomings. The design of these measures places an undue reliance on monitoring and enforcement, rather than incentives and processes that might allow trucks to "self-regulate" their behavior.

Figure ES-8. Current measures to address dray operation inefficiencies and their limitations

Operational Measure	Limitation
Manual truck call up processes at port gates	Current procedures are manual and ad hoc with gate security personnel searching queues for trucks intended to be called up. This places the burden on the port and terminal operators.
Empties handling policy	While a recent NPA directive requires empties to be stored off-site until needed by the shipping lines, the measure will only pay off with adequate capacity at off-site holding bays, and adequate monitoring and enforcement.
Truck route and travel time restrictions	Current law restricts articulated trucks and petrol tankers to only enter the LMA between 9pm and 6am. This is often not enforced, and trucks bypass the requirement by queuing up near the ports so that they don't traverse the LMA.
Oversize / overweight load restrictions	Trucks regularly exceed the weight limit of 30 tonnes per axle (road design standard) as they try to accommodate more load to counteract the aforementioned issues. Roads continue to deteriorate in the absence of weight restriction enforcement and maintenance leading to slower travel times.

Implementation Recommendation: Enforcement of Existing Policies

As described above in Figure ES-2 and in our detailed case studies (Section 4 of this report), enabling structural mechanisms and necessary enforcement, especially on the public sector side, are necessary to support coordinated operations across actors so that dray truck movements at the port-truck interface can ultimately be streamlined to mitigate queues and related truck congestion. In the absence of enforcement of existing regulations and laws, any proposed solution will not have any traction, which is why this enforcement is recommended as a complementary strategy, and to also demonstrate commitment on behalf of agency stakeholders.

With improved structural mechanisms, a system of truck parking coupled with technological solutions improving **truck and asset observability** could produce material benefits. Truck traffic projections in the following section show that enforcing these measures and developing a comprehensive set of reinforcing solutions will become increasingly important as the volume of truck trips increases.

Traffic Analysis and Projections

While truck congestion and queue lengths in the Lagos Port Complex are currently severe, the passage of time will only likely exacerbate them under a "do nothing" or business as usual scenario. To understand the potential of negative impacts over time, and the expected benefits of addressing congestion, we developed a projection of queue conditions in the port environs.

Our data sources include historical operating results and annual reports published by the NPA and macroeconomic GDP forecasts from the UN National Accounts Main Aggregates Database. The total number of trucks on port area roads is determined by the following key factors: import and export freight volumes, the backhaul / reclaiming of empty containers by shipping lines, customs and yard handling time and delays, road conditions, and travel times for traversing the local road network in the LMA. Section 3 describes the model and assumptions in detail.

Truck Count Forecasts

Figure ES-9 shows truck counts at the two main freight generators (Tin can and Apapa) at five-year intervals over a 20-year time horizon (2018-2037). Three growth scenarios are modeled for each facility (for container and bulk trucks) and results are aggregated.

Our methodology is built on the results from a detailed traffic report developed for NPA. Projects freight growth by category and port was applied to the number of trucks in the base year to develop the truck forecast. Trucks were assumed to grow half as fast, since some of the increased in freight is assumed to be absorbed by competing facilities, through improvement in truck logistics, and by new rail connections.

Our analysis show that about 6,000 trucks on average are parked on roads in the LPC area in various queues and informal lots today. By 2028, these grow to more than 8,600 trucks in the base scenario, but the number could be as large as almost 12,500 trucks in high growth conditions.

Under a business-as-usual scenario, congestion is likely to cripple operations in the Lagos Port Complex over the next 20 years.

Going further out to 2037, truck counts could range from about 7,700 trucks in the low scenario to as many as 20,500 in the high scenario. It becomes clear that congestion and truck queues will be greatly exacerbated over time.

Figure ES-9. Truck Counts in the Lagos Port Complex under three Growth Scenarios (2018-2037)

	2018	2023	2028	2033	2037
Apapa					
Base	3,226	3,832	4,372	5,030	5,641
High		4,538	5,918	7,841	9,875
Low		3,457	3,643	3,853	4,033
Tin Can Island					
Base	2,798	3,561	4,301	4,917	5,512
High		4,473	6,481	8,458	10,632
Low		3,086	3,331	3,515	3,680
Total					
Base	6,024	7,392	8,672	9,947	11,154
High		9,012	12,400	16,299	20,507
Low		6,543	6,975	7,368	7,713

Source: CPCS analysis (2014 and 2018)

Case Studies on Port-Truck Interface Improvement Programs

Case studies on leading ports around the world (including Africa) demonstrate that the scheduling and buffering mechanism for coordinating operations is an advanced mechanism, attempted only after other measures are in place and most often as a part of a broader program of environmental and congestion impact management.

In Section 4 of this report, we present a critique of the programs of ten metropolitan port-truck interface improvement programs, across North America, Europe, Africa, the Middle East and Asia. Each of these programs is multi-pronged, and consists of:

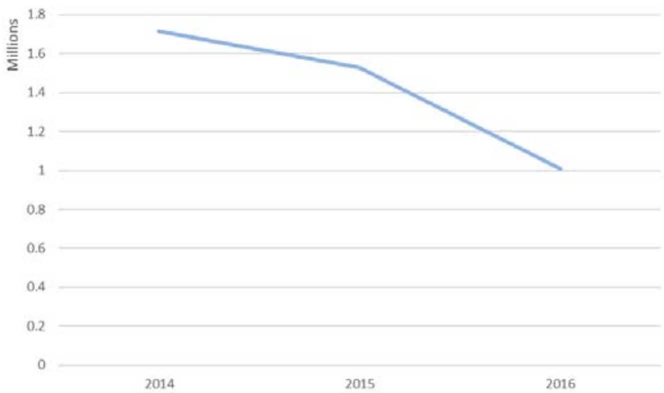
- Updated rules and regulations on the part of the public sector for functions such as driver licensing and operating authority requirements, including truck and driver registration databases.
- Coordinated single window / clearance / gate processing approaches that require public and provide coordination between public entities, shipping lines, terminal operators, and cargo owners
- Changes to operating hours, queueing processes, and fee structures for drayage and container moves
- Fleet tracking and truck identification solutions to locate trucks as the move about the port, or within the vicinity

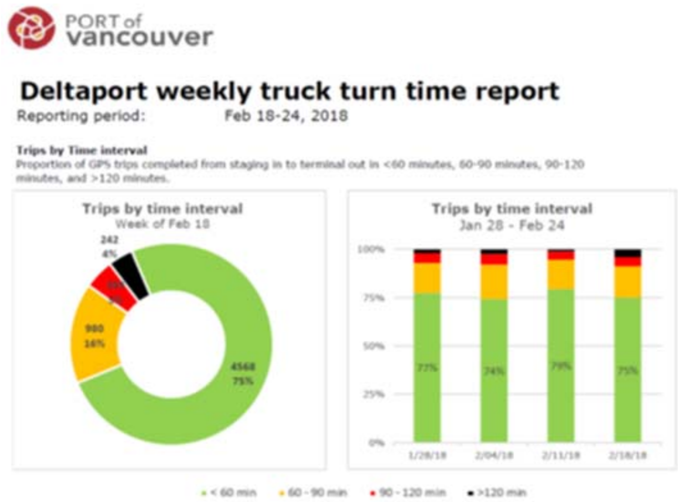
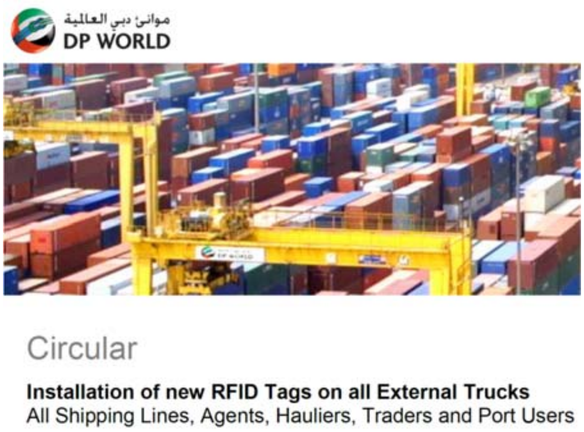
- Quayside and yard area automation, and increased reliance on electronic transaction and identification data
- Truck appointment systems, without and with buffering arrangements

None of these measures provide a silver bullet to addressing congestion. The evolution of these ports shows that mechanisms such as automation, tracking, and electronic transaction management depend on fundamental structures being gradually phased in over time. Port-truck interface automation continues to be an area of emerging techniques and solutions, and is yet to become mature and standardized, although many ports seem to already be capturing significant benefits. Scheduling and buffering using ICT should therefore be thought of as an advanced scheme for Lagos area ports.

Figure ES-10 summarizes findings from a few of those ports, showing how they are increasing the ***effective* capacity** of existing infrastructure through coordination and dynamic efficiency improvements.

Figure ES-10. Case studies – role of scheduling and buffering in port operational improvements as an advanced mechanism

Case Study Port	Key Takeaways
Port of Manila Decline in container demurrage charges levied as a result of container throughput improvements after implementing the Terminal Appointment Booking System.  Source: CPCS Analysis of Philippines Ports Authority Annual Reports 2015 and 2016	The Port of Manila in the capital of the Philippines is located in a dense metropolitan region of about 13 million people. Recent operational changes at the port enabled it to increase throughput by 14% (0.5 million TEUs) within a single year. In September 2015, the Port commenced operations with a Terminal Appointment Booking System (TABs). The terminals operate 24 / 7 using this new system. Fees range from USD 5 / TEU in non-peak hours to USD 20 / TEU during peak hours. Carriers receive a discount for night hours, and face penalties if they miss appointments or are outside a grace period window. The main results of the program include: → A 25% increase in throughput during peak periods → Eliminated cash payments and paper processes → Truck dwell time went from 130 minutes and 48% served within 2 hours down to 100 minutes with 72% served within two hours → Load factor went from 1 per trip to 1 each way with 60% of trucks carrying two It is worth noting that the TABS is implemented without any buffering lots.

Case Study Port	Key Takeaways
Port of Vancouver Weekly Smart Fleet performance report for a terminal at the Port of Vancouver  Source: Vancouver-Fraser Port Authority	The Port of Vancouver is the largest port in North America by tonnage and handled about 140 million tons of cargo in 2017, valued at 20% of Canada's total goods trade. It implemented a smart truck fleet program in 2013 for: → Instrumenting fleets with GPS → Implementing a software model for drayage → Reforming the Truck Licensing System for environmental requirements, and → **Implementing a truck appointment system**. **The Truck Appointment System for scheduling and buffering is one element of a broader program for operational efficiency improvements.**
DP World – Multiple Ports  Source: DP World	Dubai Ports World (DP World) operates over 50 terminals in 31 countries, handling over 50 million TEUs / year. The company has worked with port authorities to address congestion in the vicinity of many of its terminals by instituting: → electronic customs clearances → electronic data interchanges (EDIs) → two way radio communications → e-token advance booking systems. → RFID-based automated port access since 2009 in Dubai, UAE ; Sydney, Australia → **Port of Antwerp recently upgraded to a Truck Appointment System with short-term parking** **Truck appointment systems are supplemented by an appropriate data architecture and other automated truck and container identification technologies for scheduling and buffering.**

Case Study Port	Key Takeaways

PierPass – Ports of Los Angeles / Long Beach

RFID-tagged trucks being processed through access gantries and lanes at POLA/LB

Source: PierPass program

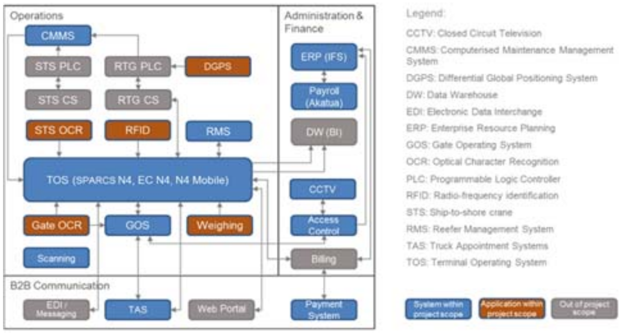
The dual port complex of the Ports of Los Angeles (POLA) and Long Beach (POLB) is one of the largest port facilities in the world. Twelve container terminal operators jointly created the PierPass program in 2005:

- → Night- and weekend off-peak shifts to address congestion
- → Approx. 15,000 trucks per weeknight (avoided queue length of 250 km)
- → All trucks required to be RFID-enabled since 2009
- → Traffic Mitigation Fee (TMF) used a congestion pricing mechanism to create incentives for off-peak operations
- → PierPass also functions as an accounting clearinghouse for allocating program costs and benefits

Terminal operators coordinated with port autorities to create PierPass as a Special Purpose Vehicle (SPV), which allows for private sector participation and the development of clear business rules for transactions.

MPS Terminal – Tema, Ghana

Overall automation architecture, data flows for MPS terminal in Tema



Source: MPS

MPS has had the concession to operate the container terminal at TEMA since 2004, and commenced operations in 2007. Within the port expansion project, the new MPS terminal at Tema was designed with a number of automated procedures in mind, including the use of a Truck Appointment System connected to a Terminal Operating System. Once truckers are registered in the TAS, the system enables:

- → 24/7 access to the booking system for appointments
- → Electronic fee payments, and customs transactions
- → Biometric fingerprint scans for truck driver identification, and appointment validation
- → RFID and License Plate Recognition for truck tracking and automated work flows in the port yard

MPS Truck Appointment System and Terminal Operating System link a number of processes and databases designed to support TEMA's single window approach for imports and exports of containers.

Case Study Port

Transnet Port Terminals (TPT), Port of Durban, South Africa

Short-term buffering lot / truck marshalling yard at Pier 2 of DCT

Source: TransNet Port Terminals

Key Takeaways

The Durban Container Terminal handles 65% of South Africa's overall container volume. With a capacity of over 3.5 million TEUs per year, Durban is one of Africa's largest container ports.

TPT's automated truck appointment system is currently at 45% utilization for container traffic, and the intended target is 80%, with the system expected to be mandatory for all fleet operators in 2019. The main features are:

- → Reduced truck turn times from 24 to 36 hours to 90 minutes for 50% of trucks
- → Reward and penalty system for appointments to ensure that incentives are aligned and appointments are honored / managed appropriately
- → Load "smoothing" over operating hours for better load matching between terminals, truckers, and container depots / holding bays

Operations at the Durban Container Terminal are representative of TPT's terminals at other boards, with provisions for integrating the Truck Appointment System with the NAVIS terminal Operation System (TOS) through Electronic Data Interchanges (EDIs)

Source: CPCS analysis

Facility Configuration and Service Design – Scheduling and Buffering

Scheduling and Buffering Concept

Key Definitions

Truck Drayage: A dray operation is the process of moving a heavy load to and from a shipper, consignee, or intermediate handling facility. Moving a shipping container from the port to a depot or import recipient /consignee is thus a dray operation and the heavy vehicle that makes this 'move' is the dray truck.

Information and Communication Technologies (ICT): An umbrella term for sensors, electronic communication techniques, and data management systems that are deployed in combination to solve an engineering or business problem.

Scheduling: A process for 'serving' pre-defined transactions in transportation and logistics. Fixing an appointment with a processing facility for picking up a shipment of goods at a specific time and date.

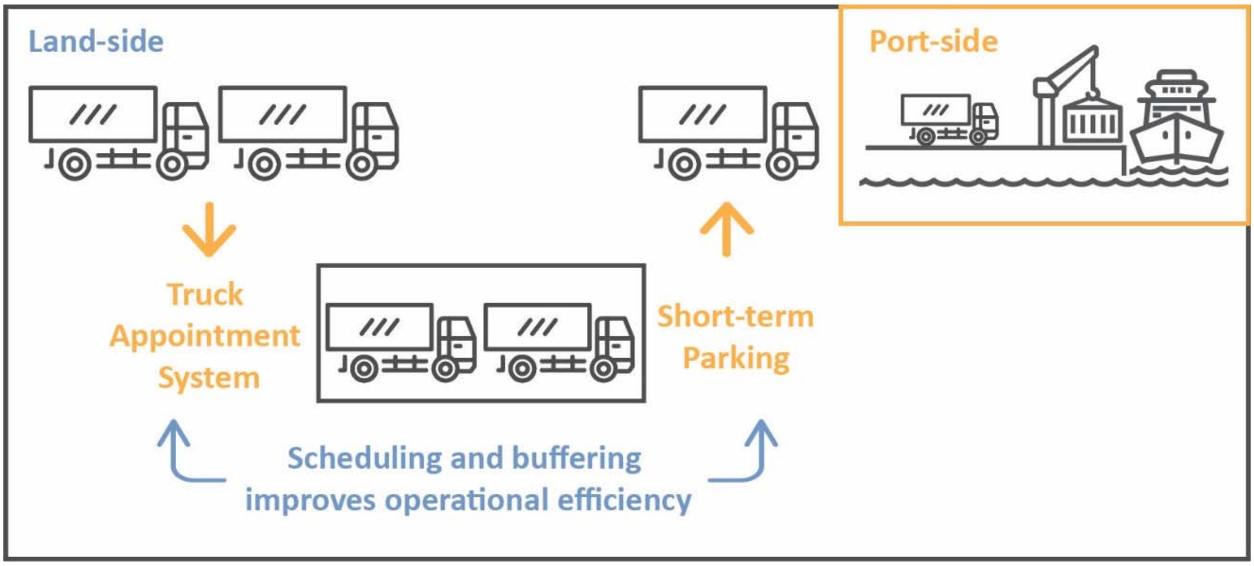
Buffering: A process or system for improving transportation flows by mitigating the negative impacts of unforeseen events or disruptions. Arriving at a scheduled appointment in advance of the pre-arranged time provides a buffer for travel delays.

The *scheduling* element of the concept centers on an ICT-enabled Truck Appointment System (TAS) that coordinates dray operations across key actors. *Buffering* involves the use of short-term holding lots or marshalling yards at a designated site(s) to accommodate dray trucks for the sole purpose of completing scheduled dray appointments. Scheduling and buffering are together expected to significantly improve dray turn times (on the order of days), unlocking significant productivity gains for Nigeria's import-based economy.

At ports around the world, once fundamental public and private sector structures and operational efficiency procedures have been put in place, the scheduling and buffering mechanism for coordinating operations has emerged as an **advanced solution** in comparison to other infrastructure-based (capacity addition) solutions for a variety of reasons. Metropolitan ports tend to be landlocked and rarely (or never) present greenfield opportunities for infrastructure capacity addition. Capacity addition (road widening, building container depots, long term parking lots) is not only capital-intensive but also disruptive to existing traffic movements. Capacity addition often also presents the same externalities in terms of construction, pollution, noise and reduced quality of life.

When ports choose this approach, the best practice is to build a combined **scheduling** and **buffering** mechanism (in addition to scheduling) to mitigate the possible disruptions of natural variation in operating conditions. Trucks that have already arrived for their appointments, but cannot be admitted to the port yet are re-routed to short-term holding lots to await their appointment time. Alternatively, trucks are asked to first report to the holding facility to await their appointment time (Figure ES-11). Buffering accommodates possible delays on both the yard-side and the land-side, as it provides a greater likelihood that trucks will be in place to perform the dray operation in conjunction with the flow of port operations.

Figure ES-11. Dray appointment scheduling under real conditions – trucks rerouted through short-term parking when needed



Source: CPCS

TPPAF Scheduling Architecture for Lagos

The TPPAF solution is a scheduling and buffering system which combines a Truck Appointment System with a holding lot(s) / truck marshalling yard to account for variance in timing of operations. An ICT-enabled scheduling and buffering approach for the TPPAF can be an important tool, and the best practice case studies showed that many urban / metropolitan ports around the world have already implemented variants of such systems.

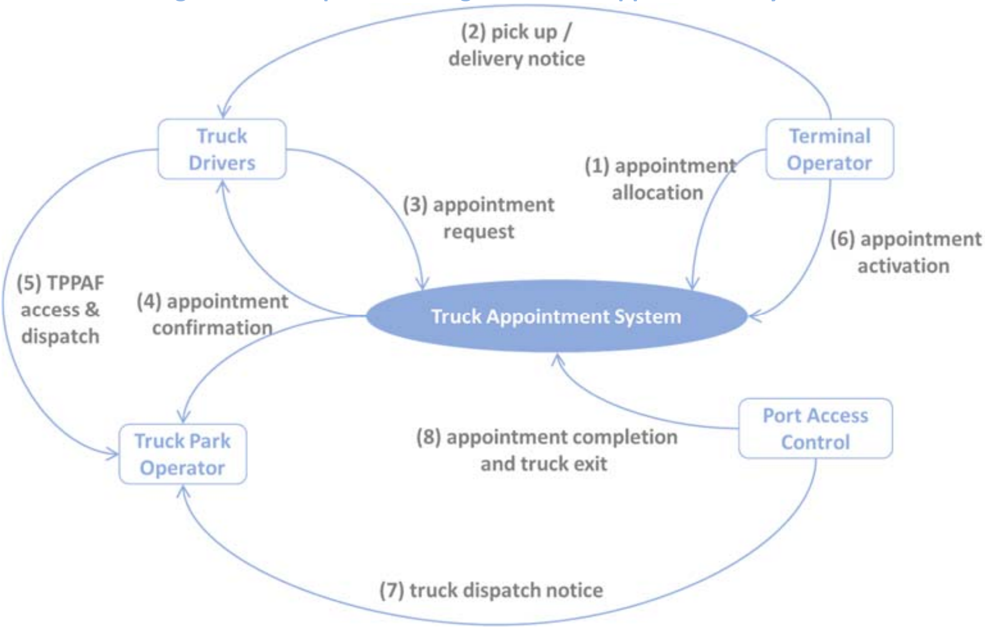
Our root cause analysis shows that the Lagos and Tin Can Island port areas have neither short-term nor long-term dedicated parking space. As demand far exceeds supply, trucks choosing to remain in the vicinity of the ports are forced to queue on streets. In other words, under a "do nothing" or business as usual scenario, truck parking supply and demand will not reach any other equilibrium than the one observed today: lengthy queues of parked trucks on the port access roads.

A Truck Appointment System aligns incentives by reducing the ambiguity around when a truck needs to report to a terminal, thereby reducing indiscriminate demand for parking in the interim.

Operating Logic for Coordinating Truck-Port Access

Figure ES-12 shows the proposed high-level process logic for a truck appointment system that was developed based on the case studies evaluated, our assessment of the most common truck booking systems, and targeted consultations with vendors. It shows how four key actors exchange information about operations in real-time and near real-time to coordinate truck movements. The actors are: (i) Terminal Operator, (ii) Port Access Control, (iii) Truck Park Operator, and (iv) Truck Drivers. A Truck Appointment System serves as a clearing house for the coordinated exchange between them.

Figure ES-12. Operations Logic for Truck Appointment System



Source: CPCS

The process involves a series of triggers and events among the actors, and can be explained as follows:

(1) **Terminal Operators** trigger the **Appointment System** by allocating batches of appointments based on yard and quayside operations, and also (2) notify **Truck Drivers** of the need for pick-ups / deliveries.

(3) **Truck Drivers** then ping / query the **Appointment System**, to request an appointment time based on the declared needs and availability of appointments across various time slots. The **Appointment System** (4) responds with confirmations, or other supporting details.

With an appointment confirmation in hand, **Truck Drivers** can (5) request access at an assigned truck park in preparation for their appointment window, and check in with the **Truck Park Operator** who can verify the confirmation with the **Appointment System**.

As soon as the **Terminal Operator** (6) activates the batch of appointments, **Port Access Control** (7) notifies the **Truck Park Operator** for dispatch of the specific **Truck Drivers** (who are also simultaneously notified by the system). **Port Access Control** admits the **Truck Driver** to the port facility.

When the **Terminal Operator** has closed the operation (and the appointment is completed in the **Appointment System**), **Port Access Control** also (8) verifies that the **Truck Driver** has exited the port facility.

This architecture does not fully represent all necessary interactions (eg. customs checks) or administrative procedures which might be specific to a particular terminal or port. There are also many variants of this type of architecture. However, as we highlight above, any variant will require the actors to coordinate in a similar manner for this type of process to be effective. For example, a number of coordination and enforcement procedures will likely to be in place and enforced such as turning away trucks who are returning empty containers without an appointment, or denying access to trucks without appointments. Further, since the buffering lots are intended for short-term use, other complementary strategies are required to address the issue of longer-term truck presence in the LMA.

Business Rules to Align Incentives

Implementation Recommendation for Aligning Incentives

In principle, this type of solution architecture does not require sophisticated ICT arrangements. The logic for information flow is common to many queueing and operations models with stocks (parking capacity) and flows (trucks, event-driven information). Indeed, the minimum requirements are desktop computers connected to the right online databases for operators to check the status of trucks and their appointments, and to update this information as necessary. Instant messaging (SMS) can also be incorporated to advise truckers of status changes and send reminders. These are basic ICT functions, and do not need massive investments in supporting infrastructure.

We emphasize that the overall logic and "business rules" for coordination must precede the choice of any technology or ICT-based system. These rules or additional process design factors can significantly enhance or diminish the efficiency of both dray trucking operations and also terminal productivity. In fact, the rules will largely dictate the desired capabilities and functional requirements and help scope the right set of enabling technologies for the TPPAF.

The business rules include, but are not limited to:

- **Windows**: The discrete time windows for appointments (ex. 6 – 9am) which are agreed upon based on adjustments to regulations, vessel calls, labor practices, etc.
- **Slots**: The number of appointments within each time window, adjusted by vessel calls, operations loadings etc (ex. 100 in an off-peak hour, but 125 in a peak hour) and terminal and port access handling capacity
- **Incentives**: Trucks that have reported to a buffering lot with a confirmed appointment are not penalized for a missed appointment because of urban area congestion or longer travel times from the buffering lot to the port on a particular day.
- **Flexibility**: options for appointment overflow or accommodation for trucks that miss a slot
- **Dynamic Pricing**: time-based pricing for certain services and fees for load shifting, peak spreading
- **Bundling of Charges**: including the fee for use of the truck appointment system in the list of mandatory fees and charges that truckers are still responsible for as a part of doing business at the port.
- **Lead-time**: advance scheduling / rescheduling / appointment modification to ensure utilization of capital equipment, truck capacity, parking lot capacity, labor shift allocation, etc.

→ **Enforcement**: penalties for appointments not honored / disregarded or other incompliance

→ **Tour coordination:** aligning drop-offs and pickups within the same windows

Business rules can be prioritized and phased-in so the essential requirements are activated first – appointment windows and slots, missed appointment accommodation, for example – whereas dynamic pricing can be deferred to a later stage as an advanced feature. Even implementing the minimum requirements, and gradually increasing compliance over time can have significant benefits for the system.

ICT Needs for Truck Appointment Systems

ICT is integral to the deployment of modern scheduling and buffering systems. Five types of components are needed to develop a fully built-out ICT-based solution using Truck Appointment Systems / call up systems. These are (i) location-based sensors, (ii) embedded hardware, (iii) communications, (iv) databases, and (iv) decision-making dashboards. Within each of these components, there are a number of options available with varying degrees of complexity.

1. **Location-based sensors**: Location-based sensors (LBS) communicate the identity and location of the dray truck, tractor and/or the container. Trucks enabled with an LBS can automatically share their location or be recognized by a tracking system in near real-time, i.e. every few seconds. The two most prevalent types of LBSs for port operations are Geographic Positioning System (GPS) (active) and Radio Frequency Identification (RFID) (passive or active).

2. **Embedded hardware**: These hardware are scanner / receiver devices that scan their environment within a short range for a LBS-enabled vehicle, or for the presence of the truck in a particular part of the port, short-term parking lot, or access road. They are usually deployed in combination as part of a broader architecture, rather than be used in isolation.

3. **Communications**: Both LBS and embedded hardware ultimately depend on communications infrastructure to be able to "shake hands" with each other and record theses interactions by "talking" to databases. There are many possible communications protocols that are well suited for the harsh industrial conditions of port environments, including fiber-optics, low-energy Bluetooth, dedicated short-range communications (DSRC), WiFi, and cellular / GSM.

4. **Databases**: Port transactions data, vehicle operator clearances, identity information, and data on truck whereabouts, interactions / "handshakes" can be stored in relational databases. As the name suggests, these databases relate attributes from one part of the system, ex. truck identity, to a separate part of the system, i.e. bookings for containers, customs clearances, etc. Such databases are the backbone of "single window" approaches adopted by many port systems. By querying databases from time to time, decision-makers obtain visibility into the separate but inter-related parts of port operations. This "enterprise" view of the port and related operations can be scaled to suit the level of automation desired and the types of operations that will be ICT-enabled.

5. **Operator dashboards for decision-making**: The complexity of port operations, and the sheer volume of interactions and transactions occurring can easily overwhelm a human operator. In reality, an operator does not need continuous access to all stored data, and rather needs to be alerted to only those decisions and operations that are imminent. Further, these data

are not very useful in their raw form, and can assist in decision-making only when they are transformed into some type of performance measure, for e.g. the queue-length at a gate, or the average processing time for container operations. The solution architecture for truck and related port operations therefore includes customizable performance dashboards to highlight for each port operator the types of information and performance that are needed for decision-making.

Suitability Analysis for Truck Parking and Buffering Site Selection

To understand the possibilities for truck parking, we conducted a broad scan of available land in the LMA. This broad scan does not assume the need for ICT related development. In contrast, the focus is on understanding land availability, the relative location of those sites, and the capacities of those sites to accommodate large numbers of trucks. In our evaluation, we accordingly applied several criteria such as:

- open / undeveloped land availability (greenfield)
- pre-existing urban properties for rent or sale within real estate comparables (brownfield)
- facility configuration technical requirements (design)
- desired accessibility thresholds determined from travel time estimates between selected sites and the port interface or main gates.

We used data based on satellite imagery in conjunction with real estate records to filter available land. The land use dataset selected for this analysis was taken from BaseVue 2013[6], from Shuttle Radar Topographic Mission (SRTM) photos.

The area of the LMA (within administrative boundaries) is about 122,500 Ha. Removing non-accessible islands, area within the international airport limits and main inland waterways, leaves about 77,500 Ha. The LMA has 10 different categories of land cover classification within its limits, as listed below.

Color	Type	Description
	Evergreen Forest	Trees >3 meters in height, canopy closure >35% (<25% inter-mixture with deciduous species), of species that do not lose leaves (includes coniferous Larch regardless of deciduous nature).
	Shrub / Scrub Land	Woody vegetation <3 meters in height, > 10% ground cover. Only collect >30% ground cover.
	Grassland	Herbaceous grasses, > 10% cover, including pasture lands. Only collect >30% cover.
	Barren or Minimal Vegetation	Land with minimal vegetation (<10%) including rock, sand, clay, beaches, quarries, strip mines, and gravel pits. Salt flats, playas, and non-tidal mud flats are also included when not inundated with water.
	Agriculture	Cultivated crop lands.
	Wetland	Areas where the water table is at or near the surface for a substantial portion of the growing season, including herbaceous and woody species (except mangrove species)
	Mangrove	Coastal (tropical wetlands) dominated by Mangrove species
	Water	All water bodies greater than 0.08 hectares (1 LS pixel) including oceans, lakes, ponds, rivers, and streams

[6] MDA Information Systems LLC. Basevue 2013 Land Cover Global Dataset at 30m resolution.

	High Density Urban	Areas with over 70% of constructed materials that are a minimum of 60 meters wide (asphalt, concrete, buildings, etc.). Includes residential areas with a mixture of constructed materials and vegetation where constructed materials account for >60%. Commercial, industrial, and transportation i.e., Train stations, airports, etc.
	Low - Medium Density Urban	Areas with 30%-70% of constructed materials that are a minimum of 60 meters wide (asphalt, concrete, buildings, etc.). Includes residential areas with a mixture of constructed materials and vegetation, where constructed materials account for greater than 40%. Commercial, industrial, and transportation i.e., Train stations, airports, etc.

Source: CPCS

The largest classifications, low-high density urban or "existing built up" area represent 71% of the total 77,463Ha. Water, wetlands and mangroves that could be "reclaimed" are deemed too expensive or would likely have high environmental significance for the LMA were dropped from the potential site selection approach. These categories represented 6% of the total area. The remainder - any open / non-built up land (evergreen forest, shrub/scrub land, barren or minimal vegetation and active cultivated crop land) - was considered suitable for truck parking in a first pass analysis.

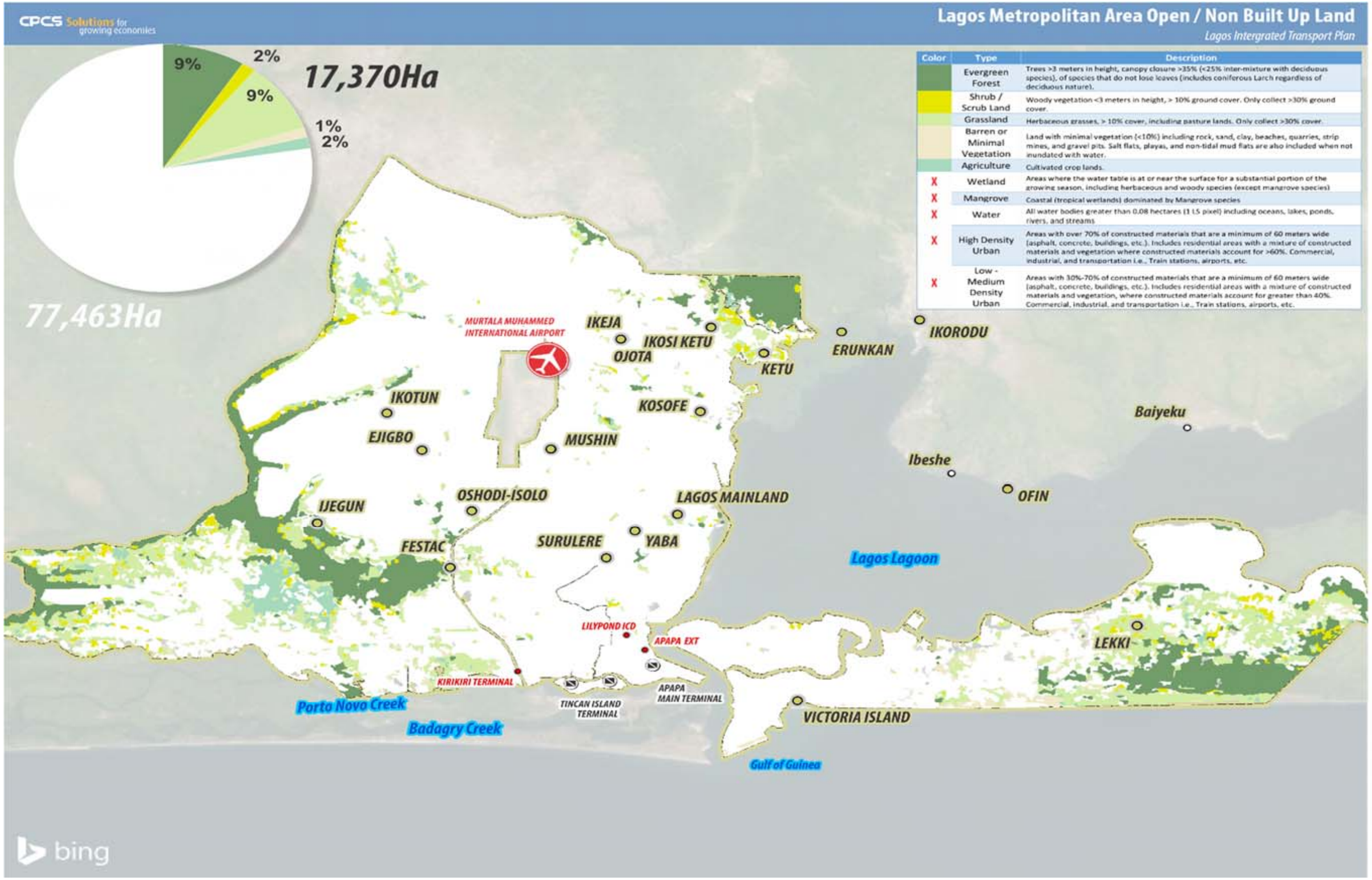
Only 17,800 Ha is deemed open / non-built up land capable of accommodating the construction of a truck park site (Figure ES-13). However, analysis of real estate listings and travel time isochrones analysis showed that only eight properly zoned sites greater than 2 hectares (capable of holding at least 100 trucks) lie within a 20 to 30-minute travel time radius. Of these, the three most promising are those studied in detail as short-term buffering sites.

After inspecting about 10,000 real estate listings, we identified only three additional candidate sites for truck parks, of at least 5 or more hectares (approximately 300 trucks at minimum). Under ideal (uncongested) travel time conditions these lie around 40 – 80 minutes away from the ports, but at least 2 hours under moving current conditions with moving traffic, in the absence of traffic jams.

We conclude that suitable long-term truck parking facilities would have to be located at the periphery of the LMA or outside it, allowing for at least 2 to 3 hours of travel time to the port facilities.

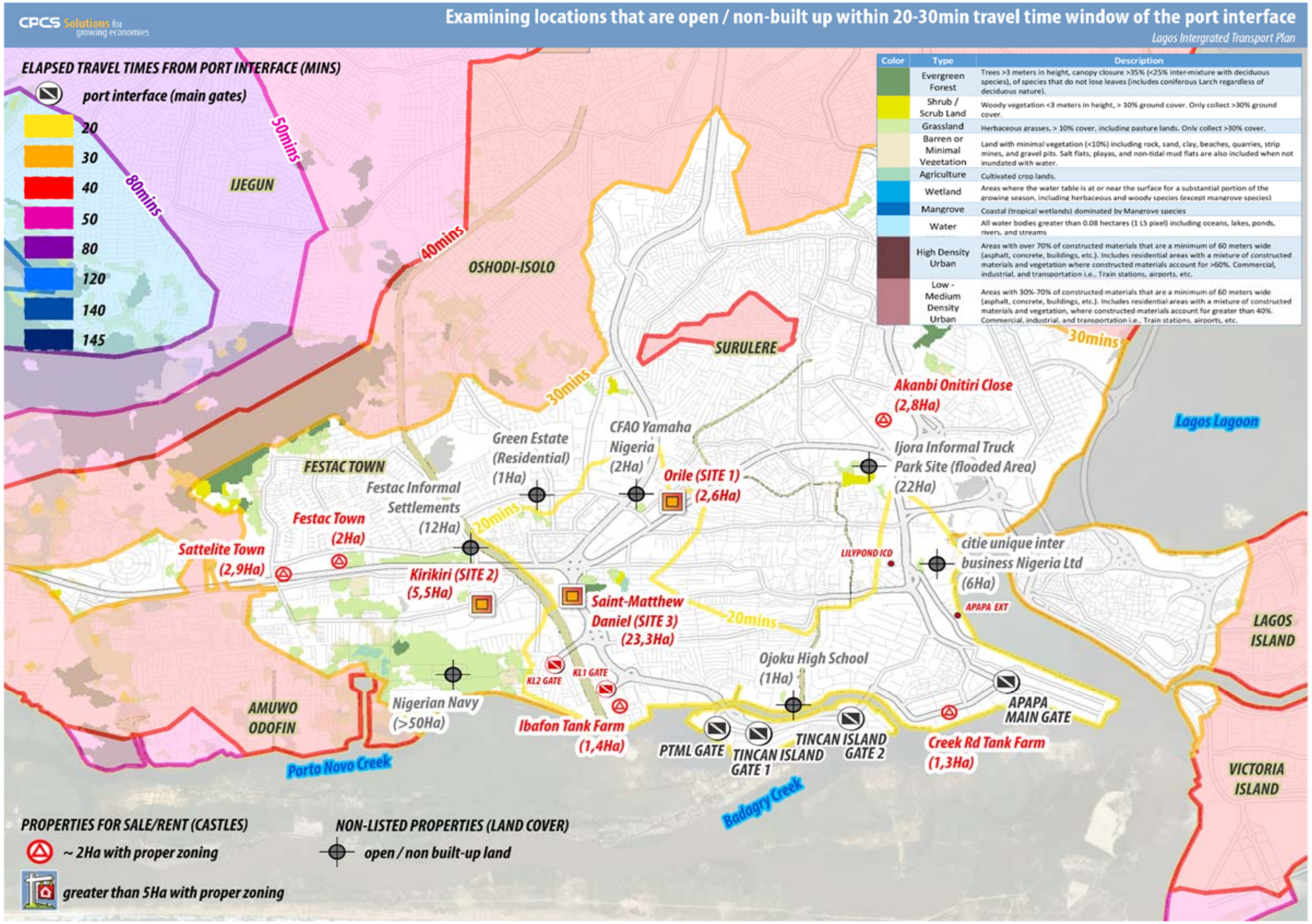
Implementation Recommendation for staging 'Unbooked Trucks': These more distant facilities can serve an important purpose of eventually acting as origination staging facilities for trucks that do not have active transactions at the port. Thereafter, once trucks have confirmed appointments, they can move to buffering lots to ensure that appointments are not missed or to accommodate delays at the terminals. However, a number of other implementation steps would need to occur prior to scaling up to this level of operation, and we therefore recommend that these distant sites be operationalized during a late stage system build-out phase of implementation.

Figure ES-13. Open Undeveloped Land in the LMA ~ 17,400 hectares



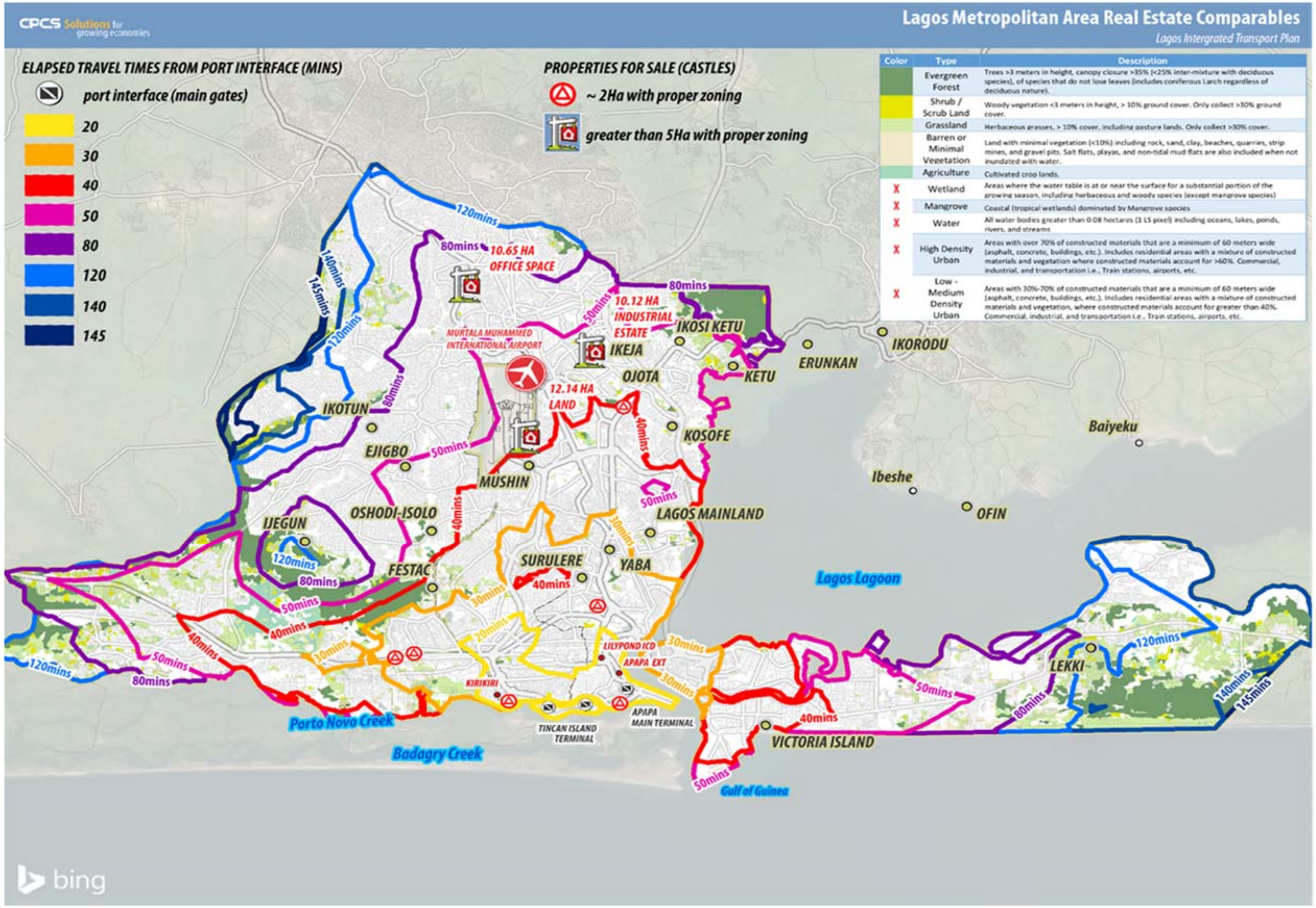
Source: CPCS

Figure ES-14. Parking site candidates within 20-30 minutes of port gates



Source: CPCS

Figure ES-15. All other parking site candidates within the LMA



Source: CPCS

Implementation Recommendation: Long-term Parking Lots as a 'Complementary Strategy'

The scheduling and buffering measures devised mainly serve to eliminate (or at least significantly reduce) queuing trucks that are not needed at ports. If an appropriate combination of restrictions and enforcement mechanisms were in effect, we estimate that a large fraction of trucks that queue today in the vicinity of the port facilities would move elsewhere.

One implication is that the unutilized trucks would instead be pushed to the hinterland, however they are likely to be distributed over a larger area. While this removes truck queues from the port area it does not systematically address the need for a solution to long-term truck presence in the LMA. In addition to the scheduling and buffering system, stakeholders desire a sustainable solution for the long-term presence of trucks.

Long-term accommodation or parking for trucks requires fundamentally different approaches for analyzing flows and truck counts, because the concept pre-supposes different needs than the scheduling and buffering concept developed here. In particular:

1. The burden of operational coordination shifts to fleets, fleet managers, or other brokers, and less so on the ports and terminals, as trucks have not really embarked on a dray operation / truck turn cycle yet. Trucks are "unbooked" while in long-term holding.
2. There is little to no need for long-term lots to be treated as a virtual "extension" of port facilities. As such they do not need to be provisioned with ICT to the same extent as short-term buffering lots or marshalling yards.
3. Longer-term holding lots will require different types of services and facilities (ex. mechanics, accommodation, spare parts, re-fueling) with associated commercial and labor organization.
4. The fee / charge structure for parking and value added services should align incentives with the longer-term situation in mind. For example, can a truck maintain a long-term "membership" / lease in a holding facility, even as it periodically enters and leaves for dray operations and be assured of its dedicated spot upon return?
5. To systematically address the issue of congestion within the LMA, long-term holding facilities could be located further out, and in proximity with freight corridors.

For these reasons, long-term parking should be decoupled from the scheduling and buffering concept. The decoupling allows for many more options such as truck transit centers, or truck "villages" outside the LMA, as a complementary strategy.

Suitability for Buffering Lots

We performed a detailed suitability analysis for open sites (closest to the port facilities, access roads, and off-dock holding bays for empty containers) to assess their value as buffering lots (parking facilities) for the TPPAF.

In total, four sites met the **suitability criteria** of **size** (large enough to handle truck movements), **vacancy** (i.e. no existing built infrastructure), and **proximity** to the port facilities, one existing facility and three new possible sites. The four sites are:

- Site 1 – Orile Site
- Site 2 – Kirikiri Site
- Site 3 – St. Matthew Daniel
- Site 4 – Tin Can Island (FMPWH site)

Since Site 4 has already been re-purposed into a truck parking lot by the Federal Ministry of Power, Works and Housing (FMPWH), we conducted a detailed facility configuration and design on the other three sites.

Implementation Recommendation: Tin Can Island Gate 2 site (FMPWH) as an early phase pilot for a buffering site

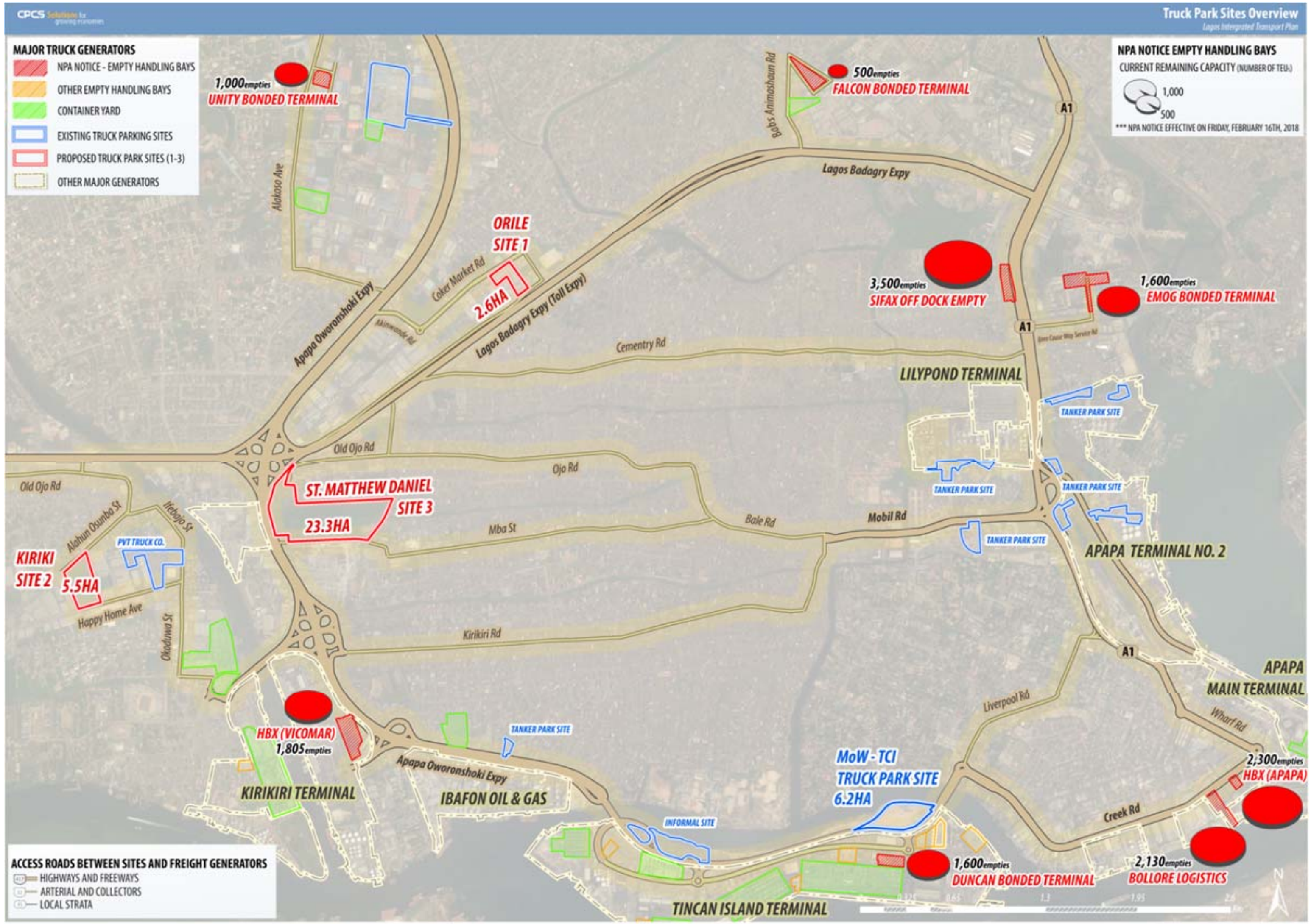
The Federal Ministry of Power, Works, and Housing has developed an empty lot of 6.2 Ha into a formal truck holding facility. The site is directly across from Gate 2 at Tin Can Island terminals, near an off-ramp providing access to TCI. Our understanding from stakeholder consultations is that this project is at 90% completion. Remaining works involve shoreline protection for environmental reasons, and completion of the access ramp to the site. No timeline has been shared for the final commissioning of the site, or operational ramp up. For the purpose of our project, we assume that this facility will be operational, and the three sites we studied are in addition to, and not as a replacement for the TCI site (see Figure ES-21).

We recommend that this site first be immediately prioritized as a staging area for registered trucks with appropriate documentation / bills of lading. This site also presents a tremendous opportunity for a pilot, in conjunction with a scheduling system, which can be implemented a second implementation phase once the framework and agreement for a scheduling and buffering program are put in place by the Lagos State Government and the Nigerian Ports Authority.

Figure ES-16 maps the location of the four sites relative to the ports complex, main access roads, other freight generators, and off-dock container holding bays.

Figure ES-17 describes the results of the suitability analysis for the three sites selected for facility configuration.

Figure ES-16. Location of Buffering Lot Sites relative to Ports, Off-Dock Bays, and Road Network



Source: CPCS

Figure ES-17. Site Attributes based on Suitability Criteria Analysis

Originating	Destined	Route Selection	Distance (km)	Google Time (Mins)	Google Average Speed (kmph)	Time @ 60kmph (Mins)	Time @ 35kmph (Mins)	Time @ 20kmph (Mins)
Orile (Site 1)	Apapa	via Coker Market Rd - Akinwande Rd - Apapa Oworonshoki Expy - Creek Rd	11.59	**30**	23.18	11.6	19.9	34.8
		via Orile Mile 2 Service Rd - Apapa Oworonshoki Expy - Creek Rd	11.72	**31**	22.68	11.7	20.1	35.2
	Tin Can Island	via Coker Market Rd - Akinwande Rd - Apapa Oworonshoki Expy - Tin Can Island Access Rd	7.13	**18**	23.77	7.1	12.2	21.4
		via Orile Mile 2 Service Rd - Apapa Oworonshoki Expy - Tin Can Island Access Road	7.10	**18**	23.67	7.1	12.2	21.3
Kirikiri (Site 2)	Apapa	via Alahun Osunba - Old Ojo Rd - Lagos Badagry Expy - Apapa Oworonshoki Expy - Creek Rd	11.40	**35**	19.54	11.4	19.5	34.2
		via Happy Home Ave - Okoduwa St - Berger Car Depot Bridge - Apapa Oworonshoki Expy - Creek Rd	10.30	**29**	21.31	10.3	17.7	30.9
	Tin Can Island	via Alahun Osunba - Old Ojo Rd - Lagos Badagry Expy - Apapa Oworonshoki Expy - Tin Can Island Access Rd	7.00	**25**	16.80	7.0	12.0	21.0
		via Happy Home Ave - Okoduwa St - Berger Car Depot Bridge - Apapa	5.90	**20**	17.70	5.9	10.1	17.7

Originating	Destined	Route Selection	Distance (km)	Google Time (Mins)	Google Average Speed (kmph)	Time @ 60kmph (Mins)	Time @ 35kmph (Mins)	Time @ 20kmph (Mins)
		Oworonshoki Expy - Tin Can Island Access Rd						
St. Matthew Daniel (Site 3)	Apapa	via Otto-Wolf Rd - Awodi Ora Service Rd - Apapa Oworonshoki Expy - Creek Rd	11.30	**24**	28.25	11.3	19.4	33.9
		via Otto-Wolf Rd - Cardoso St - Mba St - Bate Rd - Mobil Rd - A1 - Wharf Rd	7.70	**31**	14.90	7.7	13.2	23.1
		via Otto-Wolf Rd - Awodi Ora Service Rd - Lagos Badagry Expy **(tolled)** - A1 - Wharf Rd	11.30	**24**	28.25	11.3	19.4	33.9
	Tin Can Island	via Otto-Wolf Rd - Awodi Ora Service Rd - Apapa Oworonshoki Expy - Tin Can Island Access Rd	6.40	**18**	21.33	6.4	11.0	19.2
		via Otto-Wolf Rd - Cardoso St - Sholade St - Okito St - Rotimi Cres - Wilmer Cres - Apapa Oworonshoki Expy - Tin Can Island Access Rd	5.70	**24**	14.25	5.7	9.8	17.1

Source: CPCS

Alternative Models

One alternative to large buffering lots that has been touted by NPA is the development of multiple smaller private sector led buffering lots. These lots could hold anywhere between 10 and 20 trucks. Licensing for these sites would be managed by the SPV created for the TAS. In the absence of larger, more coordinated solutions, this approach could unlock some of the private sector ingenuity while supporting the overall implementation of the TAS.

This model would increase the emphasis on the need for specific business rules (e.g. Incentives for using lots), and may require some flexibility on others (e.g. bundling of charges, as parking fees may differ significantly based on the location/services offered).

Conceptual Design and Layouts of Buffering Lots (Truck Parks)

We evaluated the three suitable sites in detail through a conceptual design approach. Design details are in Section 6. Figure ES-18 below summarizes site design attributes and truck holding capacity based on design considerations.

Out of the three sites, Orile is more of a brownfield rehabilitation project as the site is technically ready to operate as is. The tarmac, fence and tower lights are in favorable condition while the only impediment is the removal of the existing warehouse/administrative building. Even so, we attributed a cost for complete rehabilitation of the tarmac; this includes scarifying, breaking and repouring of concrete. Although Orile is likely the easiest site to implement and least expensive in terms of capital spend required, it is also the smallest with room for only 138 truck stalls of dimension 20x5.2m.

On the Kirikiri site, some civil works have been undertaken in the past but unfortunately the site still suffers from major drainage problems. The project would be treated as a greenfield development, and we expect it to be used primarily for oil and gas tankers (696). Within this context, the site would require specialized drainage infrastructure and civil works.

Lastly, St. Matthew Daniel would be the most expensive to develop. The project would be entirely a greenfield development, since the site has no existing infrastructure on it. The entire area is heavily forested and one of the branches of the Lagos canal system terminates there. However, it is the most promising because it can hold more than 1,950 trucks at a time and is reasonably proximate to both Tin Can and Apapa facilities, as well as a number of holding bays.

Figure ES-18. Site Design Summary and Truck Holding Capacity

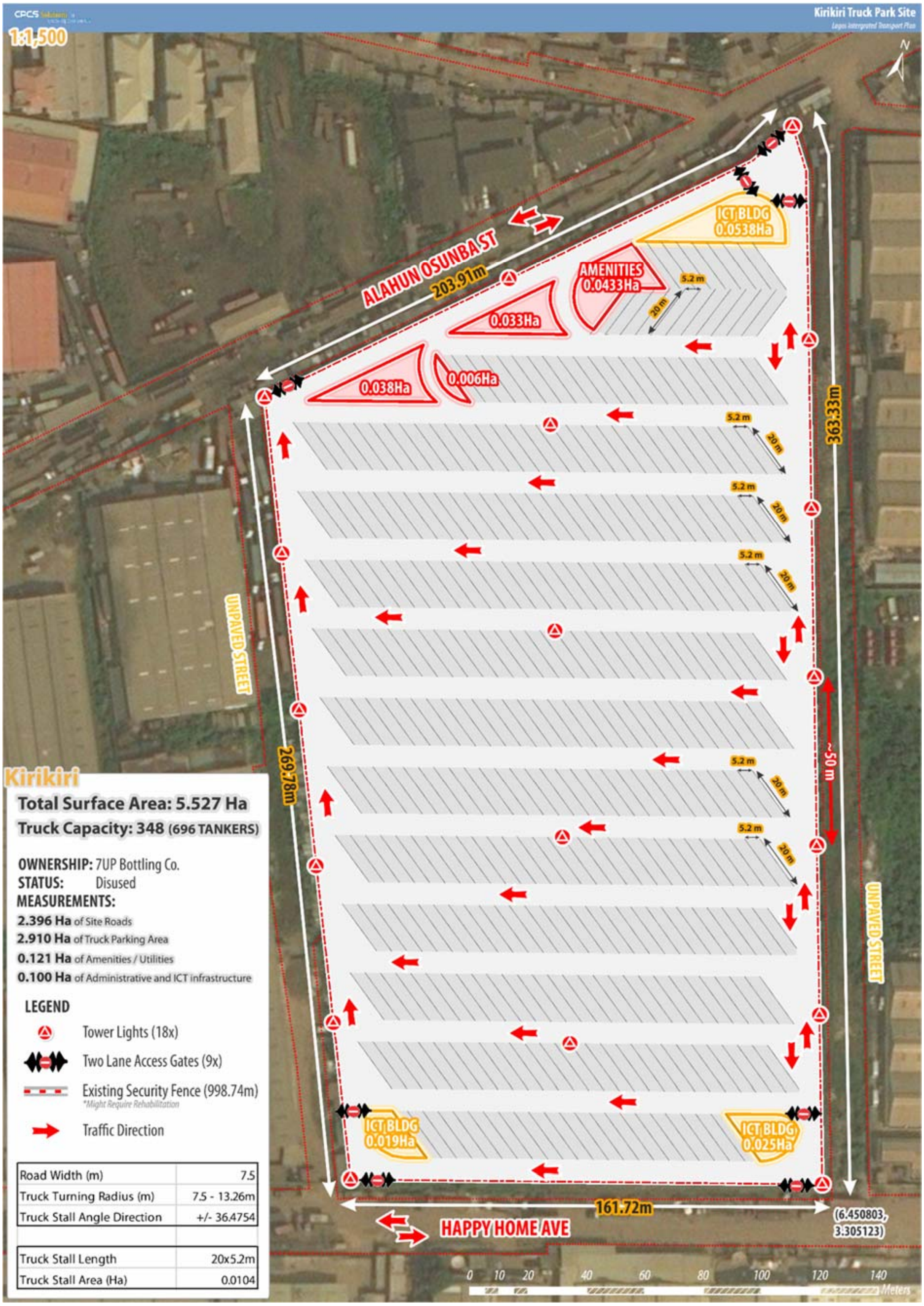
Site Number	Site Name	Total Area (Ha)	Existing Buildings (Ha)	Site Roads (Ha)	Gate, ICT and Administrative Buildings (Ha)	Amenities and Services (Ha)	Total Area Designated to Truck Stalls (Ha)	Total Truck Capacity
Site 1	Orile	2.58	0.13	1.35	0.02	0.03	1.18	**138**
Site 2	Kirikiri	5.53	-	2.40	0.10	0.12	2.91	**348 (696 tanker trucks)**
Site 3	St. Mathew Daniel	23.29	-	6.24	0.47	1.47	15.11	**1,958**

Source: CPCS

Of the sites available as buffering lots, St Mathew Daniel is the most promising for container trucks, while the KiriKiri site might be best repurposed as a dedicated tanker truck facility.

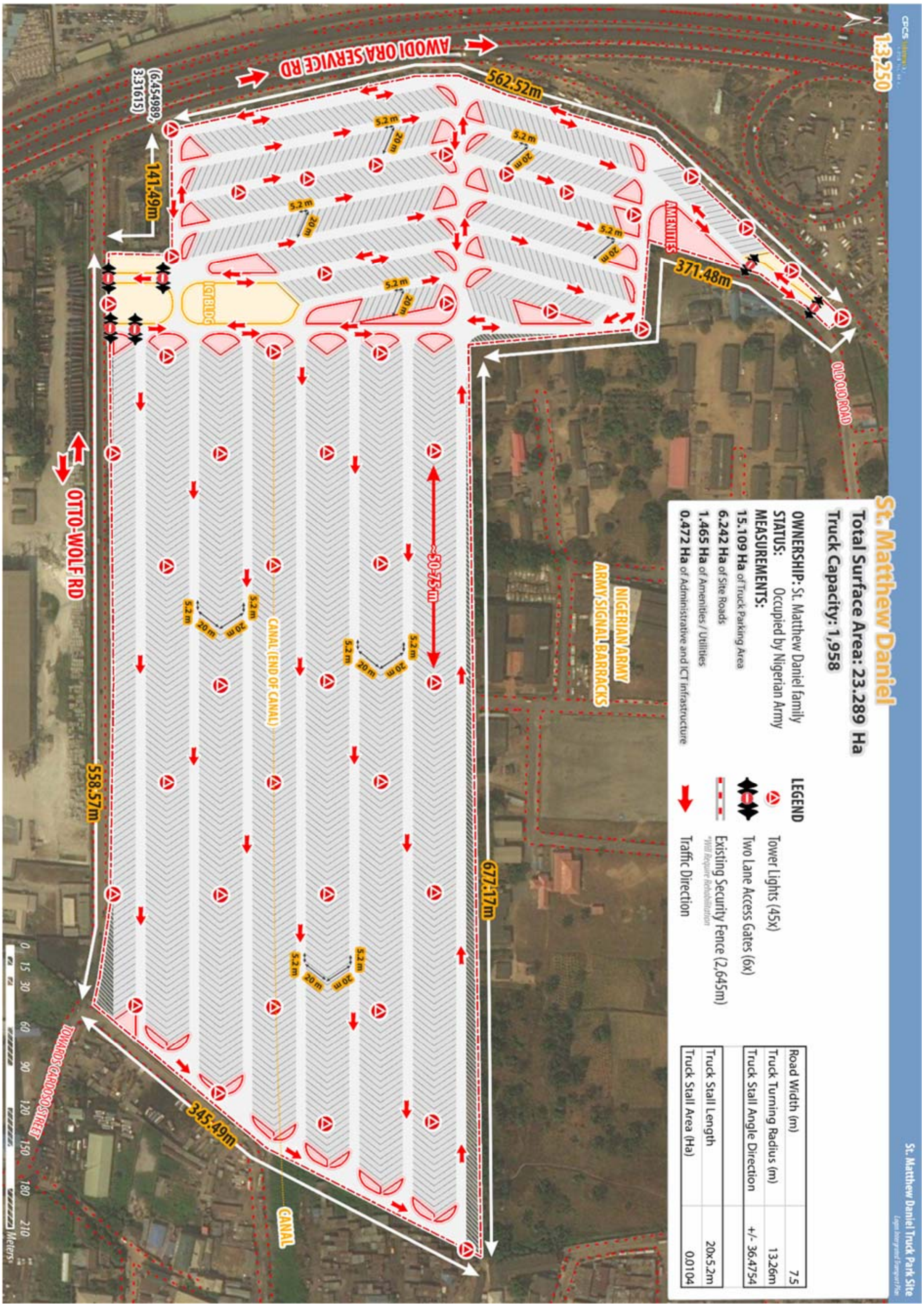
Figure ES-19 and Figure ES-20 highlight the site designs for the two most promising sites of KiriKiri and St Mathew Daniel, in addition to the pre-existing FMPWH site in Figure ES-21.

Figure ES-19. Site Design for KiriKiri



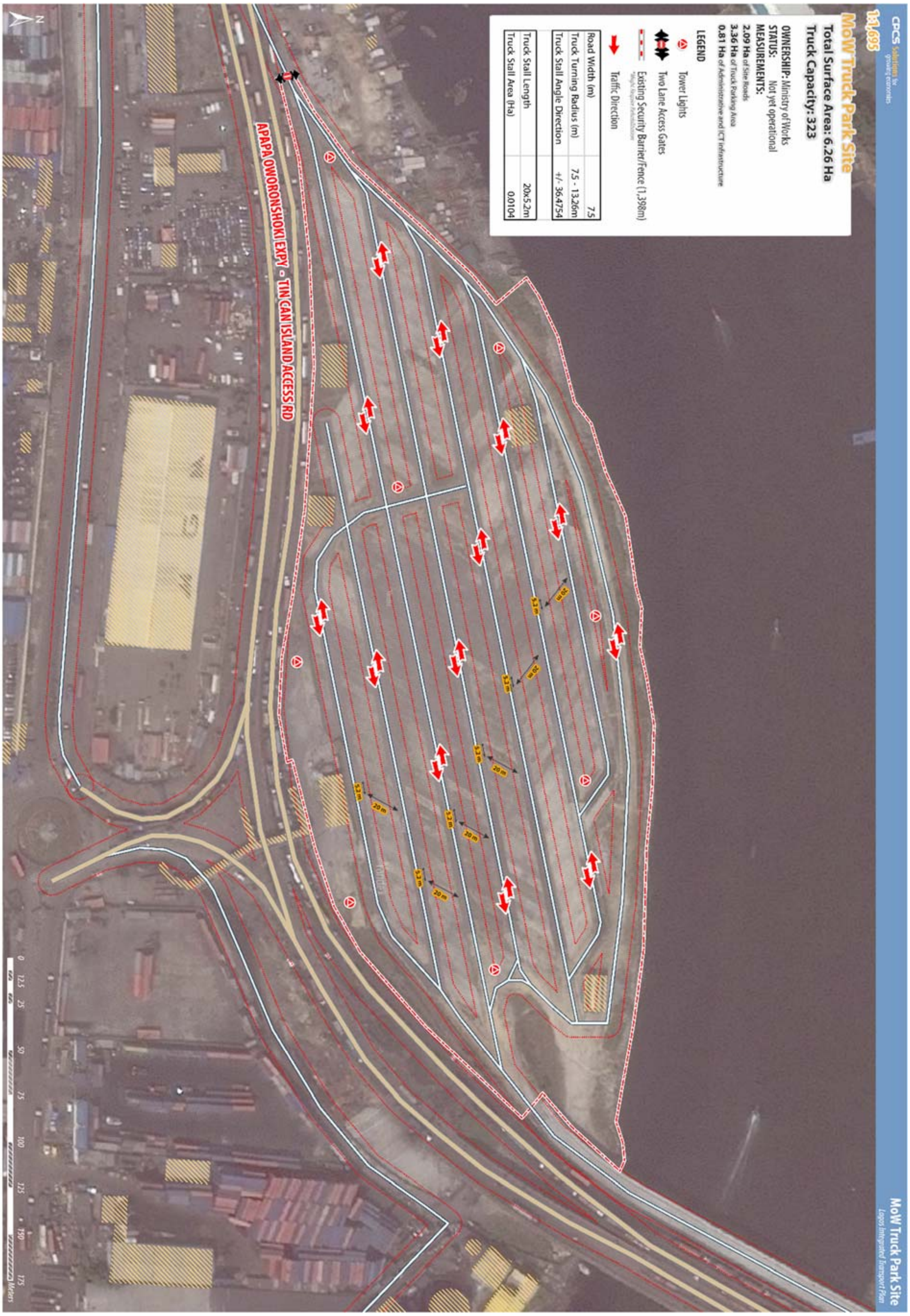
Source: CPCS

Figure ES-20. Site Design for St Mathew Daniel



Source: CPCS

Figure ES-21. Site Design for the 90% complete FMPWH site at Tin Can Island



Source: CPCS

Capital Costs

The two main elements of the project – scheduling and buffering – each have their own capital cost structures.

ICT and Scheduling System Costs

Capital costs of scheduling systems depend to a large extent on the solution architecture, and also on the degree to which ICT is already deployed and used by terminals and port authorities in their operations.

The Truck Appointment System is a software system that requires a number of hardware, software and database components including electronic data interchanges, automated sensing gantries, scanners, communication network and systems. These are independent of the ICT equipment required at buffering lots, which are priced separately.

Based on our vendor research, for ports that have already deployed ICT extensively with sensors, databases, and dashboards, the incremental addition of a Truck Appointment System needs only on the order of a few hundred thousand US dollars for integrating and commissioning the remaining hardware and software components of the TAS. On the other hand, for ports with little to no automation, a full build out of sensors, scanners, databases, and dashboards can cost on the order of tens of millions of dollars.

The financial valuation analyses described in Section 7 assume the cost of a full system build out, as there is little to no automation, sensing, and digitalization today at Apapa and TCI port facilities. We summarize the approximate capital costs of those components below, based on discussions with a leading operator. Given the low degree of automation at Lagos area ports, significant investments will be incurred to develop a functioning fully automated system. Based on NAFITH's outline business case, and discussions with vendors, we estimate a capital cost of about USD 10 million for the TAS.

Figure ES- 1-22. ICT-related System Installation and Upfront Costs

Cost Component	Upfront Cost (USD)
Superstructure, including IT Networks, automated kiosks, road monitoring, IT equipment, RFID	3.5 million
Software licensing and databases	3.5 million
Setup costs such as training, deployment, etc	3 million
Total	**10 million**

Source: vendor outline business case

ICT systems have an accelerated depreciation schedule compared to other built infrastructure, as technologies tend to become obsolete every five to seven years.

In the interest of developing a feasible solution however, the minimum level of ICT capability can be initially deployed (in a pilot stage for example), before scaling up to a fully automated system.

Buffering Lots (parking facilities)

Modelled capital costs are captured from the "bottom up" cost items for buffering site acquisition and development, as described in detail in Section 6. Land acquisition costs are significant component and summarized in the figure below for all three candidate sites. The St Mathew Daniel site is the most expensive because of its size, while the unit rate is highest on the KiriKiri site.

Figure ES-23. Site Land Acquisition Costs

	NGN 000 000 / Per Ha	Truck Parking Area (Ha)	Site Roads (Ha)	Amenities / Utilities	Administrative / ICT Infrastructure (Ha)	Total Space Requirement (Ha)	Land Acquisition Cost (NGN 000 000)	Land Acquisition Cost (US 000)
Orile	925.00	1.18	1.35	0.04	0.02	2.58	2,383	7,802
KiriKiri	975.00	2.91	2.40	0.12	0.10	5.53	5,389	17,645
St Mathew Daniel	625.00	15.11	6.24	1.47	0.47	23.29	14,555	47,659

Source: CPCS Analysis

Other civil works elements such as site preparation works, built elements, buildings, amenities, and road rehabilitation for site access are summarized below. Once again St Mathew Daniel has the largest costs because of its size.

Figure ES-24. Site Capital Costs

	Civil Works: Land Preparation	Civil Works: Site Infrastructure	Administrative and ICT Buildings	Amenities Building	Civil Works: Offsite Road Rehab and Access	Total Terminal Infrastructure Capital Cost (NGN 000 000)	Total Terminal Infrastructure Capital Cost (US 000)
Orile	289,791,952	74,920,872	91,518,487	36,482,155	9,087,776	501.80	1,394
KiriKiri	622,567,430	94,953,741	198,219,709	298,873,231	811,584,292	2026.20	5,628
St Mathew Daniel	2,514,142,850	184,839,586	956,643,175	3,830,702,396	188,849,025	7675.18	21,320

Source: CPCS Analysis

Operational Costs

Modelled operational costs are as summarized below. Operating expenses for the buffering lots are primarily related to labor (salaries). Operating costs for the TAS relate to licensing and service payments to the vendor providing the system, based on our discussions. Operating costs for ICT thereafter tend to be low, on the order of tens of thousands of US dollars in licensing and service agreements.

Figure ES-25. Project Operating Parameter and Costs

	Terminal Manager (Units)	Terminal Manager (Unit Salary US$)	Admin Officer (Units)	Leasing Officer (Unit Salary US$)	Cleaning Staff (Contracted Out) per Ha	Cleaning Staff for Public Areas (Contract Cost per Ha)	Park Control (# of Gates)	Parking Control (Unit Salary US$)	Security Personnel (Contracted Out) per Ha	Security Gaurds (Unity Salary US$)	Total Cost (US 000)
Orile	1	15,000	1	9,000	2.58	1,130	7	1,700	2.58	420	120
KiriKiri	1	15,000	1	9,000	5.53	1,130	9	1,700	5.53	420	144
St Mathew Daniel	1	15,000	2	9,000	23.29	1,130	6	1,700	23.29	420	238

TAS Licensing & Service	-	-	-	-	-	-	-	-	-	-	100

Economic Analysis

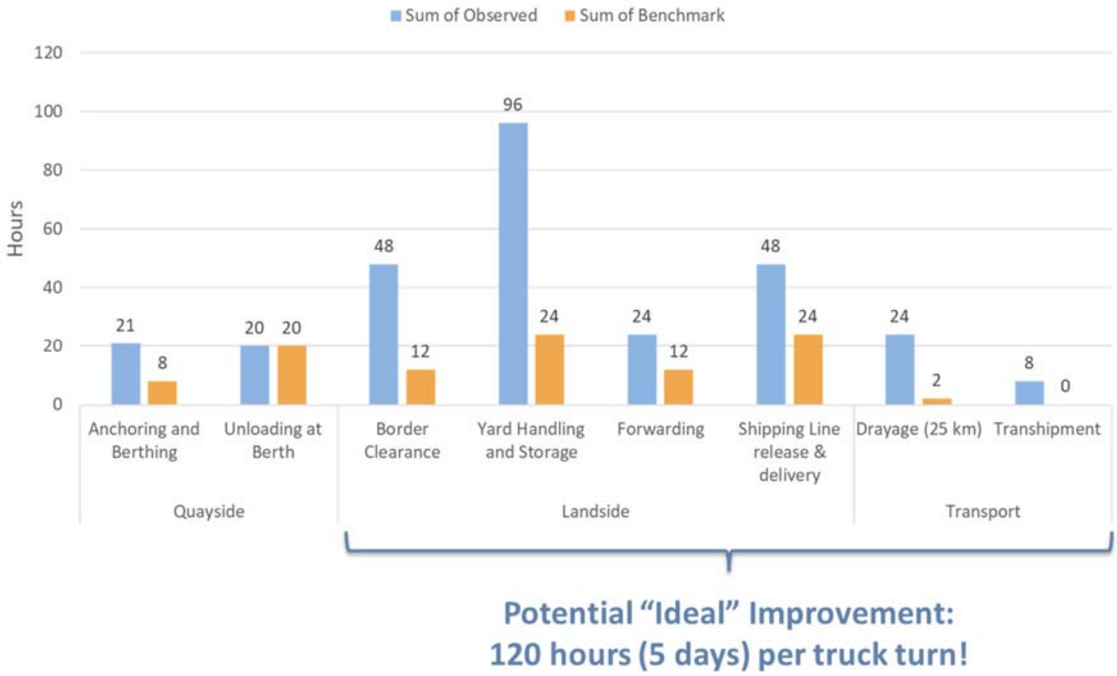
The economic benefits of alleviating congestion are likely to be significant, given the dire forecast of congestion and also because of the significant benefit available for every truck operation. The main outcome of reduced congestion is increased throughput, and this forms the basis of calculating available economic benefits.

From an operations perspective, throughput is measured by truck turn time, as defined earlier. Based on detailed published data[7], we estimate that truck turn times could be improved by as much as 5 days in the ideal, by improving the efficiency of both port landside operations, as well as dray operations over the last mile network in Lagos, i.e. moving containers to and from area facilities (Figure ES-26). The time saving translates to a potential ideal cost savings of US$1,200 per truck turn. While these (unit) benefits are large, only a fraction might be capturable in practice.

The map in Figure ES-27 shows how reducing congestion in the port vicinity by eliminating extensive queues will enable improved throughput and port access. The main performance metric used is an improvement in Volume to Capacity Ratio (VCR). As VCR decreases (negative percent change), capacity and throughput on port access roads increases. Roads with significant potential improvement are highlighted in green, and those with little to no improvement (as a result of reduced congestion) are shown in blue / gray.

[7] NEXTT (2015)

Figure ES-26. Potential Ideal Economic Benefits per Truck Turn (Hours and Dollars)



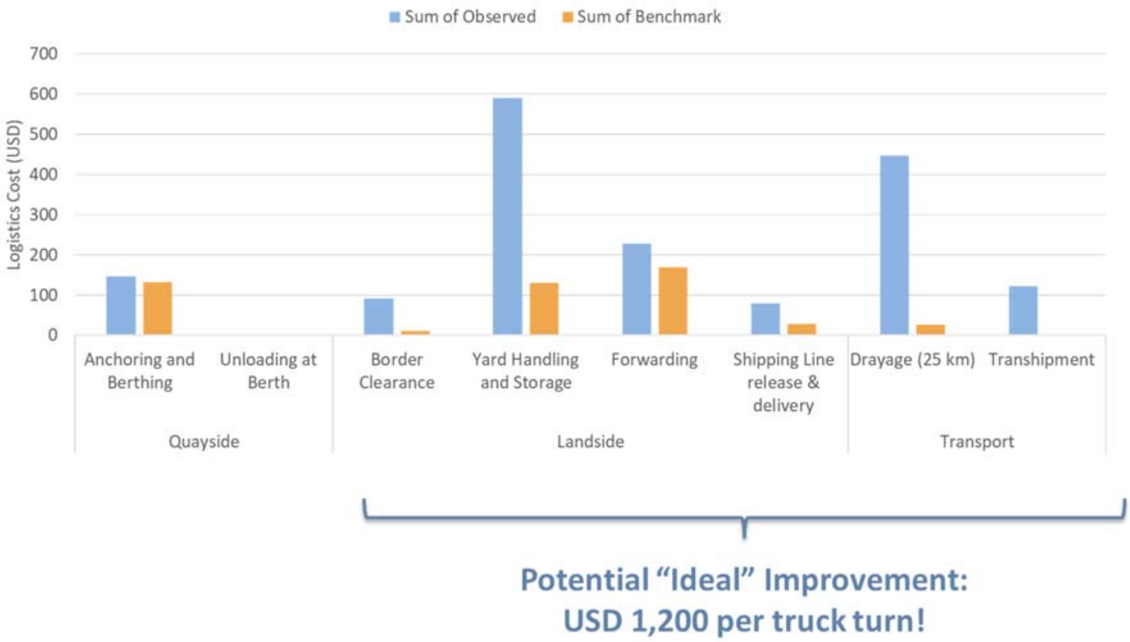
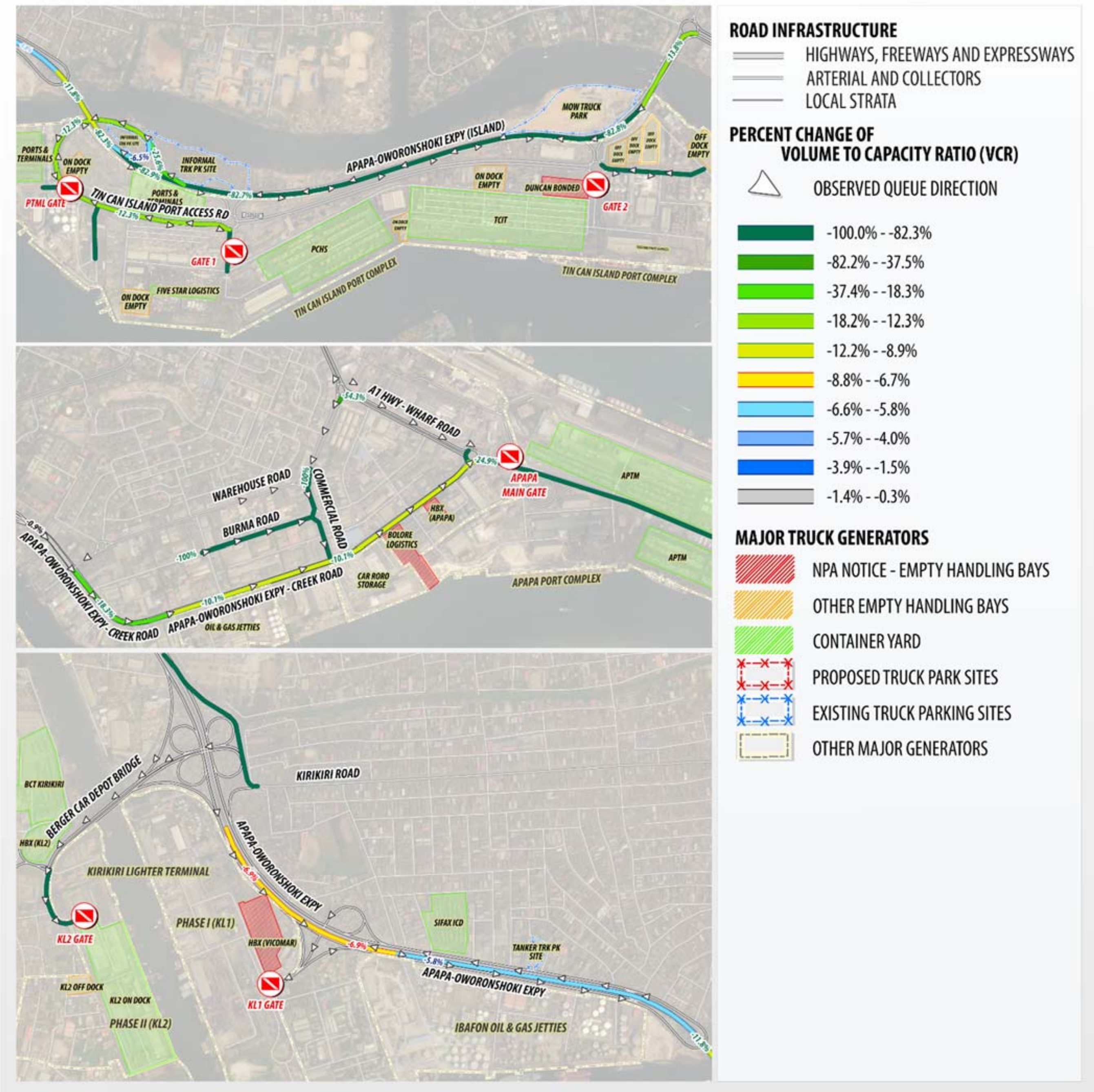


Figure ES-27. Capacity improvement in the port area network as a result of congestion reduction



Source: CPCS analysis

Benefit Estimates

Reduced congestion and increased throughput translate into economic benefits. The economic benefits are composed of avoided operational delays (value of time) and avoided indirect cost of congestion. We ascribed a unit benefit value of **$250 / TEU** (i.e. per truck turn) for container trucks and about **$150 / per turn** for non-container trucks, using very conservative estimates (20 – 30% benefit capture) of the "ideal" available benefits highlighted earlier. The unit benefits are applicable to those queues that actually perform turns (~ 1 in 5 trucks in the queue on a given day).

Figure ES-28 summarizes the cumulative benefits of operational improvement and congestion reduction between 2018-2037, using the same scenarios developed earlier for truck count forecasts.

Figure ES-28. Cumulative Economic Benefits under conservative assumptions

Truck Turn Growth Scenario	Low	Base	High
EIRR	62 %	68 %	71 %
Avoided GHG Emissions (ton CO2)	0.82 million	1.08 million	1.34 million

Source: CPCS analysis

The Economic Internal Rate of Return (EIRR) to the LMA supply chain as a consequence of congestion reduction and increased throughput ranges between 62 – 71%, with avoided GHG emissions of at least one million tons of CO2 in the base case.

It is hard to ignore the significant economic and environmental benefits that are available to the LMA supply chain – even under conservative assumptions – were congestion and operations to be systematically addressed.

Commercial, Financial and PPP Analysis

Improving the efficiency of dray operations in the Lagos and TCI Port Complexes will make available significant economic benefits. The financial valuation analysis investigates how this available value can be captured and internalized within the scheduling and buffering project concept.

The role and scope of the private sector is a central aspect of this analysis, along with key responsibilities assigned to the public sector. In sum, while the private sector plays an integral role under any of the potential project structure options, the viability of those options will depend on the extent to which the option delivers commercial returns to private sector participants. The public sector may therefore have to play a key role, over and above the granting of commercial authority, permits, and facilitating coordination across actors.

We developed a financial valuation model to study commercial viability of a Truck Appointment System, separately and together with buffering lots. Key assumptions of the model are documented in Section 7, but some key assumptions are highlighted alongside.

Key Highlighted Variables - Financial Valuation

PSP Hurdle Rate	10% / year
Appointment Fee	starting at $5 / TEU but varied in a sensitivity analysis
Concession period	10-19 years
Truck appointment / transaction growth scenarios	Low – 2% / year, Base – 5% / year, High – 7% / year

The initial fee tested for truck appointments is as low as **USD $5 / TEU**, which is calibrated to recent deployments of appointment systems in metropolitan ports such as Manila. For scale, current estimates of the cost of moving a container over a distance of 25 km in Lagos is upwards of $400 / TEU. While any new fees would undoubtedly be negatively perceived, it would likely represent a small portion of the overall logistical costs for goods transiting within the LMA ports. Moreover, a truck parking solution complemented with appropriate enforcement could reduce other charges faced by stakeholders.[8]

While we have already acknowledged that the available economic benefits of a scheduling and buffering system are significant, capturing these benefits in a manner that is commercially viable for private sector participation hinges on two important variables:

- The fee that the project operator charges trucks for using the Truck Appointment System (appointment fee) and buffering lots, which is the commercial revenue source to the project.
- The degree to which the private sector is responsible for the significant capital costs of acquiring land for the buffering lots and site preparation.

Needless to say the two variables are linked because, as the project's costs go up, the project operator will need to raise the appointment fee to break even.

The financial analysis shows that a TAS system provides healthy returns for fee levels as low as US$ 2.5 / TEU, however returns are more robust under all truck traffic scenarios tested at a higher fee range of US$ 5 / TEU. Implementing a TAS on its own can result in significant benefits, as evidenced in the Manila project. In comparison the Port of Manila project had fee levels ranging from US $5/TEU to US $20/TEU, depending on time of day. Thus implementing the scheduling system (TAS) by itself is a viable option, with the opportunity to re-use the returns from such a project either for reinvestment into scaling up the TAS, or towards buffering lots.

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	1,294	3,068	-789
5	11,005	14,503	6,931

When coupled with a buffering site, the fee level required is between US$ 3.40 / TEU (for Orile) and US$ 20.43 for St Mathew Daniel, depending on the traffic scenario. For these options, the

[8] In particular, our stakeholder consultations and studies published by World Bank, USAID have indicated that trucks queuing in the streets often face 'informal / other charges', and those charges are far from insignificant.

cost of land acquisition is borne by the public sector, whereas the capital and operating costs of the TAS and buffering site operations are the responsibility of the private sector.

	Base Traffic Case	High Traffic Case	Low Traffic Case
TAS + St Mathew Daniel	16.0	13.5	20.43
TAS + KiriKiri	6.76	5.71	8.62
TAS + Orile	4.01	3.40	5.10

The private sector participant would undertake the concession on an integrated deployment, management, and operation basis over a period of 8 - 10 years, with a 7-9 year operating period. As indicated by the traffic scenarios, the private entity would bear the revenue risk of the project.

The distinction between scheduling and buffering thus provides a natural decoupling point. We draw attention to this because the available economic benefits of removing truck queues in the LPC and associated positive impacts on the LMA supply chain are so compelling that they merit the pursuit of a scheduling (Truck Appointment System) element independent of buffering.

A private-sector scheduling system is commercially viable and robust at appointment fee levels of $5 - $20 / TEU, as a stand-alone system. A TAS could be coupled with buffering lot(s) provisioned by the public sector, to strengthen the TAS solution itself.

These results inform the PSP implementation strategy as discussed below.

PSP Implementation Strategy

Based on the precedent observed in the Manila case, the specific modeling results for the TAS only option tested here, and the significant benefits of addressing extreme congestion at the Lagos area ports, implementing the TAS is a compelling option.

Setting the Stage

For the TAS to work however, some pre-requisites would first need to be addressed. Each truck wishing to conduct a dray move at the port would need to be registered in a common database. The database would be accessible by agencies such as LASG as well as the NPA to enable identity validation checks and to allow these trucks to access port facilities. Without this registration certificate, trucks would not be able to access the port or participate in the appointment system.

It is critical that LASG and NPA enforce the required registration and confirmation of appointments for port access, otherwise the TAS will lose its power for controlling truck flow entirely.

Another priority is to develop and enforce parking restrictions in the vicinity of the ports, and access roads. This is important to ensure compliance with the above requirement that only registered trucks with confirmed appointments should be able to access port facilities, and that when they do travel to the terminals, the port area access roads can indeed allow for a reasonable flow of traffic. LASTMA is the appropriate agency to oversee the enforcement of a parking policy within a security cordon established around the ports. Both the NPA and LASTMA would need to be involved to screen consignment notes or bills of lading, to ensure that trucks have legitimate business. Without these checks and enforcement, trucks will not have an incentive to participate in the TAS system, and are therefore not part of the captive revenue stream.

In the meanwhile, as stakeholders engage in developing these pre-requisites, the truck parking facility on Tin Can Island owned by FMPWH is 90% complete and should be operationalized to provide some staging space for trucks (~350 trucks). While the measures above are being put in place, some trucks can be accommodated in the TCI site. Additional coordination is required between the NPA and FMPWH to enable this.

Overall, NPA, LSG and FMPWH would need to agree on the holistic port access governance arrangement, enforcement policies and mechanisms, and the implementation agreements to deploy the new procedures. This charter and pursuant agreements would need to be in place to enable the PSP option, and to determine the business rules that govern how and when charges are levied for the use of the TAS.

Various stakeholders should be engaged and sensitized to proposed changes, and the new procedures and protocols. As described below, participation in a pilot demonstration would be critical for the buy-in and value proposition of those who may have reason to initially resist participation.

NPA can pave the way for an eventual PSP project by engaging with STOAN as a representative of terminal operators to put in place the framework for formulating an Authorized Economic Operator (AEO), a Special Purpose Vehicle that will ultimately oversee the procurement of the scheduling and buffering scheme. The terminal operators (concessionaires) would altogether comprise a 49% minority equity stake in the AEO. A transaction for the 51% majority stake would be conducted to identify the private sector anchor for the AEO. To align interests and incentives, a foreign entity with expertise in Truck Appointment Systems and port operations would form a joint venture with a local Nigerian firm to ensure that the local context is respected, international expertise is brought to the table, and local capacity continues to build.

Piloting a Truck Appointment System with Buffering

The combination of truck registration, transaction documentation checks, and enforcement of no parking can by itself remove congestion from near the port gates, however this will only move truck queues a bit further out into the LMA, as the fundamental ambiguity in when trucks need to arrive at the port has not been resolved. The Truck Appointment System is therefore critical to provide this visibility.

As a first step in this phase, the AEO can retain a transaction advisor to develop the business rules among terminal operators, trucks / carriers, shippers and government agencies. The clarity of business rules must indeed precede the operating procedures that will be put in place.

The business rules provide a set of performance objectives, which the AEO can then use to conduct a tender process for the selection of the international private partner. The private partner would either integrate is own TAS, or procure one on a pilot basis.

The TAS could be operated in conjunction with the aforementioned truck holding lot to provide a buffering aspect of the pilot. FMPWH participation in this overall project is therefore instrumental. Data should be collected to assess the impact of the pilot TAS and buffering lot on truck dwell time, container throughput, and overall process efficiency.

Once registered trucks have suitable assurance that they can clear the security in a timely manner with the necessary documentation, and their arrival at the ports will have a reduced dwell time due to confirmed appointments, they will have a stronger incentive to register and participate in the system. Indeed in the absence of their fulfilling these requirements they will not be able to engage in dray moves. The pilot will help establish the precedent for refining the approach, and eventually scaling up to a broader system build out.

At the same time, a number of complimentary strategies such as enforcement of the empties handling policy, truck route and hours of travel restrictions, etc should also be implemented to enhance the likelihood of success of the TAS.

Building out the System

Revenues from the TAS pilot can be re-invested into both scaling up the TAS to additional terminals, as well as developing either the St Mathew Daniel, KiriKiri, or Orile sites as additional buffering facilities.

Market Sounding

We conducted market sounding discussions with key stakeholders involved in the LMA supply chain including terminal operators, trucker representatives, the NPA, and potential investors. A stakeholder workshop was also conducted to facilitate a discussion around the scheduling and buffering project concept, and the identification of risks.

Stakeholders affirmed two main ideas with respect to the project concept:

→ **Improving operational coordination**: There was overwhelming support for the objective that the queue removal in the Lagos ports envelope and better coordination of truck movements (including the management of empties) must be addressed. In the absence of such coordination, the available economic benefits from dray operation improvements will be left uncaptured. The private sector, i.e. terminal operators and private investors, confirmed their interest in integrating and operating ICT-enabled Truck Appointment Systems (scheduling) to support this objective.

→ **Allocating risks appropriately**: The private sector would focus their efforts on the scheduling component and corresponding operational protocols, business rules, and management mechanism as these are the sector's main areas of expertise (consistent with project structure Option 3). The buffering element (short-term holding lots) is best unbundled and allocated to the public sector as it might be in a better position to acquire land, provision the buffering lots, maintain environmental and social impact standards, and provide the overall enabling environment. Conversely, allocating these responsibilities and risks to the private sector would drive up the cost of the solution considerably, as the private sector risk premium would be reflected in the charges for truck appointments. This risk premium could be reduced only if the enabling environment was stable, reliable and tested over time.

Further, all stakeholders pointed to the need for complimentary strategies to provide the enabling environment for the scheduling and buffering solution.

Legal and Institutional Framework

A separate report reviews the legal, institutional and environmental framework. Salient findings are nonetheless summarized here.

The Nigerian Port Authority (NPA Act 2004) defines the functions and mandates of the NPA as providing and operating necessary facilities in ports and maintaining, improving and regulating the use of the ports; and to provide for matters connected therewith. Critical to NPA's jurisdictional authority and types of activities is the definition of a port and its extent. At present, any facilities not immediately within the port envelope / cordon cannot be considered port facilities and the NPA has no jurisdiction over them. The implication is that:

Establishment of truck parking facilities in the city of Lagos – even if not too distant from any of the Lagos Ports (as defined in Item 1 of Part 1 of the Second Schedule of the NPA Act) – do not currently fall within the statutory purposes of NPA.

NPA - Section 30 (1) of NPA Act provides that Federal Ministry of Transport can declare any place in Nigeria as a Port facility, which would then allow NPA to claim port land rights and build short- or long-term truck holding facilities. However, until such time such a declaration is made, NPA does not have clear jurisdiction of truck parks located outside port limits.

Lagos State recently enacted the State Transport Sector Reform Law 2018 signed by the Governor of Lagos State on February 28, 2018, under which a Lagos State Parking Authority (LSPA) (Part IV of the Transport Sector Reform Law) is proposed to be established, mandated to develop truck terminals and on-street and off street parking spaces throughout the State. The LSPA is yet to become operational.

PPP framework

The Lagos State PPP Framework is guided by the **Lagos State Public Private Partnership (LSPPP) Law 2011** which establishes the **PPP Office** (LASG) to be the default procuring entity for projects involving PPP in the state of Lagos. All Concession Agreements must be ratified by the House of Assembly and only companies registered in Nigeria can enter into a PPP agreement. It also requires user fees to be approved by the PPP office.

Implementing Agency

Either LSPA or NPA can act as concessioning authorities depending on the project structure. The short-term buffering lots or marshalling yards may fall under the jurisdiction of LSPA while the Truck Appointment System ('Scheduling') under NPA.

Environmental and Social Assessment

The Federal Ministry of Environment (FMEnv) is responsible for issuance of EIA and other environmental compliance certificate on every developmental project in Nigeria. Based on project significance, may be categorised as Category I or II, requiring a full EIA. Lagos State Ministry of Environment (LsMoE) plays some oversight functions in ensuring that environmental due diligence is carried on projects.

The World Bank OP 4.01 guidelines, IFC OP 4.03, World Bank OP 4.12 and IFC Performance Standards (PS) 4, 5 and 7, will also be relevant in case of this project.

Based on reconnaissance visits, issues of involuntary resettlement are not deemed significant.

As discussed, the potential sites for the truck park will need to be acquired by the public sector (NPA or another agency) to make the project commercially feasible. Section 6 provides estimates of market value for land in the vicinity of the truck park sites under consideration.

The project has significant positive impacts and most negative impacts can be effectively mitigated.

Recommendations and Next Steps

Our analysis has documented the severe conditions around truck dray operations and queues, extensive economic benefits for the LMA that could result from addressing those issues, technical and operational logic for scheduling and buffering as a solution, and the financial viability of project structures under a PSP approach. Our recommendations emerge from this holistic view.

Recommendation 1: Public sector agencies should coordinate to provide an enabling environment for a private sector-led deployment and operation of an ICT-enabled Truck Appointment System (scheduling).

Recommendation 2: Agencies should supplement the scheduling element by provisioning truck holding lots (buffering), to be operated in conjunction with the private sector-led Truck Appointment System.

Recommendation 3: Agencies should also focus on separate but complimentary strategies to extract value from the deployment, including long-term parking solutions outside the LMA.

Benefits of an ICT Approach to Scheduling

ICT arrangements are not required for deploying a basic Truck Appointments System, but they are a significant enabler in accomplishing the objectives of the TPPAF. There are many primary functions and benefits that an ICT-enabled TPPAF can deliver for the four main types of actors defined earlier, which come with requirements for investing in not just technology but also capability and skills. Both beneficial functions, and required commitments are in Figure ES-29.

Figure ES-29. Benefits and commitments of moving to an ICT-enabled Scheduling and Buffering System

Available Beneficial Functions	Required Commitments and Efforts
Real-time (or near real-time) information on truck-related operations and interactions	Developing and continuously feeding electronic databases with truck records, transactions, and other attributes for making appointments
Single source of "truth" for a variety of decentralized decisions	Holding actors accountable for information submitted, and including a number of validation and verification steps
Automating and streamlining mechanical but error-prone tasks	Moving to digital data entry and records, minimizing human touch points on the event data, and additional training and skills on new systems for operators
Performance data collection over time, including for storing and analyzing "big" data on operations	Leveraging data as a benchmark for performance monitoring and improvement
Reporting for compliance, planning, and operations objectives	Key interfaces and visibility for jurisdictional authorities such as NPA, customs, other agencies
Additional security layers for sensitive data	Building in appropriate safeguards for private, or otherwise commercially sensitive information to ensure participation

Source: CPCS analysis

Phased Approach for Implementing Recommendations

The proposed scheduling system with or without buffering lots, is only likely to be successful if some other fundamental mechanisms and complementary strategies are in place and working. As such, our proposed **phased approach** for the project is as follows:

Phase 1: Setting the Stage

8. **Registration**: Begin requiring drivers and fleets to register their trucks in an electronic Lagos State Parking Authority (LSPA) database, and then enforce port-area and terminal access only for those with the recognized authority to operate. The Nigerian Ports Authority (NPA) must be able to access the database for port-area checks.

9. **Implementation Charter**: LASG and the Federal Government (represented by the Federal Ministry of Transport - FMOT, the Nigerian Ports Authority and the Federal Ministry of Power, Works and Housing – FMPWH) come to an agreement with the objective of decongesting the ports and improving traffic flow in/around the Lagos ports area. The charter would impose obligations on each party with LASG assuming responsibility for enforcing parking restrictions (#3 below), FMOT and NPA granting access to the port gate (#6 below) and FMPWH providing the Tin Can Island site as the buffering lot staging platform (#4 below).

10. **Port Traffic Management**: LASG to ensure that Lagos State Traffic Management Authority (LASTMA) develops, implements and enforces regulations restricting arbitrary parking in the port environment, creating an environment conducive to a scheduling system.

11. **Special Purpose Vehicle**: NPA to convene stakeholders and oversee an arrangement leading to the formation of a Special Purpose Vehicle (SPV), which would later be granted status as the Authorized Economic Operator (AEO) in a PPP for implementing and operating the Truck Appointment System and the buffering site. It is envisioned that a competitive process (transaction) would be undertaken (see Phase 2a below) to identify a private foreign entity who would enter into a Joint Venture with a local firm to form a majority group (51% equity stake) in the SPV. This approach would bring both the needed international expertise and also ensure capacity building for the local participants. NPA to hold discussions with terminal operators under the umbrella of the Seaport Terminal Operators Association of Nigeria (STOAN) to ensure fairness and transparency in dealings, with terminal operators on Tin Can Island and Lagos port complexes forming a minority group (49% equity stake) in the SPV. As terminal concessions expire and new concessionaires are identified, the equity stake can be transitioned to them to maintain the 49% among active concessionaires.

12. **Buffering / Staging**: FMWPH, via the Implementation Charter, commit to leasing its truck holding site (currently at 90% completion) to the AEO / SPV to manage as a buffering lot staging area for trucks destined to either of the Lagos area ports. The objective of this optional component of the approach is to strengthen the TAS as a solution and extract value from it.

13. **Port Access Governance**: NPA to provide firm commitment in Implementation Charter on port access, and their interest in implementing a scheduling system. Such systems always face some level of opposition from vested interests, and commitments from key stakeholders are a must. This commitment must include unequivocal declaration to allow gate access to only vehicles with valid registration and documentation. The updated provisions to also include a separate line item for the inclusion of the service fee for the use of the TAS, as one of the business rules for the AEO.

14. **Awareness**: Sensitize key stakeholders (particularly road transport unions) about the benefits of the truck scheduling scheme, emphasizing successes in other jurisdiction such as Manila and other congestion management efforts at other African and global ports.

Phase 2a: Operationalize Pilot Phase of Scheduling System

The first step of this phase would be to implement a transaction to identify and select a private group acting as an Authorized Economic Operator to manage the Tin Can Island staging area. This private group would hold a controlling stake (51%) in the SPV assigned the lease to operate and manage the Tin Can Island truck staging area. The SPV would include terminal operators as minority members (holding 49% stake) of this SPV. The Authorized Economic Operator would be responsible for stewarding linkages between Terminal Operating Systems and port-truck interface / landside operations. Specific steps would involve:

7. **Business Rules**: Engage a Transaction Advisor to develop an Outline Business Case (OBC) identifying the business rules that will govern transactions between the terminals, trucks / carriers, and the NPA. Harmonize the various fees, charges, and requirements holistically.

8. **Truck Appointment System**: Implement a competitive tender process to identify a private group that will assume a majority stake in the Authorized Economic Operator and be responsible for procuring / integrating a common Truck Appointment System across participating terminals. The entity is likely to be foreign, given the specialized technical and operational experience required, but could enter into a Joint Venture with a Nigerian firm to ensure that the local context is respected, international technological expertise is brought in, and local capacity building is fostered over time. The initial focus for TAS implementation could be on TCI terminals.

9. **Tin Can Island Buffering Lot**: Leverage the almost-operational truck holding lot on Tin Can Island as the first buffering lot to test the scheduling and buffering concept, and refine operating rules. Very little ICT investment is deemed necessary at this stage, with the minimum requirements being a computer system to validate truck identities, transaction statuses, and registrations. Radio communications with the terminal operators will also streamline information flow.

10. **Assessment**: Evaluate the changes / impacts to throughput from the use of the scheduling system and the pilot buffering lot.

In parallel to Phase 2a related directly to the project, other reinforcing measures must be put in place to maximize the likelihood of success.

Phase 2b: Reinforcing Measures

Without supporting measures, there is a likelihood that a scheduling system will not bear the anticipated fruits. By far the most important measure is the enforcement of port-area access and parking restrictions, which would also be a strong indicator of the authorities' commitment to deal with the congestion issue. As such, key measures would be as follows:

11. **Port Access**: Enforce the requirement for valid truck registration (license to operate), and consignment notes / bills of lading for access beyond a security cordon in the vicinity of the ports, in line with the new LASTMA legislation and regulations for implementation noted above. There are no additional fees or charges beyond what trucks are already responsible for today.

12. **Parking**: Enforce restrictions of truck parking on port-area access roads beyond that security cordon.

Phase 3: System Build-Out

Once the system is working at TCI terminals, and the supporting measures are well in place, the financial balance of the project should be quite positive. If the staging area has been successful, the TPPAF area of operation can be extended to the Lagos port complex terminals, this should allow for a significant fee, which could be reinvested to build up additional buffering zones and other supporting infrastructure. As such, key steps would be:

4. **Scale Expansion**: Expand scheduling to all terminals, renegotiating a concession fee to be used for initiatives related to port congestion management initiatives.
5. **Buffering Capacity Expansion**: Pursue site acquisition for St. Mathew Daniel and Kirikiri sites as optional buffering lots, using some of these funds. Alternatively, develop and implement a small-scale buffering lots licensing program.
6. **Long-term Parking**: Develop long-term parking zones further away from the port outside the LMA and near major freight corridors, as a feeder to the port area facilities and buffering lots.

In particular, long-term parking zones with suitable pricing will become interesting to truckers if they have some level of confidence that *when granted an appointment* they can move from a long-term parking lot to the port access are, and a buffering zone if needed and wait for their scheduled appointment with limited to no risk of missing it. The choice of staging in long-term parking and then in buffering zones near the port will be reinforced significantly by a strict enforcement of the use of the Truck Appointment System and parking rules near the port, and the requirement to have the necessary registration, consignment notes, and confirmed appointments. Complimentary Strategies

Complimentary strategies include investments in infrastructure, services or amenities that indirectly decrease congestion, decrease dwell times and increase truck driver performance at the port can also be phased in over time. These can also be tied to value added services for truck drivers who have appointments at the TPPAF.

- **Empty Container Policy**: NPA should assess the impact of the new empty container handling policy by collecting data on number of trucks with empties attempting to access ports, recording delivery notes for the holding bays to which those containers have been assigned, and documenting the dwell time and turnover rate of those empty containers in holding bays.
- **Improved Processes**: Harmonize and streamline the process for customs, inspections, and administrative checks for releasing containers and digitize transactions to provide a single source of truth for agencies, terminals and carriers. Leverage the efforts of the Nigerian single window initiative to expedite the development of the unifying database.
- **Routing**: Harmonize and enforce truck routing and travel time restrictions within the LMA to ensure that trucks are neither affected by peak congestion, nor exacerbating it. Publicize information and ensure adequate signage for routing and hours to assist truck driver navigation.
- **Axle-Weights and Safety Inspections**: Enforce truck loading axle-weight restrictions to minimize road wear and tear and reduce the likelihood of truck breakdowns. Inspect trucks for emissions profile and safety as part of checks.

→ **Real-time Truck and Traffic Visibility**: Appointment systems can deliver real-time information updates on congestion in the vicinity, transit time to the TPPAF from main access roads, transit time between the truck park and port access control, etc. real time information to drivers in transit and at the port

→ **Infrastructure Design and Maintenance**: Associated investments in access roads will significantly improve overall travel time reliability as trucks enter the "last mile" of port access. Improvements in signage, lighting, and design considerations and route restrictions for improved safety will help feed truck traffic into and out of the port area

→ **Long-term Parking** options such as "truck villages" outside the LMA with food service, toilets, sanitation facilities, convenience store, and refueling options

1 Introduction

Key Messages

With average travel speeds during peak morning and peak evening being less than 19 miles per hour in most parts of LMA, this project assesses initiatives to reduce road congestion through the pursuit of integrated transport projects.

The focus of this workstream is to design a solution architecture for a Truck Parking and Port Access Facility (TPPAF) using information and communication technologies. The purpose of the TPPAF is to mitigate congestion and truck queues near the port facilities by ensuring smooth truck access and exits from the port terminals.

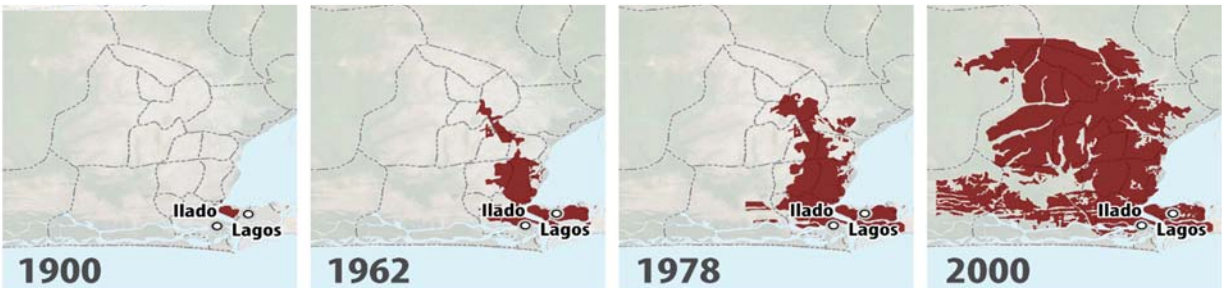
The tasks and major activities followed for the execution of the assignment and preparation of the Draft Assessment Report are enumerated in this chapter. This includes field missions, conduct of primary surveys, review of secondary data, extensive stakeholder consultations and field reconnaissance, and finally market sounding to provide feedback on project structure. As part of the assignment, we adopted an approach of submitting Working Papers (WPs) on key tasks of the assignment with objective to continuously seek feedback on our analysis and outputs, address comments and receive suggestions which have been fed into this Assessment Report.

1.1 The Project Context

Urban Congestion

Over the years, Lagos, the commercial capital of Nigeria, has witnessed a rapid increase in population amid tremendous urbanization and expansion. The transport system has not grown adequately to meet this demand. The city is congested with transport services dominated by informal service providers and privately owned cars. Over a century of growth in Lagos State has resulted in an urban sprawl along the main north to south transport corridor, and more recently along the west. This has resulted in growing traffic congestion in Lagos with peak morning and peak evening speeds at 0 – 19 miles in most sections of the urban network[9].

Figure 1-1. Time Series of Urban Growth in Lagos (1900 - 2000)



Source: Ministry of Physical Planning/Environment (1900, 1963) LAMATA (2000). Data from the Global Human Footprint Dataset's Human Influence Index – HII (2005).

[9] Frederic Oladeinde. Presentation on the Lagos Strategic Transport Master Plan. Lagos Metropolitan Area Transport Authority (LAMATA). 2017

Truck Activity in the LMA

There is a significant truck presence in the LMA. Many of these trucks transit to and from the port facilities and freight facilities within the LMA, or access major arteries and highways for long-haul journeys. These vehicles include trucks (tractors and chassis) with containers, tanker trucks, and other vessels carrying bulk materials. The movement of these trucks within, and into and out of the LMA, is commonly held to be a major cause of congestion.

The congestion along the Lagos-Jibiya corridor trade route (the primary north to south transport corridor) is so acute that drayage costs are exorbitant relative to quality and value of service. The short dray segment from the Lagos Port Complex to warehouses in Lagos (2% of the total distance) costs shippers $434, representing 22% of the total land transport price . Extra costs related to transport from the Ports to Lagos warehouses represent 94% of the total cost, driven mostly by congestion and poor road conditions.

1.2 Authority of the Assignment

As part of the Lagos State Government (LASG) commitment to the continued improvement of transport connectivity in the Lagos metropolitan area, it has identified three transport sector initiatives with potential for private sector participation (PSP): the Interstate Bus Terminals Project (Mega Terminals Project), the Lagos State Water Transport Program (LSWTP), and the Truck Parking and Port Access Facility (TPPAF) using information and communication technologies.

The TPPAF is being implemented by the Nigerian Ports Authority, an agency of the Federal Government, but in close collaboration with Lagos State.

The World Bank, alongside the Management Unit of GIF (MU) and PPIAF (the three are collectively termed as the 'Client'), have engaged with the Lagos Metropolitan Area Transport Authority (LAMATA), the Lagos State Waterways Authority (LASWA), and the Nigerian Ports Authority (NPA) to assess the options available for attracting private sector investment and participation into the three transport initiatives.

The objectives of the assignment are to:

→ identify the legal, regulatory and institutional opportunities and bottlenecks and formulate recommendations to solve these within the framework of each of the three projects;

→ assess early stage feasibility of the three projects; and

→ build consensus regarding the options presented and identify necessary next steps.

This Draft Assessment Report was prepared under the authority of the contract signed between the World Bank Group (WB) and CPCS Transcom Limited (CPCS) on December 21, 2017, for the Project, "Private Sector Participation in an Integrated Transport System in Lagos" (Selection No. 1248779).

1.3 Scope of this Report

This Report consolidates all of our analysis, findings and recommendations, addressing the entire scope and the work undertaken for the TPPAF project. The major tasks as defined in the Terms of Reference (ToR) includes:

Workstream A: Cross-cutting institutional, legal and regulatory framework diagnostic

- Task A1: Review of cross-cutting institutional, legal and regulatory framework (PPIAF).

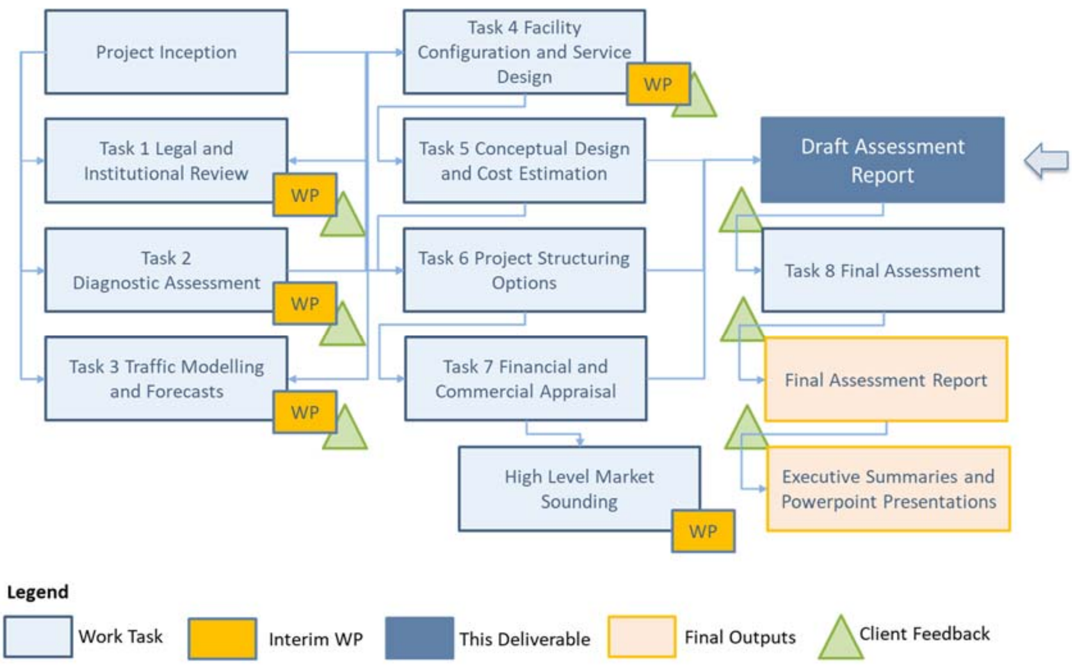
Workstream D: Truck Parking and Ports Access Facility using information and communication technologies (ICT)

- Task D1: Diagnosis of Existing Situation and Do-Minimum Scenario (PPIAF) **–** a detailed analysis and diagnostic of the current and future congestion problem at the Ports of Lagos through review of existing data, traffic models and short duration traffic surveys of the area to be undertaken by the consultant;
- Task D2: Technical Options Analysis for Developing a Satellite Parking Facility (GIF) – an appraisal of options for developing a new parking facility;
- Task D3: Demand and Revenue Forecasts for Preferred Technical Option (GIF) – demand and revenue assessment; and,
- Task D4: Financial and commercial analysis of Preferred Option (GIF) – financial modeling of preferred option to assess likely private sector investment in sector.

1.4 Task Organization

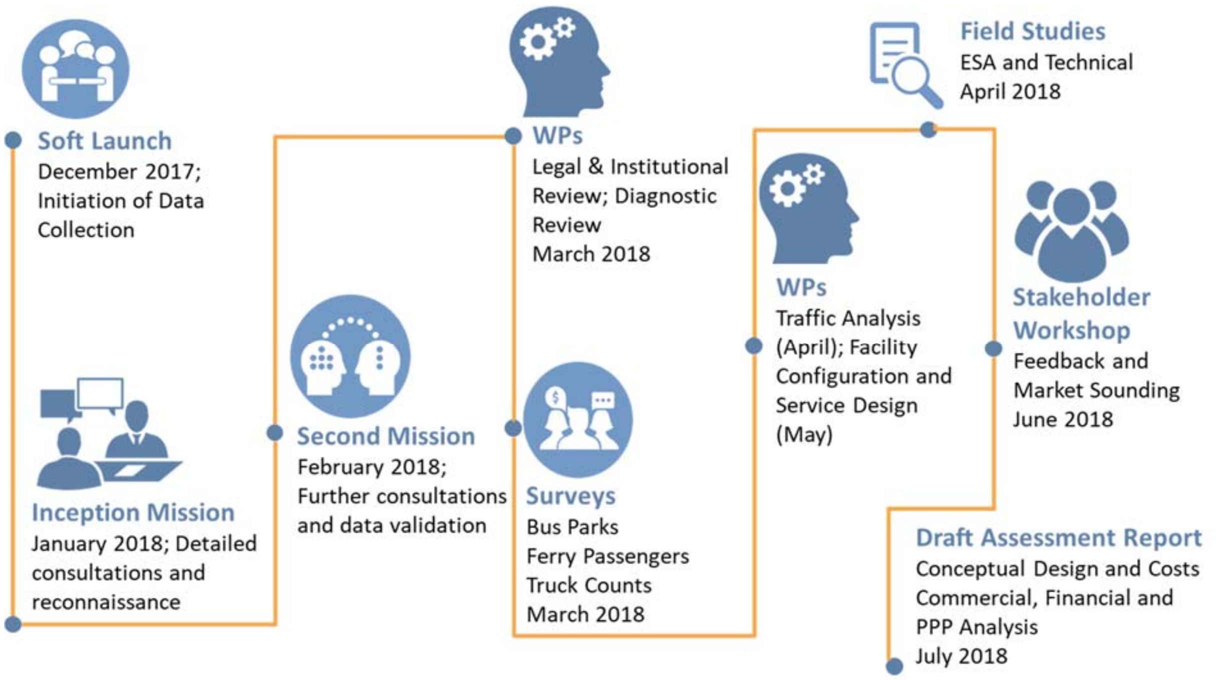
Figure 1-2 enumerates the task organization followed for the execution for the assignment.

Figure 1-2. Task Organization



1.5 Major activitives

Figure 1-3. Timeline for major activities



Inception Mission

We undertook a joint field mission with the World Bank team to Lagos, Nigeria, over the course of five days from January 15 - 19, 2018, followed by meetings in Abuja, Nigeria, on January 22 and 23, 2018.

During the mission, we undertook:

- Discussions with the key Implementing Agencies (IAs) viz. LAMATA, LASWA and NPA;
- Site visits[10] to potential project sites for the proposed Truck Parks; and
- Consultations with other stakeholders including:
    - Lagos Global[11];
    - Planet Projects[12]
    - Association of Maritime Truck Owners (AMTO);

[10] During the Inception Mission, the team visited three potential sites including Orile site, Coker Road; Kirikiri site, Happy Home Avenue; and St. Mathew Daniel.

[11] Office of Overseas Affairs and Investment, known as Lagos Global, Lagos Global is a creation of the present administration to make Lagos an investment destination of choice, by creating a favourable environment for local and Foreign Direct Investment (FDI) to thrive.

[12] Planet Project is one of the prominent Nigerian companies operating in construction, operation and consulting for transportation infrastructure in the country. The intra-city Ikeja Bus Terminal facility was constructed by Planet Project under World Bank financing. The CPCS team consulted with Planet Projects to gauge their interest as a potential private sector partner and also to seek their views on the sector as a whole. They shared data with the CPCS team as a matter of courtesy, and have been given due credit in the report.

- o Association of Corporate Fleet Owners (ACFO);
- o Key ministries at the Federal level.

The findings of the Inception Mission were documented in our Inception Report submitted on February 3, 2018. A revised Inception Report, after addressing comments received from the World Bank team, was submitted on Februray 23, 2018.

Stakeholder consultation and second field mission

A consultative process was the cornerstone for the execution of the assignment. We conducted a second field mission during the during the week of February 12-16, 2018, with the purpose of holding further consultations with stakeholders, addressing information gaps and collecting further data.

A complete list of stakeholders consulted as part of this study is presented in Appendix A.

Document/ data review

The three agencies and other stakeholders have been generous with sharing of information and past studies/data, which has aided our analysis. Key among these with respect to the TPPAF which were reviewed by the team are:

- Lagos Region Freight Demand Study, Cambridge Systematics, Inc. April 2016;
- Federal Ministry of Transportation (NGA), Axle Load Study and Review and Update of Design Standards for Federal Roads, Nigeria. November, 2008;
- Consultancy Services for the Extension of the Strategic Transport Master Plan (STMP) and Strategic Travel Demand Model (STDM) to Cover the Mega City Region, ALG and europraxis, December 2014 (Chapter 4 - Freight Plan); and
- 25-Year Freight Forecast for the Nigerian Ports Authority, CPCS, 2014.

A comprehensive list of secondary data/documents reviewed for this project is presented in Appendix B.

Survey

The survey included a manual truck count and select interviews with drivers of the trucks waiting to enter the port. The information obtained from the drivers included type of truck, type of cargo, origin of truck, and the number of days spent in the queue. The survey covered heavy trucks and was carried over a 12-hour period (6am – 6pm). The surveys were undertaken on a single weekday (Monday) in March 2018. It included both truck counts and interviews with drivers. The questionnaire template used for the purpose of the survey is presented in Appendix C.

Submission of Interim Deliverables

Working Papers

As part of the assignment, we adopted an approach of submitting Working Papers (WPs) on key tasks of the assignment with objective to continuously seek feedback on our analysis and outputs, address comments and receive suggestions which have been fed into this Assessment Report. We submitted the following working papers:

Figure 1-4. List of WPs submitted

S.No.	Working Paper	Submission date	Date of recipt of Comments	Revision date
1	WP1: Legal and Institutional Review	March 14, 2018	April 5, 2018	April 17, 2018
2	WP2: Diagnostic Review	March 13, 2018	April 5, 2018	April 13, 2018
3	WP3: Traffic Modelling and Forecasts	April 24, 2018	May 23, 2018	June 6, 2018
4	WP4: Facility Configuration and Service Design	May 16, 2018	June 11, 2018	Responses submitted on June 15, 2018

Engagement with Implementing Agencies

In addition to initial consultations during the Inception Mission and data collection, a presentation on WPs 1 and 2 was held via videoconferencing on April 5, 2018, with a view to seek feedback from the respective IAs. Meetings and stakeholder workshops were also held in July as part of presenting the project concept and market sounding.

Progress Reports

These were submitted every two weeks, after the submission of the Inception Report, for the information of the World Bank team, with an update on the activities conducted and progress of the assignment. The reports also flagged delays and challenges encountered during the execution of the assignment.

Reconnaisance Visits for site verification and ESA review

Our team of Engineers and Environment and Social Expert conducted site reconnaissance of the proposed sites (3) during the month of April, 2018, with the objective of preparing designs and layout for the propose sites, and flagging any issues with respect to environment and social assessment.

Market Sounding exercise

We commenced the market sounding exercise in the week of June 4, 2018, soliciting feedback from a variety of stakeholders including:

- industry associations;
- ICT vendors;
- terminal operators; and
- banks and financial institutions (FIs).

A list of stakeholders for the project, including those consulted in market sounding is in Appendix A.

1.6 Structure of this Report

The remainder of this report is structured as follows:

- Chapter 2: Diagnostic Review – this presents the findings from our as-is review of existing transportation facilities, and the nature of truck traffic, queues and congestion near the port complexes, and current ICT capabilities;
- Chapter 3: Legal and Institutional Review – this corresponds to Workstream A (as referred in the ToR). The Chapter provides an overview of applicable laws and regulations; key institutional agencies, their mandate and authority to enter into contract for the proposed project, and inter-agency coordination required; PSP options and assessment of legal constraints (if any) to PSP for the project;
- Chapter 4: Traffic Analysis and Projections – the chapter presents long term traffic forecasts which have been used to determine the size and specifications of each of the facilities to be built or transport services to be provided;
- Chapter 5: Facility Configuration and Service Design – this presents an implementation blueprint for the Truck Parking and Port Access Facility including configurations for the various infrastructure facilities, based on the traffic forecasts and potential for optimization of revenue for the project;
- Chapter 6: Conceptual Design and Layouts – this summarises assumptions for design and layout development for the TPPAF candidate sites;
- Chapter 7: Commercial, Financial and PPP Analysis – presents findings from our commercial analysis and financial modelling of various project/PPP structures;
- Chapter 8: Environment and Social Assessment – presents findings from a high level scoping exercise and potential positive/negative impacts of the project; and
- Chapter 9: Recommendation on Way Forward – summarises our key recommendations and documents immediate next steps.

1.7 Limitations

This report is intended to inform the way forward on the assignments. It is not a detailed feasibility study for the projects, but identifies (at a high level) potential options which may be pursued. If they are approved to be procured using PSP, it is assumed that a consultant would be hired for Transaction Advisory who would validate the feasibility of the projects in detail.

2 Diagnostic Review

Key Messages

We assessed available data on truck movements, queue lengths, drivers of congestion, and various attributes of port area operations.

Freight Generators

Major truck freight generators within LMA are primarily the Lagos Ports Complex (LPC) (also referred to as Apapa Ports Complex) and Tin Can Island Port Complex (TCI), facilities composing the Lagos ports. Container traffic is a major segment of truck traffic at these facilities. both ports accounted for nearly 87% of the Nigerian container trade in the first and second quarter of 2017. Lilypond Inland Container Depot is the oldest functioning container depot in Nigeria, originally operated by MCIS. Pre-2006, it was a holding-bay that had the capacity to accommodate nearly 7,000 trucks. At present, it is primarily used to service containers that should have arrived at Apapa, but have arrived at Tin Can Island instead, where they have been refused customs clearance. Intermediate freight generators include a number of transshipment facilities and smaller warehouses, processing facilities and other types of shippers and receivers that are distributed in the LMA.

Modal Interfaces

For aggregate handling of freight in the LMA, ports and terminals listed above account for 46% of the total tonnage handled while 54% is associated with trucks and less than 1% is associated to rail and air cargo. Both rail and air interfaces have seen extremely low use. The NPA however invested in a partial double tracking of the rail line into LPC with plans to move containers to inland container depots in the interior of Nigeria. In the last 5 years, NPA reports that its freight railway is minimally used. In fact, APTM is the only terminal to use it.

To our knowledge, the concept of extending the existing narrow gauge railway line to the second port in Lagos, TCI, has been discussed often, but includes no systematic study. We therefore assume that the main modal shift at the Lagos ports would be either from / to trucks.

Main Transport Corridors

Truck freight predominantly moves along two major transport corridors, namely the Lagos – Jibya axis (North-South, know as the LAKAJI corridor) and the Lagos – East axis. Within a regional context, both freight corridors converge on the Lagos Ibadan Expressway (E1) near Logbara and funnel truck traffic south to Ojota. Survey estimates from 2016 revealed 7,820 trucks converging daily.

Four other smaller corridors have similar shares of the daily traffic and represent 52% of the total daily traffic. These flows when added to the 7,820 trucks on the main E1 expressway, amounts to 16,408 trucks entering/exiting the LMA on a daily basis.

Other major arterials and expressways serve as local delivery roads, routes for bypassing the downtown core, or congested expressways. The E1 into Lagos/Victoria Island has traffic of about 2,242 trucks a day that eventually move on to the Lekki-Epe Expressway or divert for local delivery. Kirikiri, Ojo, Malu and Cementry roads are all used for local delivery as a way to avoid using expressways. Other major arterials and feeder roads closer to the port gates are severely congested.

Key Messages (continued)

Current Protocol for Truck Access and Parking at Port Facilities

Trucks with scheduled transactions at the port facilities undergo both formal and ad hoc procedures for port access. Formal procedures include the necessary documents that trucks must obtain before they access terminals. Truck drivers arrive at the ports with their documents, park along the road outside of the terminal gate, and present their papers, and queue in the port gate stall until the terminal operator performs a “call up” from the street. This latter process is manual and ad hoc, with port security personnel often searching queues for the truck to be called up, making this a highly inefficient process.

Many trucks that join queues are behaving opportunistically. In other words, they do not have a pre-approved transaction (or necessary papers) and are waiting for the possibility of being called up because of their proximity, or because of imminent transactions.

At present, there are no designated areas or off-dock facilities to park trucks save for the roads themselves.

Limitations of Efforts to Manage / Influence Congestion

There have been disparate efforts over the years to manage or influence truck movements to counteract congestion. These measures include routing, restricted access in certain locations or at specific times, truck parking facilities for extended dwell times, and freight facilities such as container bays and yards. In some cases, the measures have been implemented but not fully leveraged, whereas others have received some degree of support, but are yet to be implemented.

Perspectives on interventions

Our diagnostic review and stakeholder consultations suggest that a piecemeal approach to addressing truck movements (including parking) and related port operations have not worked, and are not likely to work in future. What is needed is coordination between all relevant parties across the freight supply chain so that solutions in one part of the chain can lead to benefits to all participants. ICT can potentially assist with this coordination.

2.1 Assessing Current Conditions affecting Trucking and Dray Operations

We assessed available data on truck movements, queue lengths, drivers of congestion, and various attributes of port area operations. The data discussed in this section, along with our primary data collection and stakeholder consultations provide insights on the current state of trucking and dray activity in the environs of the Lagos Ports.

2.1.1 Data Sources

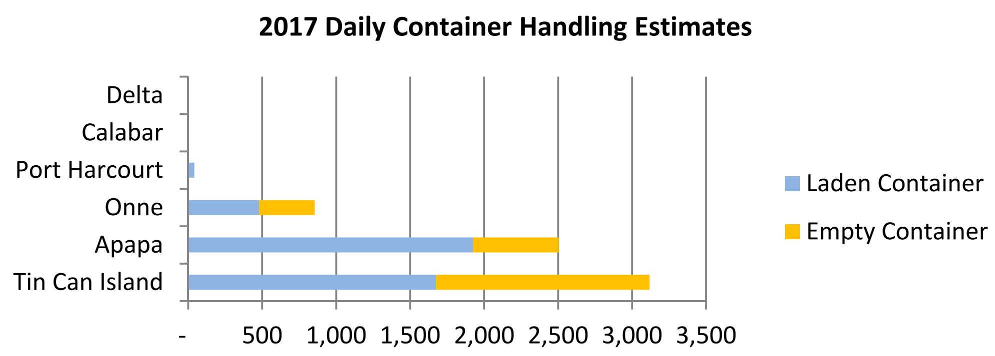
Several organizations have undertaken quantitative assessments of daily truck volumes within the LMA. Notable among these are studies led by ALG and Europraxis[13] completed in 2014 and more recently, a freight demand study[14] by LAMATA completed in 2016. Prior to both of these (in 2008), Federal Ministry of Transport published an axle load study that incorporated a truck based origin-destination (O-D) survey at the national level[15]. Analysis completed by CPCS to inform a freight assessment for the Nigerian Ports Authority also addressed levels of freight generation within the LMA, and a traffic demand analysis.

2.1.2 Freight Generators

Major truck freight generators within LMA are primarily the Lagos Ports Complex (LPC) (also referred to as Apapa Ports Complex) and Tin Can Island Port Complex (TCI), facilities composing the Lagos ports. These include all major oil jetties, Kirikiri Lighter terminals (KL1 & 2) and Lilypond container depot. Truck movements therefore eventually either emanate from or converge to these facilities. The corridor analysis below illustrates these patterns.

Container traffic is a major segment of truck traffic at these facilities. Provisional traffic figures released by NPA[16] indicate that both ports accounted for nearly 87% of the Nigerian container trade in the first and second quarter of 2017. These provisional figures are in line with the estimated forecasts for 2018 daily container traffic carried out by CPCS for NPA.

Figure 2-1. Totals derived from 2017 quarterly traffic figures publicly released by the NPA



Source: CPCS analysis of NPA data

[13] ALG. Europraxis., 2014. Consultancy Services for the Extension of the STMP and STDM to Cover Mega City Region.

[14] Cambridge Systematics Inc., 2016. Lagos Region Freight Demand Study: Final Study Report. Prepared for the Lagos Metropolitan Area Transport Authority (LAMATA).

[15] Federal Ministry of Transportation (NGA), Axle Load Study and Review and Update of Design Standards for Federal Roads, Nigeria. November, 2008.

[16] Nigerian Port Authority, 2018. Ports Statistics; Container Traffic (TEUs). www.nigerianports.gov.ng/ports-statistics/.

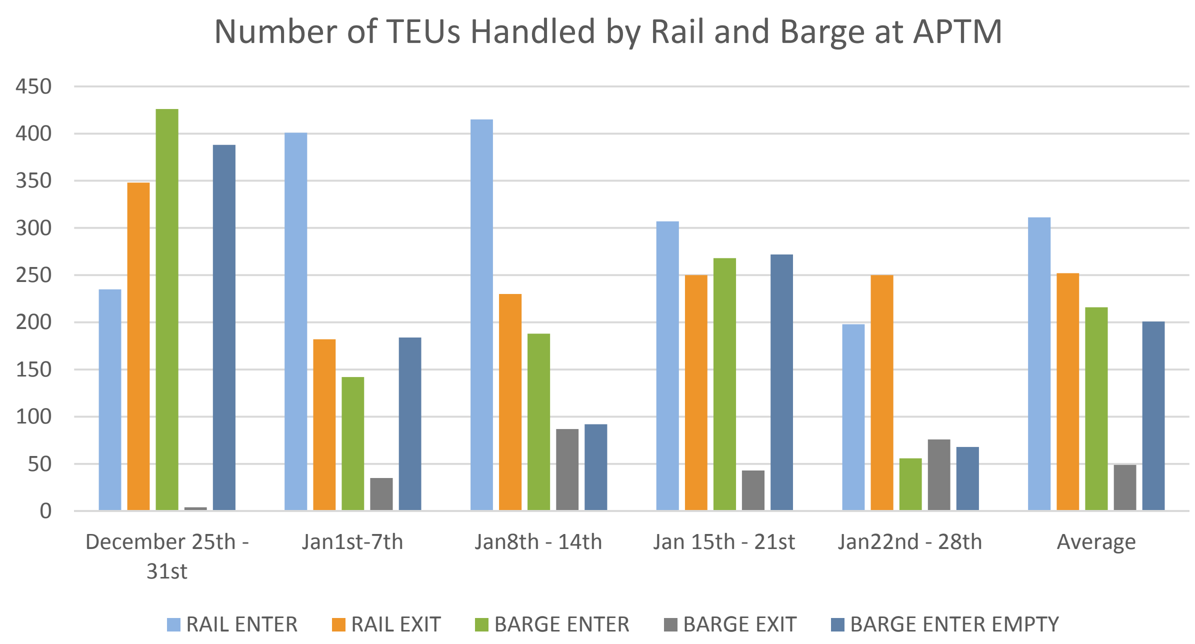
Lilypond Inland Container Depot is the oldest functioning container depot in Nigeria, originally operated by MCIS. Pre-2006, it was a holding-bay that had the capacity to accommodate nearly 7,000 trucks. At present, it is primarily used to service containers that should have arrived at Apapa, but have arrived at Tin Can Island instead, where they have been refused customs clearance. These are therefore moved at night under escort to Lilypond, where they are within the Apapa customs clearing zone and are released back to Apapa for customs clearance. This movement takes on average 3-4 hours per trip. In addition, a shipping fee of NGN27,075 (approximately US$75, 2018) is charged for the transfer of each empty container from Lilypond to APMT at LPC. Apart from the logistics inefficiency, it is not a very effective use of Lilypond as a facility. Lilypond was for a period of time envisioned as a method of decongesting the port areas by re-purposing it as an overflow container depot. Unfortunately, declining throughput had the operator withdraw from its lease. In 2013, less than 800 containers were handled by the terminal.

Intermediate freight generators include a number of transshipment facilities and smaller warehouses, processing facilities and other types of shippers and receivers that are distributed in the LMA.

2.1.3 Modal Interfaces

For aggregate handling of freight in the LMA, ports and terminals listed above account for 46% of the total tonnage handled while 54% is associated with trucks and less than 1% is associated to rail and air cargo. Both rail and air interfaces have seen extremely low use. Weekly operational summaries from December 25th, 2017 to January 28th, 2018 from NPA report the following total number of TEUs handled by each mode.

Figure 2-2. TEU Traffic Handled By Other Modes Than Trucks



The existing railway sees little use save for dry bulk companies at Apapa (e.g. Flour Mills ltd and SCC Nigeria ltd). The NPA however invested in a partial double tracking of the rail line into LPC with plans to move containers to inland container depots in the interior of Nigeria.

In the last 5 years, NPA reports that its freight railway is minimally used. In fact, APTM is the only terminal to use it.

To our knowledge, the concept of extending the existing narrow gauge railway line to the second port in Lagos, TCI, has been discussed often, but includes no systematic study. Nigeria railways are currently undergoing a multitude of studies at various stages, three of these remain closely linked with the port interface in the LMA (Figure 2-3), however the projects have not addressed as of yet how it will interface with the port itself.

A study for the Federal Ministry of Transport (FMOT) in 2009 assessed traffic that could be captured by a revitalized railway. CPCS was retained by Bureau of Public Enterprises (BPE), on behalf of the FMOT, to assist on this study. Critical steps within this study helped identify the share of freight volume that could be captured by rail and a high level estimate of the cost associated with the construction of the rail link to TICT. It is our understanding that from that point on, no other official **localized** study has been conducted on the extension of the existing narrow gauge railway line to TCI.

Overarching factors that help validate share of volumes that rail can handle

1. Rail would not be suitable for "anchor" traffic as these commodities, typically dry bulk cargo, project cargo are reprocessed, packaged within LMA warehouses, processing facilities and refineries near Lagos ports only then to be transhipped to their destination inland. The only fitting type of cargo for move by rail would be non-anchored containerized cargo.
2. The existing narrow gauge reaches LPC and not TICT, which from a current freight share perspective, is the larger of the two to move containerized cargo.

Under Nigeria's railway modernization program, it is expected that 3,500km of narrow gauge existing network will undergo rehabilitation. This includes the existing narrow gauge rail between Lagos to Kano; expected to get underway between 2018-2021. In addition, the railway modernization program is currently building or has nearly completed two separate standard gauge rail lines that could potential accommodate the LMA. (Lagos – Ibadan Double Track and Abuja – Idu – Kaduna).

Current air cargo volumes are extremely low, as per data from the National Bureau of Statistics.

We therefore assume that the main modal shift at the Lagos ports would be either from / to trucks, which then traverse the corridors described below.

Figure 2-3. Nigerian Railway Modernization Program

2.1.4 Main Transport Corridors

The map of heavy commercial traffic flows in Figure 2-4 shows that truck freight predominantly moves along two major transport corridors, namely the Lagos – Jibya axis (North-South, know as the LAKAJI corridor) and the Lagos – East axis. The former, is a 1,225km freight corridor linking Apapa and Tin Can Island ports to Nigeria's heartland, the commercial center of Kano, and the Niger border at Jibiya.

Within a regional context, both freight corridors converge on the Lagos Ibadan Expressway (E1) near Logbara and funnel truck traffic south to Ojota (illustrated in Figure 2-5). Survey estimates in the 2016 LAMATA study revealed 7,820 trucks converging daily.

Four other smaller corridors have similar shares of the daily traffic and represent 52% of the total daily traffic:

- A1 via Ikorodu (inland east-west axis) with 1,976 trucks,
- Lekki-E. Expy (coastal east-west axis) with 1,885 trucks,
- Lagos-B. Expy (coastal east-west axis) with 1,750 trucks, and;
- A5/Old Abeokuta Rd (northwest axis) with 2,977 trucks

These flows when added to the 7,820 trucks on the main E1 expressway, amounts to 16,408 trucks entering/exiting the LMA on a daily basis.

Based on a further analysis of these 5 corridors, the following inner city motorways and/or combinations of major arterials were deemed to be the major freight generators in Lagos:

- A1-Apapa Road; South of the Ijora Causeway with 5,773 trucks
- Oshodi-Oworonshoki Expressways; South of Airport Road to Lagos-B. Expressway sees varying volumes ranging from 4,188 to 5,250 trucks, while Oshodi-Oworonshoki Expy and Gbagada-Oworonshoki Expy portions range between 5,776 and 6,045 trucks
- Lagos-B. Expressway; East of the Apapa-O. Interchange towards Ojo Road and Cementery Rd with 3,037 trucks and the remainder to the A1-Apapa Road with 2,500 trucks

Within the port terminal area (5km vicinity), daily traffic estimates from the 2016 survey[14] range from 2,500 to 3,773 trucks via several route combinations. Truck traffic is captured along Apapa Road (3,773), Apapa-O. / Tin Can Island Access Rd (3,210 west of Tin Can Island and 2,978 east of Tin Can Island) and Lagos-B. Expressway (3,037 west and 2,500 east) to reach the terminal gates.

Other major arterials and expressways serve as local delivery roads, routes for bypassing the downtown core, or congested expressways. The E1 into Lagos/Victoria Island has traffic of about 2,242 trucks a day that eventually move on to the Lekki-Epe Expressway or divert for local delivery. Kirikiri, Ojo, Malu and Cementry roads are all roads used for local delivery as a way to avoid using expressways. Other major arterials and feeder roads closer to the port gates are severely congested.

Figure 2-4. Map of Avergae Daily Heavy Commercial Vehicle Traffic Projections for 2018

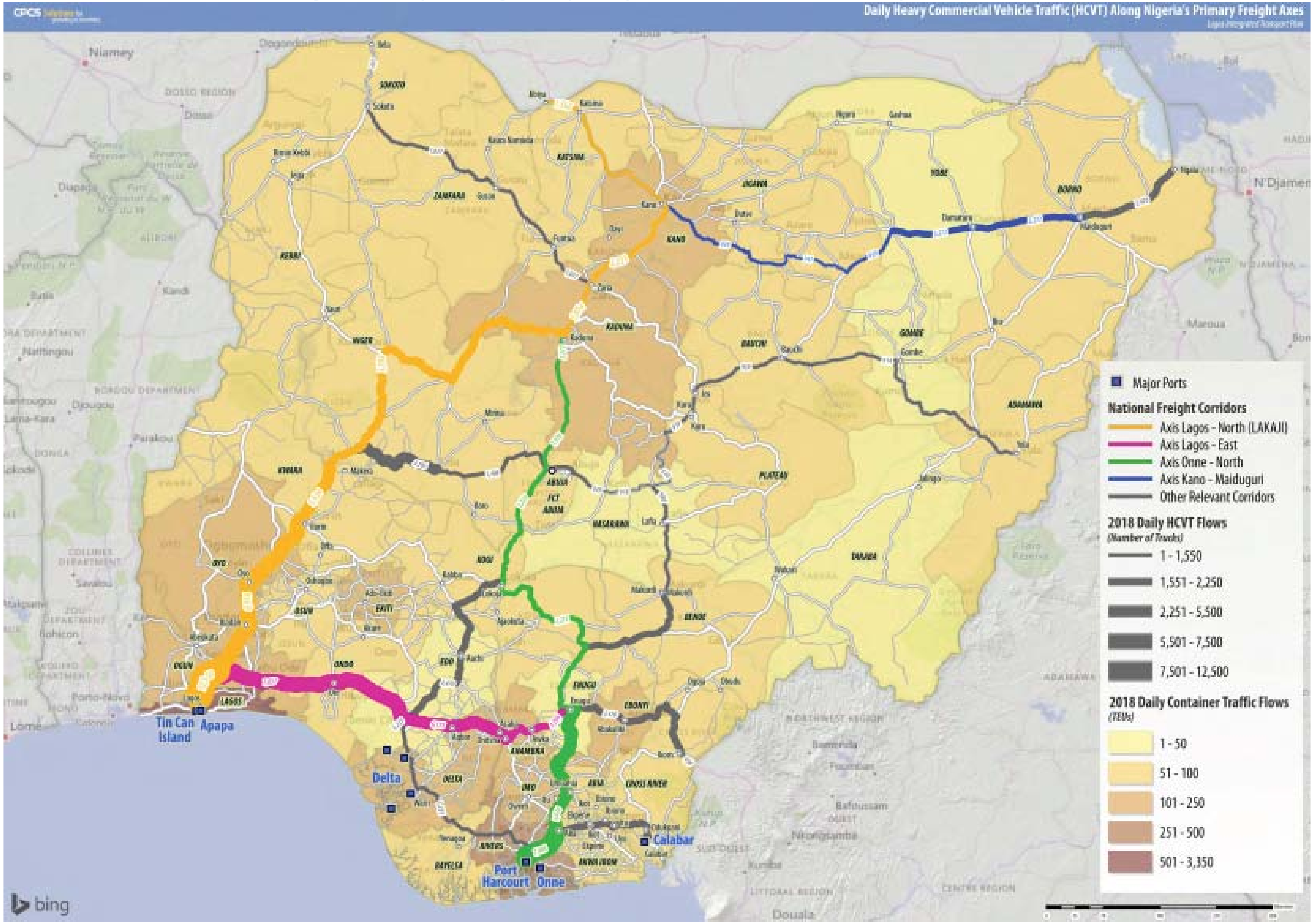


Figure 2-5. Map reflecting primary freight corridors catering to regional traffic

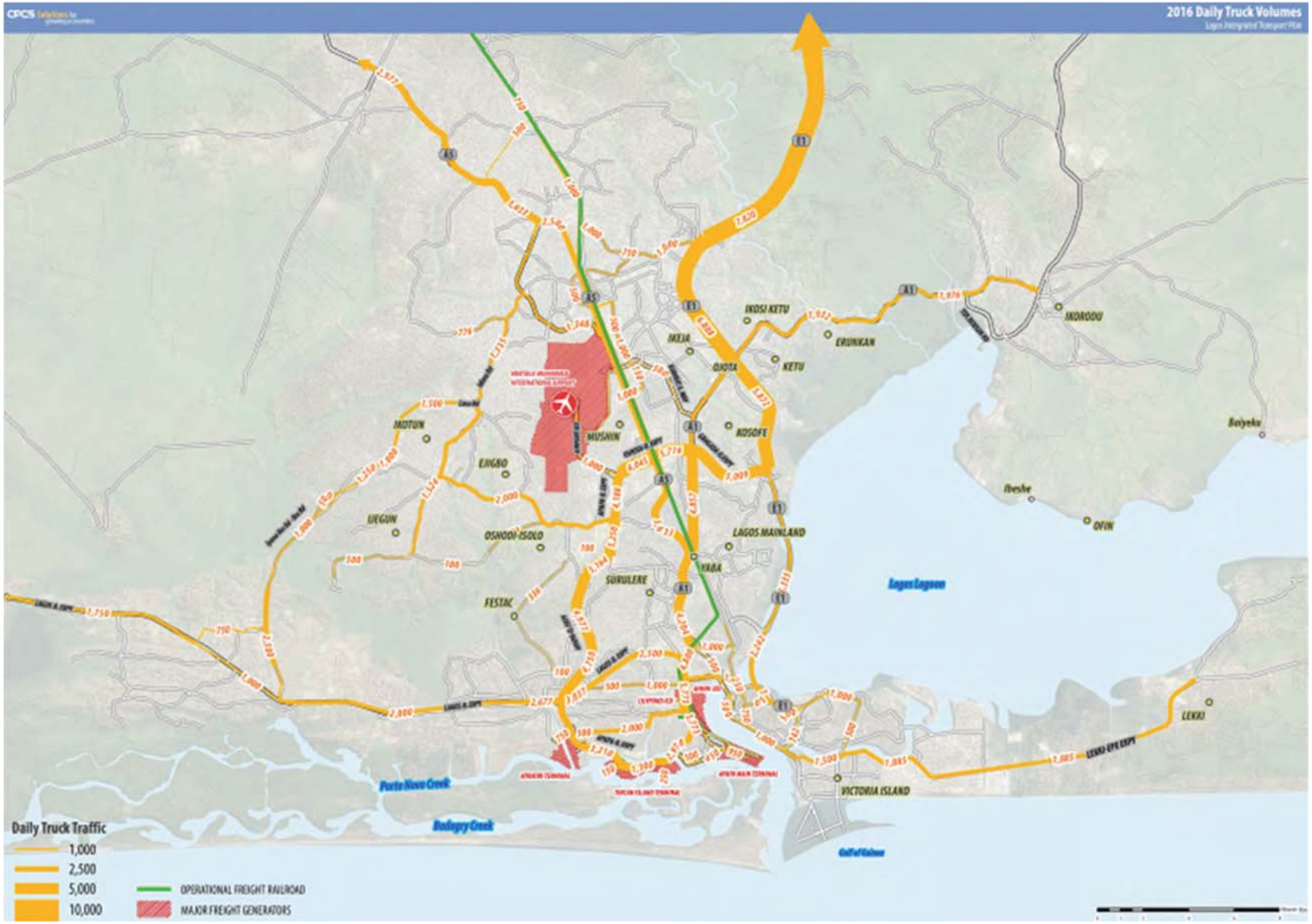


Figure 2-6. Map showing accumulation of trucks at major freight generators

2.1.5 Current Protocol for Truck Access and Parking at Port Facilities

Trucks with scheduled transactions at the port facilities undergo both formal and ad hoc procedures for port access.

Formal procedures include the necessary documents that trucks must obtain before they access terminals. The terminal issues two paper documents; (i) Authority to Load (ATL), issued to the receiver agent which is then passed on to the truck driver. Without the ATL document, the receiver/trucker will not be granted the right to retrieve a container / goods. (ii) Vehicle Entry Permit (VEP), similar to the ATL document, is a security document that allows the truck driver to gain entry to the port and access to the terminal. Truck drivers arrive at the ports with both documents, park along the road outside of the terminal gate, and present their papers, and queue in the port gate stall until the terminal operator performs a "call up" from the street. This latter process is manual and ad hoc, with port security personnel often searching queues for the truck to be called up. As the next section in the report shows, queues can often stretch for kilometers (hundreds of trucks), making this a highly inefficient process.

Additionally, many trucks that join queues are behaving opportunistically. In other words, they do not have a pre-approved transaction (or necessary papers) and are waiting for the possibility of being called up because of their proximity, or because of imminent transactions.

At present, there are no designated areas or off-dock facilities to park trucks save for the roads themselves. Oil and gas companies which have their own exclusive parking sites are the exception, although the space available is insufficient for the volume of trucks we have observed, as discussed in Section 2.2.

2.1.6 Limitations of Efforts to Manage / Influence Congestion

There have been disparate efforts over the years to manage or influence truck movements to counteract congestion. These measures include routing, restricted access in certain locations or at specific times, truck parking facilities for extended dwell times, and freight facilities such as container bays and yards. In some cases, the measures have been implemented but not fully leveraged, whereas others have received some degree of support, but are yet to be implemented. Several factors (enumerated below) have acted together to exacerbate current levels of congestion, in spite of the presence of measures.

Unenforced restrictions on routes / times

In August 2012, mounting pressure to deal with an increasing number of truck related fatalities and cargo related thefts left the Ministry of Transport to initiate Section 2 (i) (ii) of the Lagos State Road Traffic Law. The law stipulated that the movement of cargo trucks (primarily articulated vehicles and petrol tankers) was restricted. These trucks were only allowed to enter the LMA between 9 pm and 6 am. In addition, movement of heavy trucks was not permitted on the 3rd Mainland Bridge.

The law has been largely ignored and continues to be ineffective. Even so, current port operations are not 24/7 primarily due to the unreliability of grid electricity. The current situation has operators supplementing outages with their own diesel-powered generators; an expensive alternative. Furthermore, outages mean that roads are not properly lit and offer little in the means for truck operator safety.

Unsupervised Queuing Behavior

All terminal operators currently use manual call up systems, whereby trucks queue at the port terminal boundary along the major access points before the main gates. However, the queue itself is largely unenforced and often consist of trucks that are vying with each other for business instead of legitimately requiring access to the port itself.

Inability to manage "empties"

Port terminal operators have expressed a lack of space to store empty containers and are refusing to accept returns of empty containers, thereby causing trucks carrying empties to join the terminal queues. Terminal operator handling bay protocols and current capacity constraints relating to the handling of empty containers have led the NPA to release an executive order requiring trucking companies to return empties at temporary off-dock holding bays that are designated in conjunction with the shipping companies themselves. At present, nine holding bays have been selected and will manage the return of empties. The nine holding bays are capable of storing 14,835 TEUs in total. This new directive should help alleviate some congestion at the ports.

Pipeline closures

Pipelines to transport refined petroleum products exist, but closures of these pipelines occur regularly in Lagos. The supply of refined petroleum products outside Lagos state is largely dependent on the trucks. All inland clients must regularly hire tanker trucks. As a result, major tank farms have unusually long queues. In addition, stakeholder consultation revealed that tanker trucks are heavily regulated and clearance of these trucks at tank farms is a time consuming process compared to clearance of general cargo, containerized merchandise, or dry and liquid bulk.

Oversize / Overweight Loads

The current carrying (weight) capacity of roads in the area is regularly exceeded. Typically, roads in Lagos are designed to carry no more than 30 tonnes per axle, though vehicles often overload, based on consultations and observation. The lack of investment in road rehabilitation compounds the issue. As a result, port access roads are in a state of disrepair and significantly contribute towards increased congestion.

2.1.7 Role of a Dedicated Truck Parking and Port Access Facility (TPPAF)

In response to the persistent congestion challenges, one promising idea is the creation of truck parks at carefully selected locations that can enable streamlined access to the ports, thereby reducing congestion. The truck park concept also envisions that some Information & Communication Technology (ICT) features could be leveraged to achieve real-time operational efficiency in truck movements. In other words, knowledge of trucks' precise locations, connected with transaction and process information in a variety of databases would assist port operators, drivers, and fleet managers to optimize truck movements. For this type of solution to be appropriate, we need to evaluate both the extent of congestion (Section 2.2) and also the feasibility of implementing ICT-related features (Section 5) to enable parking and related operations.

At the same time, congestion is not the only operational issue that could potentially benefit from increasing use of ICT. Streamlining port area operations from a security, customs, and transactions perspective (e.g. “single window” arrangements) could also rely on ICT. In these cases, existing approaches to managing operations (primarily manual transactions) and the current decentralized operations decision-making could benefit from re-evaluation.

Another specific issue is the management and hand-off or storage of “empties”, as trucks carrying back these empty containers may exacerbate queue lengths and congestion. Further, some trucks in port-area queues may be scouting for business. Some have proposed an ICT-based call up service to restrict movements to those with appointments / calls and minimize or re-schedule any non-essential truck movements. Integrating these functions into the truck park concept may thus mitigate congestion as well as help streamline operations.

2.1.8 Perspectives on interventions

Our diagnostic review and stakeholder consultations suggest that a piecemeal approach to addressing truck movements (including parking) and related port operations have not worked, and are not likely to work in future. What is needed is coordination between all relevant parties across the freight supply chain so that solutions in one part of the chain can lead to benefits to all participants. ICT can potentially assist with this coordination.

Holding Bay / Empties Policy: The policy of requiring trucks to drop off empty containers outside the ports at holding bays until they have an appointment to bring one in, or until the terminal can receive them, is likely increase the total number of truck movements and add to queues, not reduce them. When an importer drops off an empty container, they might pick up a full one. Disallowing such a naturally coordinated multi-transaction movement will lead to separate truck trips for dropping off an empty in a bay, bringing the empty back into port when necessary, as well as making additional trips to pick up and drop off full containers.

It is also very likely that Nigerian importers and exporters will absorb the costs of the additional movements at about NGN 100,000 per container, as they typically contract the trucks for these moves. If the shipping lines are required to manage these movements, it is most likely that they will pass these costs on to their contracting parties. A better way to think about the problem is to focus on transaction visibility, so that the importers, exporters and fleets can have a more coordinated and efficient internal market for these movements, creating stronger incentives to reduce trucking time, costs and trips required.

Another important aspect of this issue is the total available holding capacity, whether at the terminals or in holding bays. Bays/parking locations for trucks waiting to drop off containers would have to be large enough to accommodate the volume of containers needed to be held there.

The location of these facilities also presents another issue. Locating them near the ports (subject to space constraints) is unlikely to reduce congestion in the vicinity, but will however keep the congestion localized. On the other hand, bays at other locations in the LMA may reduce port area congestion, but the travel time reliability of movements to and from the ports will become a significant factor, likely increasing the cost of movements.

Palletization Policy: As part of a recent Executive Order, the Federal Government of Nigeria mandated that most/all goods imported into the country via containers must be palletized to enable quick customs clearance.

The current policy of requiring palletization for containerized goods can potentially increase the number and types of containers required for the same volume of goods, resulting in additional truck trips. For example, the same volume of product previously shipped in a 40 foot container may now have to be palletized and distributed into a 40 foot and a 20 foot container. Moving these two containers for the same volume of products is a significant trade-off vis-a-vis any benefits from palletization. There would also be additional costs including cost of pallets, additional investments in forklifts, supplier charges to palletize cargo; all of which will be passed on through the supply chain.

Road Quality and Reliability of Access: The quality of supporting road infrastructure and the impacts that poor roads have on travel time reliability cannot be separated from considerations of where to locate truck parking/holding bay sites.

It is likely that a significant number of trucks would be taken off the road, if road quality and travel time reliability were to improve. A smaller fleet of trucks would be able to do the same number of movements within the same time. For any ICT-enabled system or call up system to succeed, it would require reliable travel times and good road conditions.

Improving road quality will also reduce wear and tear on trucks. This in turn also reduces the likelihood of breakdowns, accidents, and other externalities that exacerbate the impacts of congestion. Stable operations on higher quality roads also reduces their emissions due to fewer starts/stops, less idling, and stable driving speeds. Currently truck owners do not have an incentive to invest in new, lower emissions fleets only to have them quickly deteriorate on poor roads.

Integrated multi-purpose infrastructure: The parking and supporting infrastructure would be better utilized if it can accommodate different types of vehicles, e.g. containers, articulates, and tankers. Currently the 62 tank farms at Apapa each service up to 200 trucks per day with little to no parking facilities. However, it is likely that the design, compliance requirements and access/egress arrangements will need to be tailored to the regulated end of the spectrum, i.e. tanker trucks (unless they have dedicated tanker parks).

2.2 Truck Congestion Analysis

The primary reason for observing truck-related delays and congestion in the Lagos Metropolitan Area is due to articulated vehicles and tanker trucks queueing on roads in order to access the city's port facilities and major freight generators. These queues are a symptom of a more fundamental issue – lack of coordination in truck movements during dray operations -- and not the cause.

LMA stakeholders do not precisely know the extent of queues, and this knowledge is a pre-requisite for informing a potential solution. This section of the report therefore analyzes previously published data, our own primary surveys, and novel data such as satellite imagery to determine the extent and implications of truck queues.

2.2.1 Methodology

Areas with significant congestion are in clusters, and are each associated with an identifiable freight generator. We analyzed levels of congestion using this clustering logic.

2.2.2 Data

Our analysis is based on the daily truck counts generated by the port terminals themselves along with a photo interpretation of the composition of the truck queues at each terminal, their preferred access routes and the overall condition of the highway. Maps and pictures have been used to support and validate the congestion analysis. This information was reinforced with field data collection from surveys undertaken specifically for determining queue composition and attributes.

Observations from satellite and aerial photos for this section were supplied by Google Earth through the third party data provider Digital Globe[17]. In addition, the newly published Google Streetview imagery of Lagos also proved useful. All photos used to measure and quantify the truck queues were taken between 2016 and 2018.

Although observations from satellite photos are static in nature and do not offer a precise index or measurement of daily/hourly truck queue lengths, the images are representative of the typical congestion witnessed near port gates. Observations based on the typical queue lengths were performed utilizing the following imagery of Lagos taken on the calendar days shown alongside.

20th February 2017 (Monday)
20th May 2016 (Friday)
10th May 2016 (Tuesday)
7th April 2016 (Thursday)
6th March 2016 (Sunday)
10th February 2016 (Wednesday)
24th January 2016 (Sunday)
22nd January 2016 (Friday)

The images provide us with fairly reasonable estimates of daytime weekly congestion near terminal gates. Two of the images were for Sundays, and were not expected to show significant congestion.

2.2.3 Metrics

The typical length and depth of the truck queues taken from each photo will help measure the reduction in roadway capacity. This is achieved by using a typical roadway capacity table. The road classification scheme associates typical Hourly Service Volumes (HSV) based on road class, number of lanes, grade (slope) and quality of the tarmac. More precisely, the HSV rating dictates how many vehicles the road can accommodate within an hour at level of service 'C'. Level of service 'C' meaning the vehicles are unimpeded and cumulatively have not exceeded 70% of the roads total capacity.

In addition to roadway capacity deterioration, we also assess the quality of infrastructure to the extent possible from satellite and fixed view imagery.

2.3 Results -- Truck Queues

2.3.1 Apapa Terminal Gate (Wharf Road)

As discussed in the above section and the observed distribution of truck queues, it appears that the majority of the incoming trucks are trying to access the gate via southbound Apapa Rd and eastbound Creek Rd. However, nearly all photos reveal trucks queuing on Warehouse, Aerodrome, Burma and Commercial Rds. There are several explanations for this.

[17] Google Earth, Time Series Satellite Photos of Lagos Metropolitan Area, 2016 to January 2018.

- Truck drivers are trying to bypass the main queues on Apapa and Creek Rd.
- Southbound Apapa Rd is so congested the truck queue extends into the Apapa/Aerodrome Rd roundabout and truck drivers are required to queue in the area's minor arterial roads.
- Creek road oil and gas jetties are responsible for generating a large tanker truck queue from Creek Rd Bridge all the way past the refineries, effectively reducing the amount of available space for trucks trying to enter Apapa.

Figure 2-7. Construction on Apapa-O. Expy / Creek Rd

The condition of the highway surface can be described as fair, although light rutting of the road is observed in the northbound Apapa Rd directly after exiting the port terminal gate, and also has fairly severe pot holes and water hazards after the Aerodrome roundabout. Google streetview photos from December 2016 reveal extensive road rehabilitation projects have been undertaken on the eastbound Creek Rd directly in front of the oil and gas jetties (refer to Figure 2-7. Construction on Apapa-O. Expy / Creek Rd).

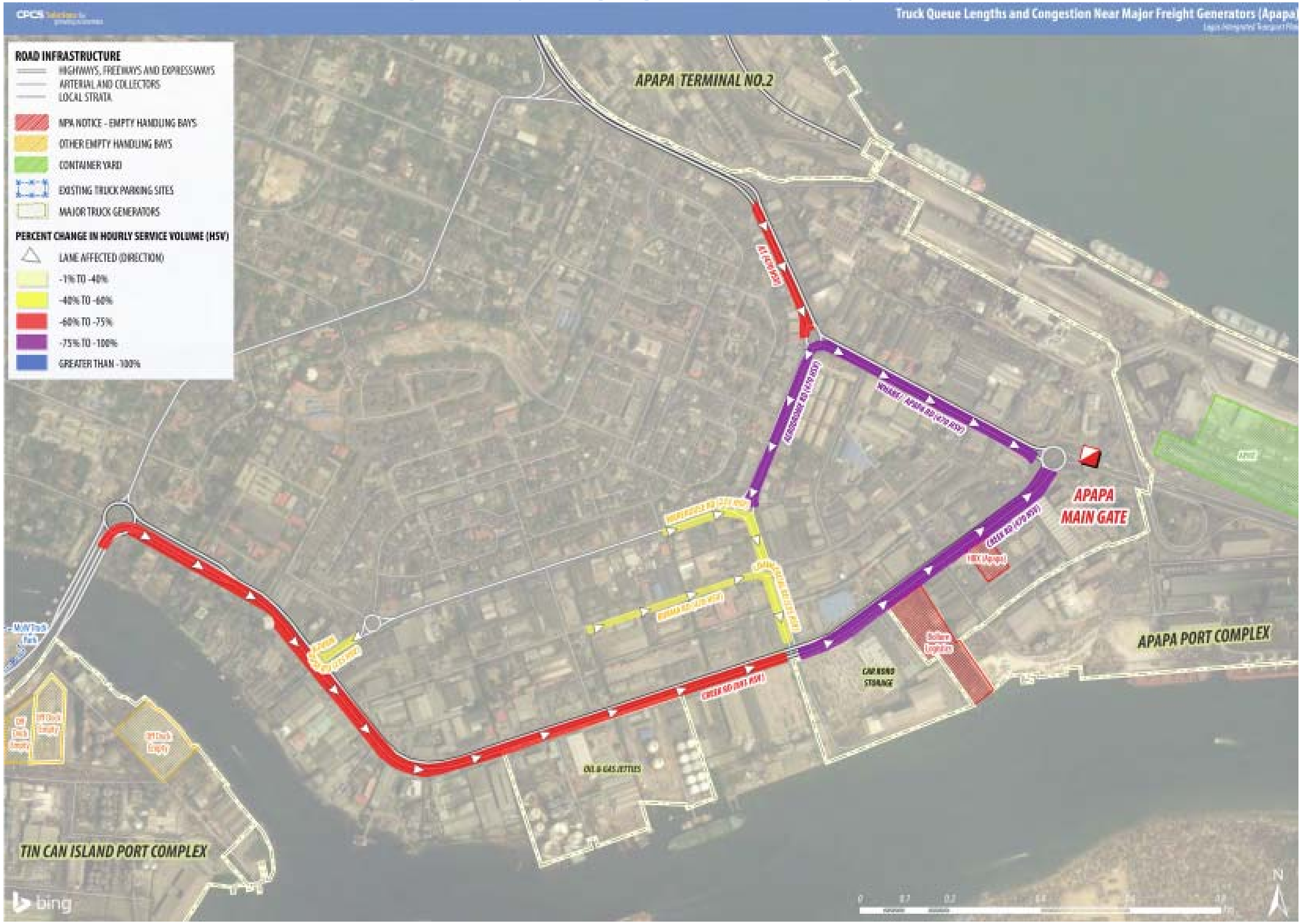
Figure 2-8. Truck queues in front of Apapa Port Complex Main Gate

Our observations from satellite photos revealed that truck queues occupy a total of 4.5km of roads near Apapa main gate (Refer to Figure 2-8. Truck queues in front of Apapa Port Complex Main Gate). We estimate that 476 trucks consistently occupy these roads on a weekly basis. The number of observed trucks was estimated based on the number of truck stalls (i.e. truck lanes) occupying each identified queue.

This has resulted in a significant decrease in the total capacity and total hourly throughput for each of these roads. Creek Rd, Apapa Rd and Aerodrome Rd all experience a 75% to 90% reduction in hourly service volume. These roads are all 4 lane major arterials (Creek Rd is technically a 4 lane urban expressway) and should exhibit, under normal circumstances, an hourly service volume of 5,000 vehicles (2,500 in both directions). Unfortunately, the poor state of the tarmac and the truck queues significantly reduces these volumes.

Figure 2-9 shows congestion on route to Apapa Port.

Figure 2-9. Map showing congestion on route to Apapa Port



Tin Can Island Terminal Gate 1, 2, Port & Terminals ltd Gate

Figure 2-10. State of Apapa-O Expy on Tin Can Island

Tin Can island is accessed via the Apapa Oworonshoki Expressway, which has two bridges and remains the single access road to enter the jurisdiction of the port administration zone. The 4-6 lane expressway is usually occupied with trucks.

Land north of the expressway to the shoreline is designated as an informal truck parking area. The Federal Ministry of Power, Works, and Housing is currently constructing a formal truck park in the east of the island[18].

The port terminal access road is reached via two separate gates with the exception of Ports and Cargo Handling ltd, which has its own separate gate. The expressway is severely congested due to truck traffic and is in a complete state of disrepair (Refer to Figure 2-10. State of Apapa-O Expy on Tin Can Island). In both directions the expressway is relegated to a single lane, much of which is flooded or where the tarmac is completely eroded.

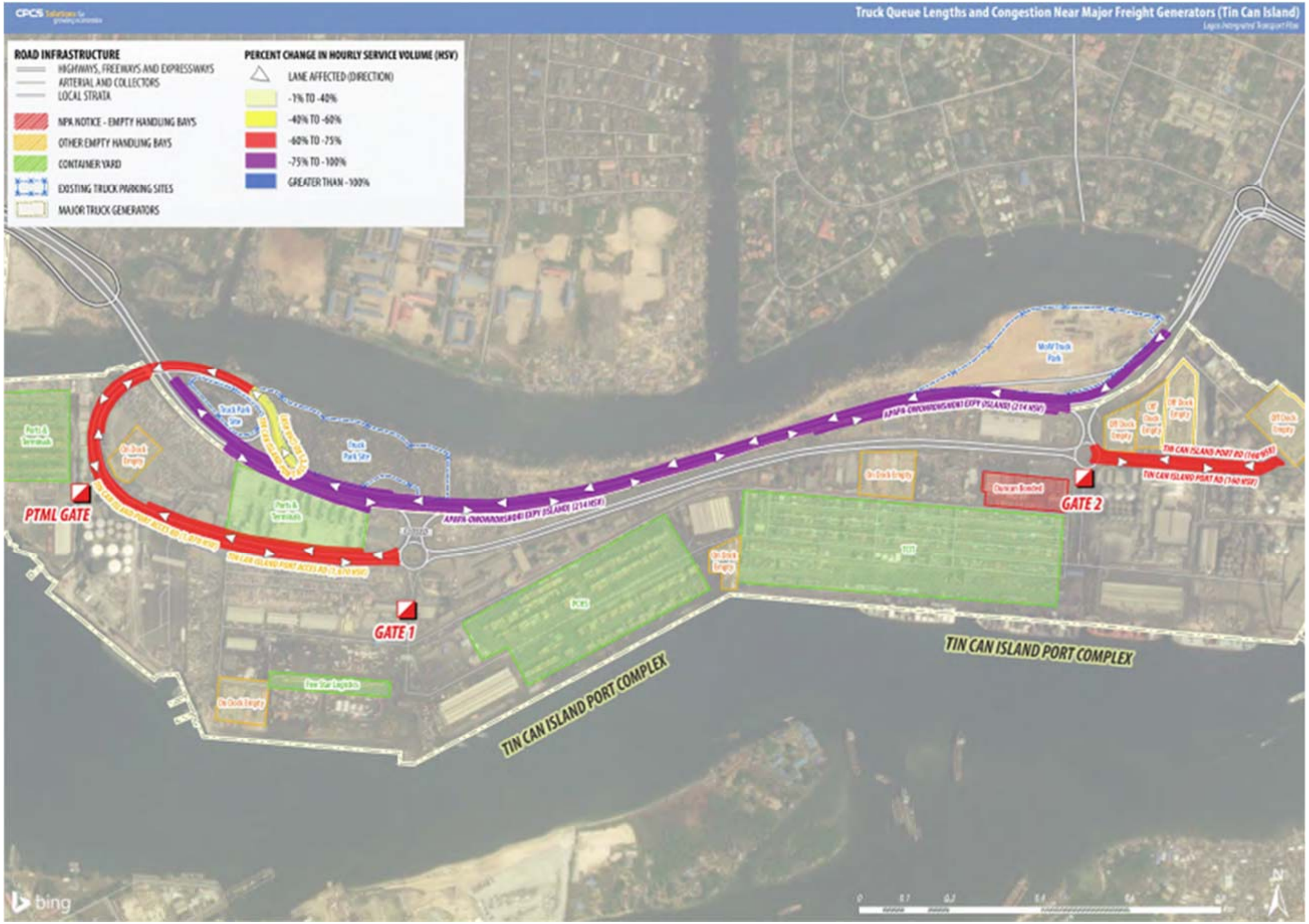
Trucks travelling westbound from the bridge attempting to access ‘Gate 2’ must circumvent the entire island since the east-side roundabout can only be accessed via the eastbound Apapa-Oworonshoki Expressway. The west-side roundabout onto Apapa-O. Expressway is gated and not open to truck traffic. Trucks are required to use the island’s off-ramp west of the roundabout into Terminal Access Road. Within the port terminal access road (between both roundabouts), there were no observed trucks parked in either direction but we noted a high level of slow moving truck traffic throughout (based on satellite photos). Apart from the expressway the only other location which experience heavy queuing is on the stretch of the off/on ramps from the expressway to terminal access road.

Nearly 8km of roads on the island are used for informal truck queues, which represents nearly 70% of the total road length. At a time we estimate that nearly 600 trucks are parked on these roads. Further, we estimate that the informal truck park sites hold roughly 1,200 trucks. The 4-6 lane expressway should effectively handle 7,000 vehicles per hour, but as per hour estimates the parking of trucks has reduced this to just over 200 vehicles per hour.

Figure 2-11 shows congestion on route to Tin Can Island.

[18] Based on secondary information, an estimated 400-500 trucks and was speculatedis to be complete by 2018. However, Tthe project may be halted until the completion of shoreline protection carried out by Honeywell Group under Corporate Social Responsibility (CSR). The ministry of works has suggested that the project is near completion (98%). Meanwhile, NPA has urged the MoW to hand over the project to them.

Figure 2-11. Map showing congestion on route to Tin Can Island



Kirikiri Lighter Terminal Gates 1 and 2 (KLTI, KLTII) and Ibafon Jetties

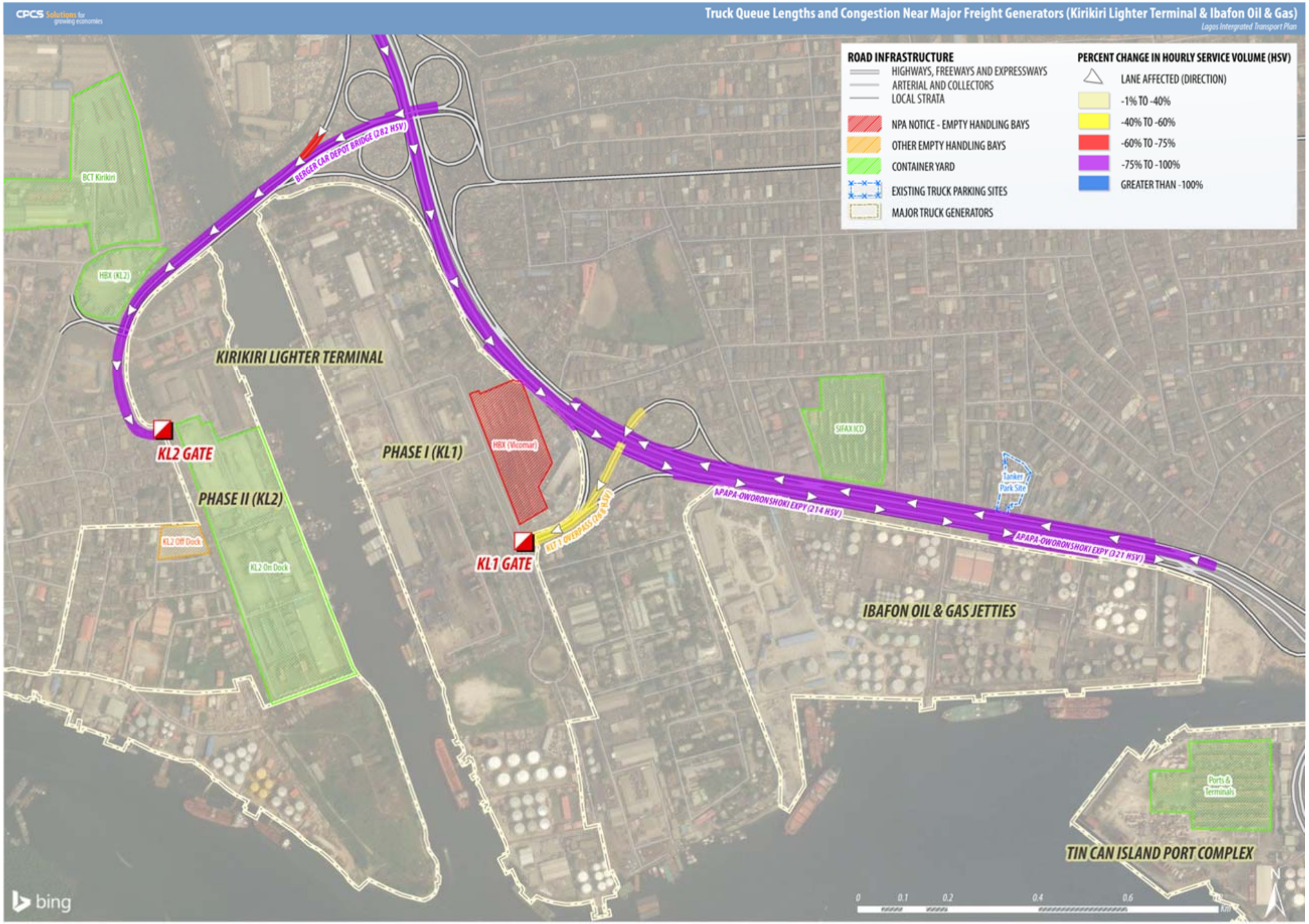
Figure 2-12. Truck queues observed on both sides of the expressway at Ibafon

All trucks within this area are tanker trucks. A significant proportion of these trucks are those serving the nearby oil and gas jetties, rather than from the Kirikiri Lighter Terminal gates themselves. Truck queues are observed from the Apapa Oworonshoki and Lagos-Badagry interchange and continue south on the expressway past the Ibafon oil & gas jetties. The queue is primarily made up of tanker trucks and occupies all but one of the southbound lanes towards Ibafon. The southbound lanes are so congested that the KLTI southbound access ramp is completely blocked and the westbound lanes on Apapa Oworonshoki Expressway along Ibafon are also occupied (Refer to Figure 2-12. Truck queues observed on both sides of the expressway at Ibafon). Stakeholder consultation confirms this. It implies that KLTI can only be accessed via westbound overpass, and KLTII can be accessed only through the Berger Car Depot Bridge (Refer to Figure 2-13. Block southbound off-ramp to KL1 terminal).

Figure 2-13. Block southbound off-ramp to KL1 terminal

5.5 km of truck queues have been observed on the Apapa Oworonshoki Expressway and Berger Car Depot Bridge. Our findings suggest that these truck queues include 568 trucks. The congestion is so excessive and the condition of the tarmac so poor that the Apapa O. Expressway hourly service volume is reduced to 214 vehicles per hour eastbound and 314 vehicles westbound, as illustrated in Figure 2-14. A typical 6-lane expressway would normally handle around 7,000 vehicles per hour (or 3,500 vehicles in each direction).

Figure 2-14. Map showing congestion on route to Apapa Terminal No. 2 Oil & Gas



2.3.2 Wider impacts of congestion

At the diagnostic stage, our assessment has focused on overall truck volumes and the resulting congestion in the relevant areas around the port, typical route patterns and truck behavior during access and egress to the port, queueing behavior and lengths, parking availability, and observed parking behavior. The negative impacts of trucks parking on the road include a loss of efficiency of port operations, worsening road conditions, and the adverse effect on the lives of the truck drivers themselves.

The wider or indirect impacts are ambient pollution levels, poor air quality, environmental concentrations of harmful particulates, cascading congestion onto other connecting segments in the road network, and truck-related accidents. These negative externalities lead to a decreased economic, environmental and social quality of life in the LMA. While we have not studied / quantified the wider externalities, the implications of doing nothing to address truck parking and its effect on port operations are that conditions are likely to deteriorate further due to growth and economic activity, making the situation worse.

2.4 Current ICT Capacity

Terminal B of the Tin Can Island Port Complex, concessioned under the name Tin Can Island Container Terminal (TICT), handles about 32% of the total TEUs through the Lagos ports and 53% of the total TEUs through Tin Can Island Port Complex alone. Between 2011 and 2016, throughput at TICT remained fairly stable showing a compound annual growth rate (CAGR) of 4.25%, from approximately 376,089 TEUs to 482,793 TEUs. One important contributing factor to this improvement in throughput is the use of ICT – in particular the OSCAR Terminal Operating System.

The TOS is intended to be a comprehensive system for port management and operations. For reference, a schematic of the TICT facility is shown below in Figure 2-15. The OSCAR TOS has the following standard ICT-enabled capabilities[19] that affect truck and container movements:

- **Truckers Appointment Module:** This capability is designed to optimize container traffic movements by sharing an appointments timetable with truckers for the receipt and delivery of containers. Truckers can access a calendar view indicating which time slots are available for their pickups and deliveries. They can specify cargo and containers to be delivered or received. Terminal operators also have access to the appointments summary table and to additional information about containers delivered (ISO codes, safety notes, reefer, oversize/overweight, etc.) The appointments are automatically archived and all data is secured and available in real time for users.
- **Yard Planning and Container Allocation:** This module allows for containers allocations in different parts of the container yard. Many parameters can be assessed while deciding where to place a container. The algorithm recommends positions for containers based on the parameters and attributes of the container. The system can also automatically assign

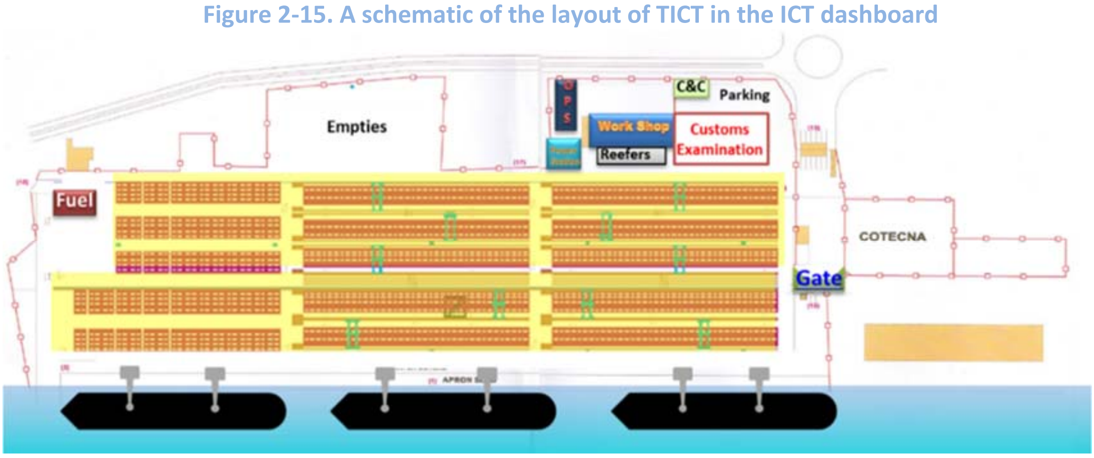
[19] Source data for technical capabilities: OSCAR TOS specifications from TMI Software

gear / machinery to a movement, based on the most current available information about terminal and yard operating conditions, to minimize movements at the terminal.

- **Dashboards:** The decision-maker portals and dashboard capabilities allow for the display of performance measures, path-following and movements where location-based data are available, and other control functions and events. There are also specific functions and triggers available in the event of disruptions.
- **Embedded Communications:** The TOS relies on either WiFi or a narrowband radio communication system. Various devices that have the requisite screens and indicators can display relevant information (for ex. gantries, riders, RTG, Reach Stackers, etc.) in real time.
- **Electronic Data Interchange:** The OSCAR system can enable access across multiple relational databases for stakeholder information sharing and "Single window" type operations between operators, port networks, customs, etc. Data formats can be standardized.

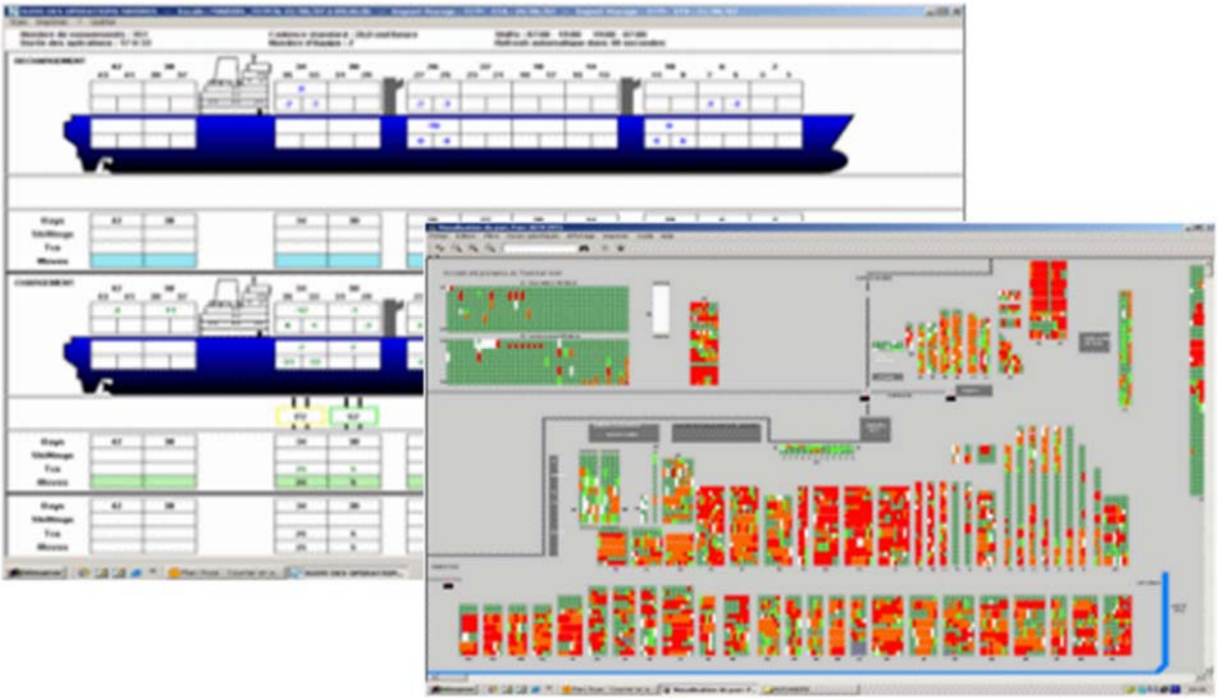
While these capabilities are available to TICT through the OSCAR TOS, it is unclear whether or how TICT actually uses these. Additional consultations suggested that TICT does not currently use the full extent the available ICT capabilities that are in place.

Figure 2-15. A schematic of the layout of TICT in the ICT dashboard



Source: TICT

Figure 2-16. Dashboards enabled by the OSCAR TOS



Source: TICT

3 Traffic Analysis and Projections

Key Messages

Basis

Truck traffic projections are based on the analysis of macro-economic factors such as GDP growth, population growth; and factors affecting trade volumes. These provide the growth rates for current truck traffic observations to be extrapolated into the future.

To develop a current baseline for the projections, CPCS undertook a survey in March 2018 of trucks parked on the roads around the ports of Apapa and Tin Can Island. Survey results indicate that there are on average around 6,000 trucks parked on the sides of the roads adjacent to the two ports on a daily basis. NPA consultations confirmed these numbers with the caveat that occasionally the numbers can shoot up to 10,000 trucks per day and that only 1 in 5 trucks interface with the ports daily. They are equally split between container and non-container trucks. However, our survey also revealed that for both ports, of the total container trucks, more than a third of trucks were carrying empty containers.

Methodology

The total number of trucks on the road will be determined by the following key factors: the volume of freight arriving and leaving (i.e. imports and exports) the port; the number of empty containers leaving the port; the time taken at the port to process a container and other imports through customs, security and other formalities; and the condition of the roads leading to the ports, which will determine the speed at which trucks can move on the road. The model considers these factors and adjusts truck traffic growth rates accordingly.

Projections

The traffic projections indicate that the total trucks on the road will increase from the current level of 6,000 trucks per day, to over 11,000 per day in 20 years under the baseline scenario. However, truck traffic could grow to as little as 7,700 trucks in the 'low' scenario to as many as 20,000 trucks in the 'high' scenario.

3.1 Macroeconomic and Historical Demand Analysis

3.1.1 Macroeconomic factors

The number of trucks on the roads will primarily be driven by volumes of freight (both container and bulk) at the Apapa and Tin Can Island Ports. Forecasts of freight volumes utilized as inputs the analysis completed by CPCS for the NPA in 2014. The forecasts were based on the following macro-economic factors:

- GDP growth;
- Population growth; and
- Factors affecting trade volumes.

3.1.2 Published data

Very limited published data is available on the number of trucks on the roads around the Apapa and Tin Can Island ports. Figure 3-1 lists the two sources from which such data is available.

Figure 3-1. Truck Count Data

Source	Truck Counts (Daily)	Comment
Cambridge Systematics Inc., 2016. Lagos Region Freight Demand Study: Final Study Report. LAMATA.	16,400	On the high side as it includes all trucks, including small vehicles
CPCS estimates based on historic NPA freight volumes	5,000	Probably on the low side
CPCS Independent Survey (this project)	6,000	Often spikes to 10,000 trucks per day depending on operations

Estimates of the number of trucks on the road vary, and hence there was a need for a comprehensive survey to be undertaken.

3.1.3 Survey data

CPCS undertook a survey of trucks parked on the roads around the ports of Apapa and Tin Can Island. The surveys were undertaken on a single weekday (Monday) in March 2018. It included both truck counts and interviews with drivers (1,388 interviews were conducted). The following were the key observations made by the survey team:

- Roads around both ports were congested, with trucks at a standstill for a stretch of between 12 and 13 km on all the routes including the bridges;
- In some sections of the routes, the trucks formed two lanes in the same direction;
- Some drivers spend weeks in the queue, living in very unhygienic conditions;
- Movement of other vehicles on the roads have been greatly impeded by the queues of trucks which has reduced the width of the road available for through traffic; and
- The ongoing reconstruction of the Apapa port road has added to the traffic chaos in the area.

The survey estimates of trucks parked on the roads are given in Figure 3-2.

Figure 3-2. CPCS Daily Truck Count Results

Port	Container	Non-Container	Total
Apapa	1,199	2,027	3,226
Tin Can Island	1888	910	2,798
Total	**3,087**	**2,937**	**6,024**

The CPCS survey results indicate that there are around 6,000 trucks parked on the sides of the roads adjacent to the two ports on a daily basis. Our NPA consultations confirmed these numbers with the caveat that occasionally the numbers can shoot up to 10,000 trucks per day and that only 1 in 5 trucks interface with the ports daily. They are equally split between container and non-container trucks. However, our survey also revealed that for both ports, of the total container trucks, more than a third of trucks were carrying empty containers. Further, field collections revealed that the average dwell time for trucks in the queue is 4-6 days.

3.2 Traffic Projections

The total number of trucks on the road will be determined by the following key factors:

- The volume of freight arriving and leaving (i.e. imports and exports) the port;
- The number of empty containers leaving the port;
- The time taken at the port to process a container and other imports through customs, security and other formalities; and
- The condition of the roads leading to the ports, which will determine the speed at which trucks can move on the road.

In Lagos, the main problem is that of trucks return to the port without a specific purpose or with empty containers, and hope to secure business once they are at the port.

According to the Lagos Region Freight Demand Study[20], a total of 7,085 trucks are generated by the two Lagos ports each day (3,391 from Apapa and 3,694 from Tin Can Island). This is in addition to the 6,000 trucks parked outside waiting to enter the ports.

The modelling methodology is a three steps process. First, we develop estimates of freight growth at each port. Second, we develop the key assumptions relating freight and truck count growth. Finally, we apply this growth to our estimate for the base year to obtain a projection of trucks for the project. Each of these steps is detailed below.

3.2.1 Freight forecast

To estimate the growth of freight at each port, CPCS relied on a detailed traffic report it produced for NPA. In that report, CPCS used demand oriented traffic projections. Historical consigned terminal throughputs (freight originating and destined at each individual terminal)

[20] Lagos Region Freight Demand Study, Final Study Report, April 2016, Cambridge Systematics Inc., for LAMATA

were derived from NPA LPC annual report totals. The reports which are generated by the NPA can be partially retrieved from their website[21] and provide a monthly breakdowns of containerized and non-containerized volumes handled at the ports.

NPA LPC reports include statistics on the following:

- Ship Traffic and Vessel Calling Information
- Cargo Traffic in Metric Tons by Trade Types (General Cargo, Dry Bulk, Liquid Bulk)
- Container Traffic in TEUs and Units (Laden, Empty)
- Import, Export Cargo Totals in Metric Tons by Trade Types from 2007 to 2014
- Import, Export Containerized Totals in TEUs and Units (Laden, Empty) from 2007 to 2016

Our three forecasts (Base, High and Low) were developed by projecting each individual port volume by trade type (containerized and non-containerized cargo types) based on World and Nigerian changes in GDP. Most GDP statistics are attainable through the UN National Accounts Main Aggregates Database and provide nearly 50 years of national economic statistics[22] and can be easily forecasted in R programming statistical software package or simply within excel by calculating the intercept and slope of the GDP values through the periods that are driving the forecast.

In this case, the equation for the forecast is:

Intercept of the demand *(entire period tested)* **+ (Slope** of the demand *(entire period tested)* ***** the **Number of total periods)** being tested *(in this case years)*.

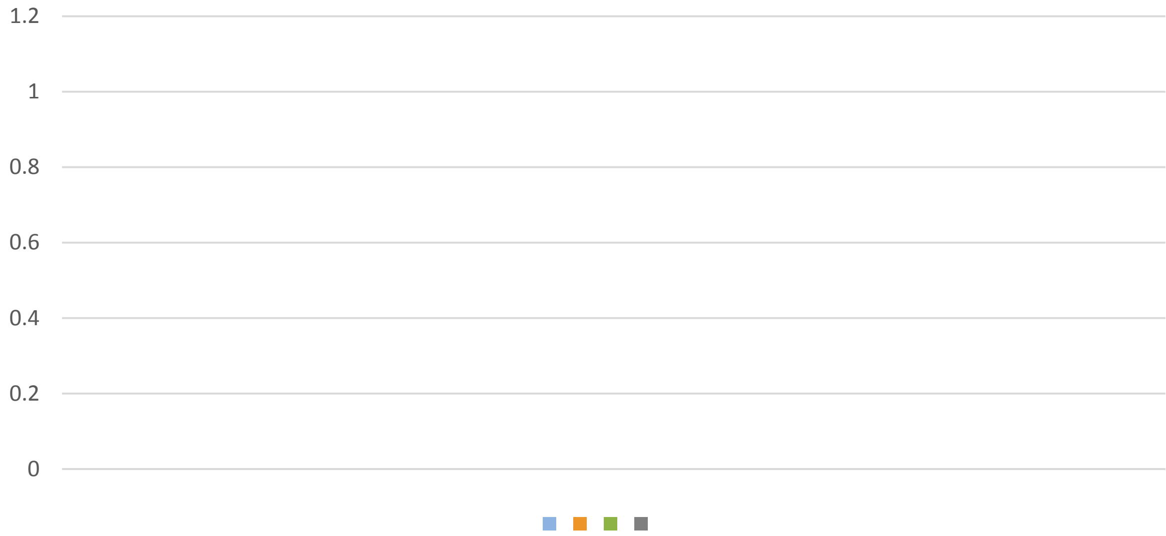
In some cases, specific adjustments were made to take into account of particular economic forecast (i.e. higher growth in the short term as the economy rebounds), specific demand drivers (e.g. import substitution policies for some bulk goods) as well as competition with other Nigerian ports given their respective hinterland and associated competitiveness. As a result, shorter-term results are much less linear than longer-term results, which rely more heavily on fundamentals.

CPCS estimated that container traffic is expected to grow between 10% to 12% per annum between 2018 and 2022. After that it is expected to grow at around 7% per annum. Non-container (bulk) traffic is expected to grow around 7% per annum between 2018 and 2021. After that it is expected grow to at around 5% per annum. The details for each port complex and each year, for the base case, are shown in Figure 3-3. The low case and high case were developed in a similar fashion.

[21] Nigeria Ports Authority. (2007-2016). Nigeria Port Statistics and Lagos Port Complex Annual Reports. Retrieved from the NPA and partially available from http://nigerianports.gov.ng/ports-statistics/

[22] United Nations. (1970-2016). National Accounts Main Aggregates Database. Retrieved from https://unstats.un.org/unsd/snaama/selCountry.asp

Figure 3-3: Annual Growth Rates - by Port and Type of Goods



We also evaluated the potential impact of air cargo volumes and we believe it will not have a major impact on truck numbers. Current air cargo volumes are extremely low, as per data from the National Bureau of Statistics. Air Cargo totals in Q1 2017 were 41,311 tonnes (lowest ever recorded since 2014). However, air mail and post was up, highest ever recorded (6,466 tonnes) was an increase of 700% from previous quarter. The composition of air cargo is largely high value commodities that would not feature in cargo transported on trucks through the ports of Apapa and TCI. Also of note, logistics providers that interface with the airport do so on airport property, never causing stationary congestion such as we see at the ports. Even if air cargo volumes grow, they are unlikely to have a major impact on truck numbers.

3.2.2 Relating freight and truck traffic growth

As freight traffic grows, we would not expect truck volumes to grow exactly in line with this freight growth. This is mainly due to the following factors:

- Shippers to use containers and trucks more efficiently, and also ensure a quicker turnaround of containers. There is currently no incentive for shippers to move containers more efficiently, but raising costs and pressure from the port authorities will probably force them to do so;
- As Apapa and Tin Can Island get more congested in the medium term, there will be potential for cargo to move to other ports, including the proposed Lekki Port;
- Plans for rail connections to Apapa and Tin Can Island will reduce cargo being transported by truck; and
- Planned improvements to the road network will be mean trucks move faster, with shorter waiting times outside the port.

All these factors indicate that there are potential future developments which can slow the rate of growth of truck volumes using the ports. However, there are no clear timescales for any of these developments, and their specific impact on volumes is very difficult to measure with a great degree of accuracy. There will always be a high degree of subjectivity when trying the measure these impacts, given that the uncertainties around implementing infrastructure and other projects in Nigeria.

Given these uncertainties, the base scenario assumes that truck volumes will increase at 50% the rate of growth of freight volumes. In the high growth scenario, the truck volumes will rise exactly in line with the rate of growth of freight volumes. In the low growth scenario, the truck volumes will increase at 20% the rate of growth of freight volumes. These growth rates are applied separately by type of truck (containers versus bulk) to come to our estimates. We believe these are conservative estimates as they assume significant modal shift and trucking improvement.

3.2.3 Traffic Projections

The projections of traffic volumes is based on 6,024 trucks currently being parked on the roads, and the future volumes are given in Figure 3-4. The traffic projections indicate that the total trucks on the road will increase from the current level of 6,000 trucks per day, to over 11,000 per day in 20 years.

Figure 3-4. Forecast of Daily Trucks

	2018	2023	2028	2033	2037
Apapa					
Base	3,226	3,832	4,372	5,030	5,641
High		4,538	5,918	7,841	9,875
Low		3,457	3,643	3,853	4,033
Tin Can Island					
Base	2,798	3,561	4,301	4,917	5,512
High		4,473	6,481	8,458	10,632
Low		3,086	3,331	3,515	3,680
Total					
Base	6,024	7,392	8,672	9,947	11,154
High		9,012	12,400	16,299	20,507
Low		6,543	6,975	7,368	7,713

The base case estimates suggest that on an average over 6,000 are queued up to enter the ports in LMA at any given point of time, which is expected to grow to over 11,000 over the next 20 years. In comparison, based on the international case studies discussed, an average of 15,000 trucks visited the ports using the Pier Pass OffPeak Program at San Pedro Bay Ports in 2016 using RFID tagging system. While the magnitude of the problem and sophistication of the solution may vary, this establishes that there are mechanisms available to address it.

4 Port-Truck Interface Program Case Studies

Key Messages

Metropolitan ports world over struggle with congestion and last mile access challenges because they are land-locked and it is rarely possible for them to mitigate congestion by "building their way" out of the problem. In fact, new builds to increase port capacity may increase congestion at the port-truck or port-city interface due to increased volumes of truck trips from port capacity expansion.

Multi-Pronged Approaches

We looked at the programs of ten major metropolitan ports across North America, Europe, Africa, the Middle East and Asia. Each of these programs is multi-pronged, and consist of:

- Updated rules and regulations on the part of the public sector for functions such as driver licensing and operating authority requirements.
- Coordinated single window / clearance / gate processing approaches that require public and provide coordination between public entities, shipping lines, terminal operators, and cargo owners
- Changes to operating hours, queueing processes, and fee structures for drayage and container moves
- Fleet tracking and truck identification solutions to locate trucks as the move about the port, or within the vicinity
- Quayside and yard area automation, and increased reliance on electronic transaction and identification data

None of these measures provide a silver bullet to addressing congestion. The evolution of these ports shows that mechanisms such as automation, tracking, and electronic transaction management depend on fundamental structures being gradually phased in over time. Port-truck interface automation continues to be an area of emerging techniques and solutions, and is yet to become mature and standardized, although many ports seem to already be capturing significant benefits.

4.1 Introduction

Metropolitan port systems in most parts of the world deal with issues such as urban congestion, long queues, and inefficient dray operations because trucks carrying containers have to intermingle with local traffic on their way to and from the port, i.e. in the "last mile". These issues are routine in ports such as the Ports of Vancouver, Los Angeles and Long Beach, Oakland, Shanghai, Dubai, Rotterdam, and Durban. These ports are important facilitators of international trade and are located along attractive waterways in densely populated cities where residents live and work. This amplifies the need for efficient and sustainable drayage transportation to both improve efficiency in trade facilitation and to reduce negative environmental and traffic impacts on the metropolitan region.

To address these issues, many ports have instituted a variety of operations improvement programs. Most of these programs are phased in over a decade due to enabling policy and enforcement needs, pilot projects, technology development, construction, and so on. Some of these programs are listed below.

Truck Fleet Tracking

Ports that are able to track trucks are able to gain operational efficiency at the terminals by pinpointing truck locations through GPS. Using GPS observations, port operators can also run simulations on how the port will operate under various different conditions and scenarios. It thus allows the port to study the impact of different policies, constraints, and regulations on port operational efficiency. Ports sometimes choose to subsidize GPS technology to reduce cost burdens on trucking companies, as the Port of Vancouver chose to do.

Truck Licensing Program and Environmental Requirements

Many ports have created truck licensing programs to institute various requirements such as minimum fleet size for companies, minimum truck age, minimum safety, and environmental requirements. Licensing may reduce clearance time for the truck at the terminal. Additionally, Ports must understand how their enterprise imposes impacts on communities in order to appropriately manage their responsibilities to the public. In response to environmental concerns from the public, many ports have implemented environmental requirements for trucks, such as the Port of Vancouver and Oakland. These programs may require certain emissions standards of their trucks in order to access the port, or they may levy fees for trucks that do not comply with these standards.

Truck Appointment System and Extension of Gate Hours

Ports may choose to schedule drayage trucks at specified appointment times in order to reduce congestion while trucks wait their turns at the terminal gates. There are many ways of implementing such an appointment system, such as specifying hour-long appointments for various trucks and charging fees for preferred times such as during peak hours. Some ports operate during normal work hours between Monday and Friday, while others have extended gate hours to accommodate night delivery and pick-up. Others still have implemented 24 hour service. These policies may reduce urban congestion by reducing wait time for trucks based on appointments, or by freeing up trucks on the road during peak hours by shifting them to nighttime.

Customer Portal

Many ports have created portals to enhance customer ease of locating, tracking, and determining the status of containers, such as the Jebel Ali Port and the Port of Durban. Portals can report on processes such as gate-in and gate-out confirmations, vessel load and discharge confirmations, and so on. This type of portal requires significant information collection and a wider enterprise software system for cargo operations.

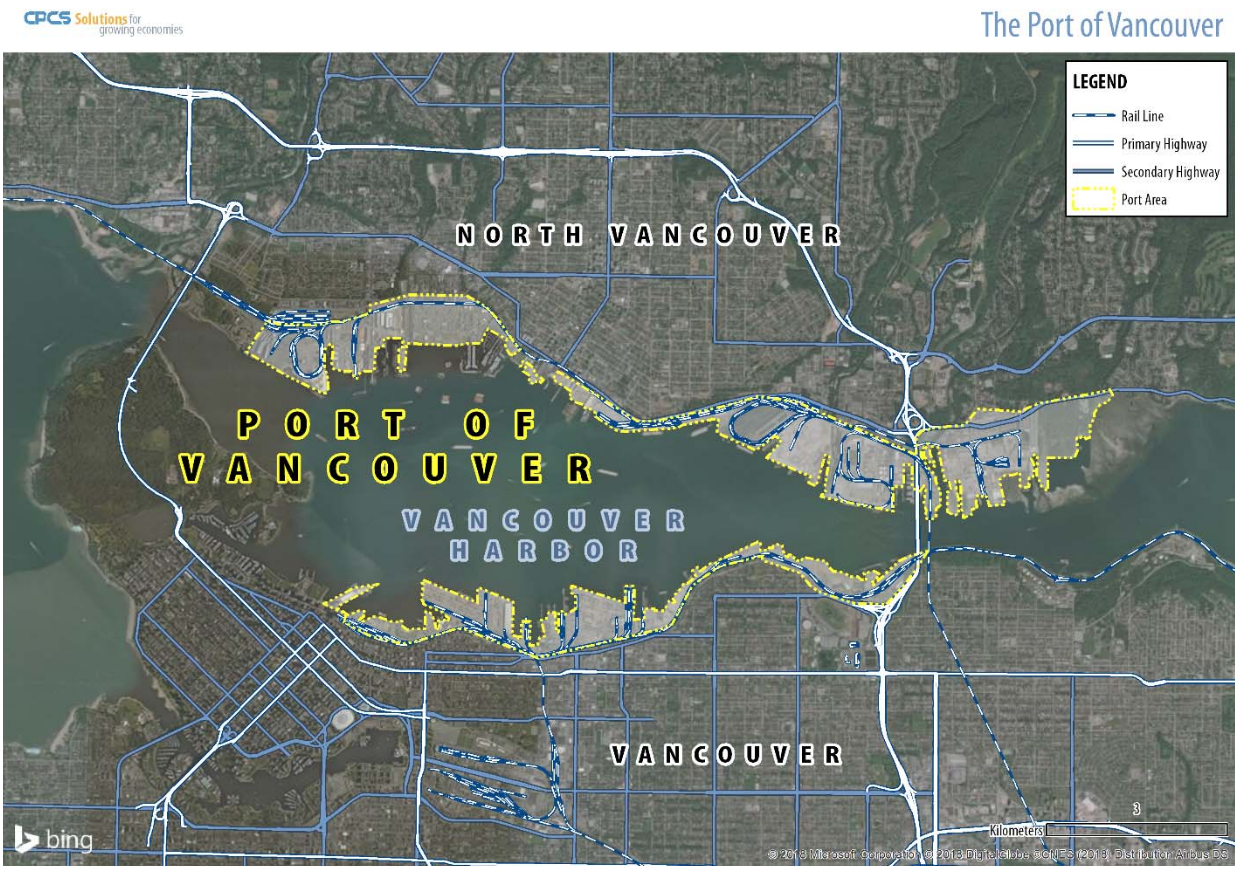
Automated Terminals

Port terminal automation allows containers to be loaded and unloaded remotely through cranes and transport of containers through driverless vehicles. Port automation exists in ports such as Rotterdam and Shanghai. Implementation is highly time and capital-intensive, but once implemented, the number of TEUs that can be processed by each crane increases significantly.[23] Ports such as the Jebel Ali port have also created a gate automation system using Optical Character Recognition to check truck license plates and record container IDs before opening the gate. This type of system facilitates 24 hour port operations without significant additions in labor hours.

The next sections will provide context for the Ports of Vancouver, Los Angeles and Long Beach, Oakland, Shanghai, Dubai, Rotterdam, Tema, Djibouti and Durban and the evolution towards these operations improvement programs. Common challenges and critiques of these programs will also be presented, followed by takeaway lessons for Lagos ports.

4.2 Port of Vancouver

Figure 4-1. Port of Vancouver



Source: CPCS

[23] FlexPort, "Why Is the Port of Rotterdam More Automated than the Port of Oakland", September 22, 2015 https://www.flexport.com/blog/port-automation-oakland-rotterdam/

4.2.1 Background

The city of Vancouver is located on the Burrard Peninsula between the Burrard Inlet and the Fraser River and consists of approximately 44 square miles. The immediate city is home to over 600,000 people as of 2016 with over 2.4 million people in the greater metropolitan region.[24] Vancouver is the densest city in Canada and the fifth densest city in North America. The Port of Vancouver is located directly north of the city along the Vancouver Harbour. The port extends from Roberts Bank and the Fraser River up to the Burrard Inlet.

The Port of Vancouver is the largest port in Canada and the third largest port in North America by tonnage. The port handled about 140 million tons of cargo in 2017, valued at 20% of Canada's total goods trade. Goods sectors mainly involve automobiles, containers, breakbulk, bulk and cruise. In 2017, the port handled 3.3 million TEUs. The port encompasses 1,000 hectares of land along 350 km of shoreline. The port consists of 27 major marine cargo terminals, three Class 1 railroads, and both deep-sea terminals and freshwater facilities.

The Vancouver Fraser Port Authority oversees port operations and their mission is to enable Canada's trade objectives, ensuring safety, environmental protection and consideration for local communities. Their vision is to be the world's most sustainable port.

4.2.2 Current Operations Improvement Program

In 2013, the Port established the Smart Fleet program to improve the efficiency and reliability of terminal operations, reduce greenhouse gas emissions, and become more competitive overall. The program has four parts:

1. Instrumenting fleets with GPS;
2. Implementing a software model for drayage;
3. Reforming the Truck Licensing System (TLS) for environmental requirements; and
4. Implementing a common reservation system.

The Port of Vancouver's Truck Licensing System (TLS) was used to reduce air emissions for container drayage trucks and target engine age restrictions and idle reduction through mandatory opacity testing, idling reduction, and a minimum truck age requirement.[25] Container trucks that are older than a certain date must fill out an Age Exception Application demonstrating that they have installed an approved emissions reduction measure.

The Port requires TLS-approved trucks be outfitted with GPS technology and by 2017, the entire fleet of drayage trucks operating at the Port (approximately 2,000 trucks) had been outfitted with GPS. GPS points, i.e. truck locations, are recorded when the ignition is turned on / off, starts / stops, during turns, and when the truck enters / leaves the geo-fenced area. The main geo-fenced areas (geography of interest) are container terminals and off-dock facilities. Points are recorded at a minimum of five-minute intervals or more frequently as and when the events above occur. The figure below shows a sample of about 200,000 trips monthly, and about 20

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[24] World Population Review, Vancouver Population http://worldpopulationreview.com/world-cities/vancouver-population/

[25] Port of Vancouver, "Truck Licensing System" https://www.portvancouver.com/truck-rail/truck/truck-licensing-system/

million GPS observations of trucks traveling between the areas of interest in the vicinity of the port. This translates to a dataset of about 15-20 gigabytes (GB) of memory.

Figure 4-2. GPS observations of trucks in the Port of Vancouver Smart Fleet Program

Source: Port of Vancouver

The drayage system software model also employs the GPS observations to simulate how the port will operate under different conditions and scenarios. Port operators can thus study the impact of different policies, constraints, and regulations on port operational efficiency.

The common data interface has also enabled a single point of entry and reservation system connecting trucking companies to all container terminal operations. These systems also build on the Truck Licensing System, which contains detailed information of the trucks themselves including, age, model, emissions profile, etc. as part of the License to Operate at the terminals.

In summary, the ability to track trucks using GPS at the Port of Vancouver has resulted in a significant improvement in operational efficiency at the terminals, and allowed industrial participants to leverage data to become more competitive. It is important to note that the use of GPS was not pursued in isolation, and rather in combination with truck tracking, reservations systems, and performance analysis.

4.2.3 Port Evolution

Prior to the Smart Fleet initiatives, the Port of Vancouver conducted a Container Drayage Efficiency Pilot Project which outfitted 16% of the Truck Licensing System fleet with GPS transponder units to test the benefits of the GPS tracking system. The Port later required all TLS-approved trucks to install a GPS Transponder Unit and provided these at no cost to the trucking companies.

The Port of Vancouver also wanted to encourage collaboration between terminal operators and industry leaders. The Smart Fleet action plan thus encouraged joint research between the Port, industry, and government through the Clean Transportation Initiative to improve sustainability. A Container Drayage Leadership Team was also created as a forum for terminal operators and industry leaders to work together to solve drayage challenges.

A "Container Vessel On-time Incentive Program" was also simultaneously introduced to encourage container vessel operators to arrive on schedule for overall supply chain consistency.[26] This program recognizes carriers that achieve on-time arrival within 8 hours of berth window start and provides wharfage reductions to qualifying carriers. The Port of Vancouver received The Canadian International Freight Forwarders Association's "Forwarders Celebrating Associates" award for Excellence in Innovation in 2014 for this program.[27]

The Port of Vancouver has a common reservation system for drayage haulers at its container terminals. This system provides specific hourly time slots for licensed carriers at no cost. Voluntary pre-booking is also available at a fee for trucking firms at a first-call and first-booked basis. This allows both trucking companies and container terminal operations to more effectively plan and select reservations to increase efficiencies.[28]

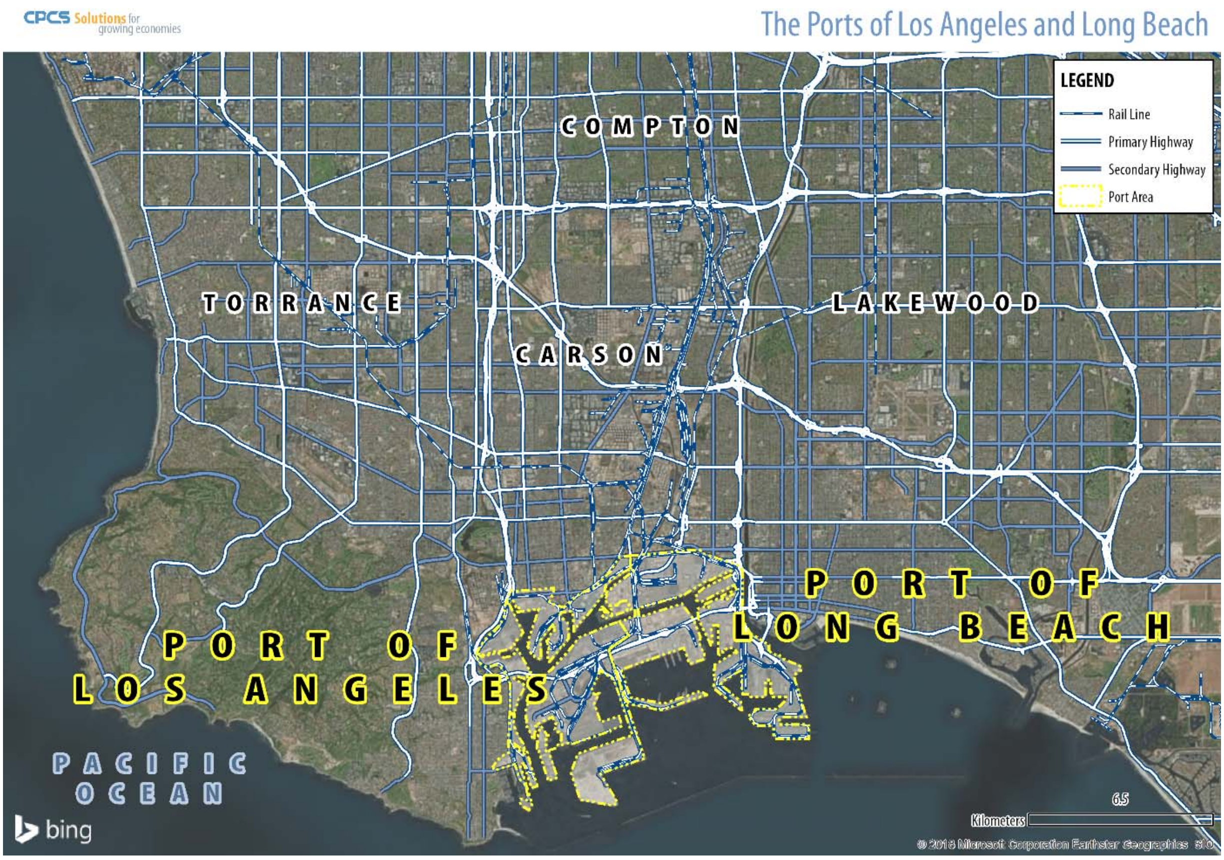
While ongoing capacity improvement projects have not resulted in major local disputes, reputation and public support continues to be a main enterprise risk for the Port of Vancouver.[29]

In the late 1980s, the Port of Vancouver was criticized for perceived insensitivity to local interests. The Port was later able to restore public trust when the Canada Marine Act required port authorities to develop land use plans and restructured port authority boards of directors to reflect local interests.[30]

[26] Port of Vancouver, "Smart Fleet Trucking Strategy" https://www.portvancouver.com/truck-rail/truck/smart-fleet-trucking-strategy/
[27] Canadian Shipper, "Shippers Recognize PMV's Container Vessel On-Time Performance Incentive Program", October 2, 2014 https://www.canadianshipper.com/sustainability/shippers-recognize-pmvs-container-vessel-on-time-performance-incentive-program/1003282303/
[28] Today's Trucking, "Port of Vancouver to Launch Reservation System Sept. 27", August 1, 2014 https://www.todaystrucking.com/port-of-vancouver-to-launch-reservation-system-sept-27/
[29] Port of Vancouver 2017 Financial Report, "Risk Management" https://www.flipsnack.com/portvancouver/2017-financial-report/full-view.html
[30] Yarnell, "Port Administration and Integrated Coastal Management under the Canada Marine Act in Vancouver, British Columbia, Canada", Coastal Management Vol. 27, Issue 4, October 29, 2010 https://www.tandfonline.com/doi/abs/10.1080/089207599263758

4.3 San Pedro Bay Ports (Los Angeles and Long Beach)

Figure 4-3. Ports of Los Angeles and Long Beach



Source: CPCS

4.3.1 Background

The city of Los Angeles is the second most populous city in the United States; the immediate metropolitan area has more than 12.8 million people, and the larger metropolitan region with 18.1 million people. Los Angeles is the single most densely populated area and the second-most populous urban area in the United States.[31] Long Beach is located in Los Angeles county with approximately 470,130 people as of 2016.

Both the Port of Los Angeles and the Port of Long Beach are located along the San Pedro Bay. The Port of Los Angeles is located in the San Pedro and Wilmington neighborhoods of Los Angeles, approximately 20 miles south of downtown Los Angeles. Adjoining the facility is the Port of Long Beach which is less than two miles southwest of downtown Long Beach and is 25 miles south of downtown Los Angeles.

[31] World Population Review, "Los Angeles Population" http://worldpopulationreview.com/us-cities/los-angeles-population/

The Port of Los Angeles handled 9.3 million TEUs in 2017, making it the largest port in the United States by container volume.[32] The Port of Long Beach is the second busiest port in the United States, handling 7.5 million TEUs in 2017.[33]

4.3.2 Current Operations Improvement Program

In 2005, the Ports of Los Angeles and Long Beach created PierPass Inc., a not-for-profit company, as a response to multi-terminal issues such as congestion, air quality and security. This program is intended to reduce severe cargo-related congestion on local streets and highways around the Los Angeles and Long Beach ports and better manage the security requirements for trucks accessing the port facilities.

PierPass's OffPeak program also established regular night and Saturday work shifts to handle trucks delivering and picking up containers at the 12 container terminals in the two adjacent ports. Under this program, a Traffic Mitigation Fee (TMF) is charged for container moves during regular weekday hours between Monday and Thursday, which offsets additional costs associated with extended gates. Fees are redistributed to terminal operators proportional to the cargo volume they handle, less operational costs for PierPass, and moves during OffPeak shifts are exempt from this fee.

A key ICT enabler of this new operating structure was the use of RFID "TruckTags".

Prior to PierPass, marine terminal gate traffic was subject to a manual check-in process by marine terminal security guard personnel. Since 2008, trucks trying to access the terminals at the two ports are required to be equipped with TruckTags and registered in the Drayage Truck Registry system. RFID tags installed on the truck's driver-side mirror are automatically read at marine terminal gate entrances using specialized scanning antennas that validate the security clearance of the truck. As part of the system, the truck driver's commercial driver's license is checked to verify they are authorized by their truck company to enter the port facility on their behalf. The RFID tags are also used to validate the truck's status in the Drayage Truck Registry (DTR) and to comply with port truck requirements.

In addition to the automated access processes, terminal operators have a number of camera feeds and performance dashboards to monitor operating conditions.

There are a number of incentives to influence the behavior of trucks that build on the RFID capability. Trucks that are not equipped with tags, are manually processed as "exceptions" and are given a trouble ticket. The additional time and effort to undergo manual processing is a significant disincentive to not participating in the program.

Prior to the OffPeak program, 88% of the containers moved during the first shift of operations, during normal hours of 8am to 5pm Monday through Friday. Under OffPeak, approximately 50% of the trucks call during the first shift and 50% during the other shifts on weekdays between

[32] Port of Los Angeles, "Container Statistics for 2017" https://www.portoflosangeles.org/business/statistics/container-statistics/historical-teu-statistics-2017
[33] Port of Long Beach, "Yearly TEUs" http://www.polb.com/economics/stats/yearly_teus.asp

6pm and 3am, and on Saturdays between 8am and 5pm. OffPeak nearly doubled the effective operating capacity of the ports by diverting more than 35 million truck trips to less congested nights and weekends.[34]

4.3.3 Port Evolution

In the early 2000s, significant growth in international trade led to increased ship queues, labor disputes, and truck traffic, leading to increasing negative public perceptions of the ports. In 2000, the South Coast Air Quality Management District's (SCAQMD) Multiple Air Toxics Exposure (MATES) II Study raised public awareness of potential cancer risk coming from diesel exhaust. A widely circulated "diesel death zone" map illustrated diesel particulate emission concentrations around the ports and the local communities affected.[35] Other events such as construction issues[36], labor disputes[37] and shortages in both longshore and railroad labor, a landmark study on I-710 with expectations of tripling port trade by 2020, and pressure from the California assembly shed light on the need to make improvements to port capacity to handle increased cargo and relieve local congestion.

The San Pedro ports were unable to undergo facility expansion projects in the short-term due to lengthy environmental review processes, lack of public funding, and public opposition to infrastructure investments for the ports. Instead, the ports discussed extending gate hours for trucks to pick up and drop off cargo to spread truck traffic over additional hours outside of 8am-5pm weekday hours.

Policy changes were required in order to implement the PierPASS program. These included authorizing charges for cargo moved during peak hours, establishing a Port Congestion Management Fund, creating a District Board, information reporting by terminal operators such as turn times, allowing off-peak operations at marine terminal facilities in California, and other policies. The District Board was particularly contested by the industry as it involved elected officials, truckers, longshore labor, and the local community in terminal operations and reviewing turn times.

A West Coast MTO Agreement amendment was also made to allow terminal operators along the West Coast of the United States to meet together to discuss "terminal rules, regulations, procedures, practices, terms and conditions for motor and rail carriers" such as gate rules, security, and fees charged shippers for leaving cargos on the docks longer than the allowed demurrage.

Acquisition of radio frequency ID (RFID) technology, distribution of tags to trucking companies, and enforcement mechanisms to ensure compliance with truck tags were also needed.

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[34] Giuliano and O'Brien, University of Southern California METRANS, "Evaluation of Extended Gate Operations at the Ports of Los Angeles and Long Beach", Project 05-12, June 2008 https://www.metrans.org/sites/default/files/research-project/05-12%20Final_0_0.pdf

[35] South Coast Air Quality Management District (SCAQMD) (2000) Multiple Air Toxics Exposure Study In the South Coast Air Basin: MATES-II Final Report and Appendices. Diamond Bar, CA: SCAQMD.

[36] Natural Resources Defense Council, "Appeals Court Stops China Shipping Terminal Construction" https://www.nrdc.org/media/2002/021030-1

[37] University of Southern California CREATE Homeland Security Center, "The State-by-State Economic Impacts of the 2002 Shutdown of the Los Angeles-Long Beach Ports", 2008 https://research.create.usc.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=1073&context=nonpublished_reports

Adjustment time is also required prior to implementation of this type of program to secure labor availability for additional shifts. Registration processes also need to be formalized to allow for fee collection.

Figure 4-4. RFID-tagged trucks being processed through access gantries and lanes at POLA/LB

Source: PierPass

4.4 Port of Oakland

Figure 4-5. Port of Oakland

Source: CPCS

4.4.1 Background

The City of Oakland is located on the San Francisco Bay and is the 8th largest city in California with approximately 425,195 in 2017.[38] Oakland is 6 miles east of San Francisco and is a principal city of the East Bay region of the bay area. The San Jose-San Francisco-Oakland metropolitan area has an estimated population of 9.6 million people. The Port of Oakland is located in downtown Oakland along the Oakland Inner Harbor directly across from Alameda Island.

The Port of Oakland was established in 1927 and waterborne commerce has traveled to the harbor since the city's incorporation in 1852. In fiscal year 2017, the seaport handled approximately 2.4 million full and empty TEUs.[39] The seaport consists of 1,300 acres of maritime facilities that serve over 14.5 million consumers. There are three container terminals and two intermodal rail facilities – Union Pacific and BNSF. All shipping channels and 90% of berths are dredged to -50 feet and capable to accommodating vessels up to 18,000 TEU capacity.[40] The Board of Port Commissioners is responsible for the Oakland International Airport, Oakland seaport, and 837 acres of land along the Oakland Estuary for commercial real estate property.

4.4.2 Current Operations Program

In 2016, the Oakland International Container Terminal introduced night service to reduce congestion and improve transaction times. Two years later, the TraPac marine terminal also installed full service night gates. Appointments are required for imports, exports, and return of empty containers, and fees are assessed on loaded containers during day and night shifts to defray cost of extended operating hours. An extended gate fee of $30 USD is charged by the Port of Oakland for all import and export loads coming in and out of terminals during both day and night. Loaded containers leaving the terminal by rail are not charged a fee.[41]

The Port of Oakland has a Comprehensive Truck Management Program (CTMP) which addresses "security, air quality, business and operations, and community issues". Specifically, this program includes a Secure Truck Enrollment Program (STEP) registry in which licensed motor carriers (LMCs) and trucks with STEP agreements can serve the seaport facilities – marine terminal, railyard, and other facilities. Temporary passes can be obtained at the port's customer service center (no more than 10 passes for any one truck and driver per year).

The CTMP program also enforces a Clean Trucks program. Seaport facility operators are required to deny entry to drayage trucks that cannot demonstrate compliance with the CARB January 2010 emissions requirements (California Air Resources Board requirements). Non-compliant trucks with overweight/oversized cargo can be allowed access at discretion, but information must be submitted to CARB for enforcement action.

[38] US Census Bureau Quick Facts https://www.census.gov/quickfacts/fact/table/oaklandcitycalifornia/PST045217
[39] Port of Oakland Comprehensive Annual Financial Report (CAFR) for the Year Ended June 30, 2017, 2016 https://www.portofoakland.com/wp-content/uploads/Comprehensive-Annual-Financial-Report-CAFR-for-year-ended-June-30-2017-2016-PDF.pdf
[40] Oakland Seaport, "Your Port Your Partner", 2018 https://www.oaklandseaport.com/
[41] Burnson, Supply Chain Management Review, "Trucking Congestion Must Also Be Addressed by Ports; Oakland is Doing Its Best", October 22, 2018 www.scmr.com/article/trucking_congestion_must_also_be_addressed_by_ports_oakland_is_doing_its_be

Several initiatives under the Port Efficiency Task Force (PETF) are underway to relieve congestion and improve operational efficiency. These initiatives include:

1. Extended Gate Operations – night gates have been in operations since early 2016 at some terminals
2. Real-Time monitoring of truck wait and turn-times and other operations-related performance monitoring/metrics
3. Deployment of a gray chassis pool – a more flexible system that allows sharing of chassis across customers/users
4. Marine terminal appointment systems
5. Development of a customer portal that would provide a non-stop source for information about Port operations

Additionally, the Port is working on improvements to marine terminals and key access points to address aging infrastructure, needs of larger ships, and congestion on roadways inside and leading up to the seaport. Some of these projects include crane raising, wharf upgrades for larger vessels, and development of an intelligent transportation system.

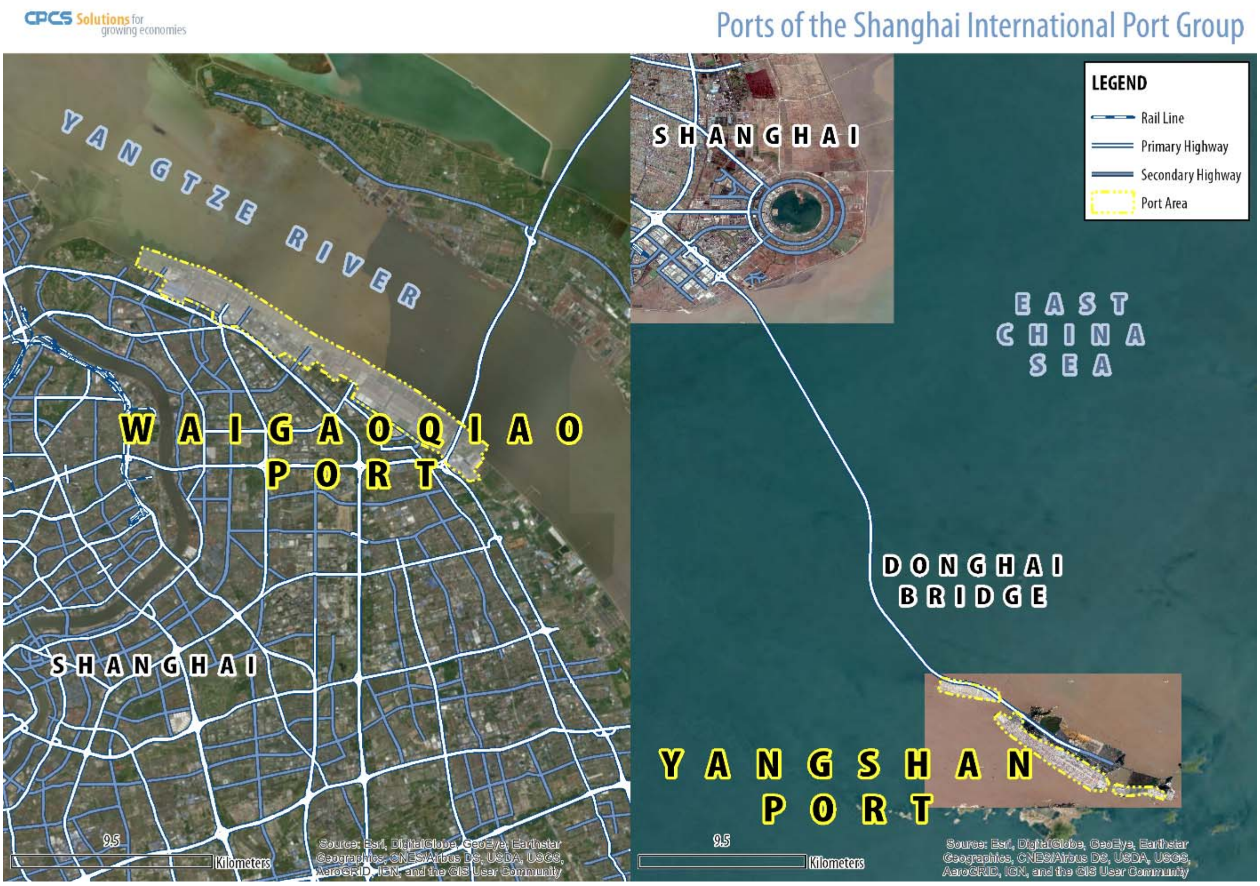
4.4.3 Port Evolution

Environmental awareness and concern by the public and the state facilitated the development of Oakland's Comprehensive Truck Management Program. In 2008, a Health Risk Assessment by the California Air Resources Board (CARB) found that Oakland seaport sources contributed 16 percent of West Oakland's health risk from diesel pollution. Additionally, 4 percent of total West Oakland health risk arose from diesel pollution due to the Port's drayage trucks. In response to this assessment, pressure from local advocacy groups, the state of California's new freight emissions standards, and in order to replace a previous plan, the Port developed a Maritime Air Quality Improvement Plan (MAQIP) in 2009. The MAQIP's primary purpose was to reduce seaport diesel pollution by 85 percent by 2020.[42]

[42] GreenPort, "The Oakland Port Board Approves Maritime Air Quality Improvement Plan and Up to $5 million for Truck Retrofits", June 9, 2009 https://www.greenport.com/news101/americas/oakland-approves-air-quality-improvement-plan

4.5 Port of Shanghai

Figure 4-6. Port of Shanghai



Source: CPCS

4.5.1 Background

The City of Shanghai is the most populated city in China and the third most populated city in the world (after Tokyo and New Delhi) with more than 24 million people.[43] The city sits in the Yangtze River Delta along the south of the estuary and is bisected by the Huangpu River, a tributary of the Yangtze River. To the east of Shanghai is the East China Sea. The Port of Shanghai includes a river and deep-sea port: the Waigaoqiao Port directly northeast of the city and the Yangshan Port in the Hangzhou Bay south of Shanghai. The Yangshan Port is connected to the mainland by the Donghai Bridge. Waigaoqiao is nestled in the intersection of the Yangtze, Huangpu, and Qiantang rivers, and Yangshan handles traffic to and from the East China Sea and Hangzhou Bay.

The Port of Shanghai dates back to the 6th century AD and officially opened to international trade in 1842.[44] The port is the world's busiest container port by volume with over 40 million

[43] 上海市人民政府 (Shanghai Government), 人口年龄构成 (Population Count by Age) http://www.shanghai.gov.cn/nw2/nw2314/nw3766/nw3783/nw3784/u1aw9.html

[44] Treaty of Nanjing

TEUs in 2017.[45] The port covers 3,917 square kilometers over three harbor zones: the Yangshuan Port, Huangpu River, and Yangtze River. Shanghai's port has a total of 125 berths and 82 of these can accommodate 10,000 DWT class or higher vessels. The port is managed by the Shanghai International Port Group which is a state-owned company that manages all port terminal operations.

4.5.2 Current Operations Improvement Program

The Port of Shanghai is home of the world's largest automated port in the Yangshan Deep Water Port, which is designed to handle up to 6.3 million TEUs. This intelligent management system for container operations officially opened at the end of 2017. This system fully automates container carriers in the entire container yard, pile and stack containers, and load and unload containers from ships.[46] This allows the port to operate without human labor in the container dock and yard, and container trucks can also be run through remote control in the monitoring room.

This automated port was designed independent of existing port automation global suppliers, and this Chinese intellectual property has the advantage of allowing port machinery to load and unload at the same time using computers and driverless vehicles. The terminal is also expected to allow energy savings by up to 70 percent.[47]

Automation makes "equipment interchange receipts" for container transfers obsolete and reduces the time it takes to transfer containers. The Shanghai International Port Group believes the paperless procedure will shorten cargo arrival to collection time from 4.5 days to between 12 and 24 hours.

4.5.3 Port Evolution

The Port of Shanghai went through economic liberalization in 1991 and international trade grew rapidly with the ascension of China into the World Trade Organization in 2001. In 2005, the Yangshan deep water port was built which made Shanghai's ports more competitive despite natural shallow water conditions.

Imports into greater China outpaced exports for the first time in 2016, which places pressure on terminal yards.[48] Recent port congestion at the berths has been due to reshuffling of large shipping alliance networks as well as unstable weather such as fog. Regrouping of major shipping alliances caused new timetable adjustments with ships failing to call at port at their designated times.[49] Inland, some factors affecting traffic congestion include labor disputes by

[45] Xinhua, "Shanghai International Port Group Breaks Global Capacity Record", January 3, 2018 http://www.thechinamoneyreport.com/2018/01/03/shanghai-international-port-group-breaks-global-capacity-record/
[46] Shanghai International port Group Co., Ltd. "Intelligent Management System of Container Operations" http://www.portshanghai.com.cn/en/channel5/channel52.html
[47] ChinaDaily, "Largest Automated Container Terminal Starts Operations", February 1, 2018 http://www.chinadaily.com.cn/cndy/2018-01/02/content_35420816.htm
[48] Knowler, "Shanghai Congestion Improving Steadily", May 4, 2017 https://www.joc.com/maritime-news/shanghai-congestion-improving-steadily-data-shows_20170504.html
[49] Whiteman, The Load Star, "Containerships being diverted to avoid congestion at port of Shanghai", April 25, 2017 https://theloadstar.co.uk/containerships-diverted-avoid-congestion-port-shanghai/

truck drivers over rising fuel costs[50] and capital projects that affect the number of truck lanes available. The port is still working to address berthing challenges and expansion projects have ensued since the 2000s in response to increased cargo traffic for both ocean-going vessels and container trucks.

[50] Legacy Supply Chain Services, "Shanghai Port Strike Affects Ocean Transportation and Logistics", https://legacyscs.com/shanghai-port-strike-affects-ocean-transportation-logistics/

4.6 Jebel Ali Port (Dubai)

Figure 4-7: Jebel Ali Port

Source: CPCS

4.6.1 Background

Dubai is the most populous city in the United Arab Emirates and is home to 3.1 million people.[51] Dubai is located on the southeast coast of the Persian Gulf and is the capital of the Emirate of Dubai. The Jebel Ali Port is located in the Jebel Ali port town of Dubai, approximately 22 miles south of the capital.

Jebel Ali Port is the largest marine terminal in the Middle East, the 9th largest container port worldwide, and has the world's largest man-made harbor. Established in 1979, the port is operated by DP (Dubai Ports) World, which has over 50 terminals in 31 countries. DP World handles about 50 million TEUs a year.

Within Jebel Ali Port, three existing container terminals have a total capacity of 19.3 million TEUs, and 28 berths are equipped with 102 ship-to-shore quay cranes. 19 of these cranes are remotely operated. Expansions are currently underway for a fourth container terminal which will increase total handling capacity to a total of 22.1 million TEUs by 2018. Additionally, the Jebel Ali Port includes a general cargo facility with over 1.4 million square meters and 26 berths.

Jebel Ali Port has the world's first dedicated sea-air customs bonded corridor between the port and Al Maktoum International Airport and has the shortest transit time between sea and air in the world. The port is surrounded by the Jebel Ali Freezone (Jafza) where over 7,300 companies are located from over 125 countries. The port is connected through the main UAE and GCC road network and it takes a maximum of 2-3 days for road transit to any country in the Gulf Cooperation Council. The port is also in the process of being connected with Etihad Rail which will be completed by the end of 2018.

At many of its terminals, DP encounters significant congestion at port entry points due to lengthy procedures, manual decision-making and paper-based logistics. Over time, DP World has implemented electronic customs clearances, electronic data interchanges (EDIs), two way radio communications, and e-token advance booking systems.

DP World wanted to move to a just in time level of service at its container terminals to improve loading and unloading operations and improve container turnaround. In 2009, DP World therefore implemented automatic RFID enabled port access systems in Dubai and some of its terminals in Sydney, Australia.

4.6.2 Current Operations Improvement Program

Jebel Ali Port uses an online platform "Dubai Trade" integrates 200 online services to support customers including berth booking, monitoring gate moves, yard inventories, container release and acceptance, vessel schedule, container tracking, port payments, electronic timeslot booking, customs declaration and payment, truck registration, container move planning, and so on.

Jebel Ali Port also has a gate automation system which works as follows: When a truck approaches the access gates, Optical Character Recognition (OCR) is used to assess whether a truck is loaded with a container, and if so to simultaneously record the container ID by reading the container's RFID tag, and the truck's license plate using Automatic License Plate Reader

[51] Dubai Statistics Center, https://www.dsc.gov.ae/en-us/

technology. The system issues a ticket to the driver, with instructions specifying the lane the driver should use for loading or unloading. The RFID-based automated access system is combined with in-road inductive loops to allow for lane visibility, i.e. the ability to identify the particular lane a truck is occupying. After the load / unload operation is completed, the RFID tag and license plate are read again when the truck exits the port.

A Remote Reefer Container Monitoring System (Refcon) also exists at the port, which allows port operators to respond quickly to emergencies and eliminate idle periods. For example, temperature problems and other irregularities within refrigerated containers/reefers triggers and alarm with the terminals control office. Reefers can also track their cargo boxes by remote access through this system. This technology helps assure a high standard of operation.

4.7 Port of Rotterdam

Figure 4-8. Port of Rotterdam

Source: CPCS

4.7.1 Background

The city of Rotterdam is located in South Holland of the Netherlands within the Rhine-Meuse-Scheldt river delta, bordering the North Sea. Rotterdam is home to over 600,000 people.52 The Port of Rotterdam stretches 25 miles along the city center's historic harbor area along the Nieuwe Waterweg and the Scheur, which connect the Rhine and Meuse rivers to the North Sea. Over time, new docks and harbor-basins have been developed to extend the port along the south side through the Europoort and Maasvlakte regions.

Rotterdam is Europe's largest seaport, handling 8.2 million containers and 13.7 million TEUs in 2017. Rotterdam has the least traffic congestion compared to other cities with major seaports in Northwest Europe as of 2017.[53] Rotterdam also has unrestricted accessibility 24 hours a day,

[52] Statistica, Total Population of Rotterdam From 2008-2018 https://www.statista.com/statistics/753250/total-population-of-rotterdam/

[53] Port of Rotterdam "TomTom Traffic Index: Rotterdam is the least congested port city", February 21, 2017 https://www.portofrotterdam.com/en/news-and-press-releases/tomtom-traffic-index-rotterdam-is-the-least-congested-port-city

7 days a week. The total port area is 12,643 hectares (31,242 acres). The Port of Rotterdam was the world's first automated port, achieving automation in 1993.

The Port of Rotterdam began offering truck parks in 2012 to prevent cargo theft, ensure personal safety for drivers, create an opportunity to avoid peak hours, provide a rest area to comply with driving and resting times, and coordinate cargo handling with terminals. The City of Rotterdam prohibits spending the night in a truck outside of truck parks.[54]

4.7.2 Current Operations Improvement Program

Rotterdam currently has five truck parks offering a total of 723 secure parking spaces. These parks are accessible 24 hours a day, 365 days a year. Daytime parking from 6am to 8pm is free. At night, fees are currently €1.10 per hour and a maximum of €11.[55] The truck parks include showers, toilets, fences, lighting, CCTV, relaxation areas, Wi-Fi, and power for cooling engines.

Rotterdam also has a Port Community System (Portbase), a non-profit organization that merged Rotterdam Port infolink and Amsterdam's PortNET legacy systems. Portbase helps exchange data between companies and government authorities to raise efficiency and reduce costs. This one-stop system includes vessel call, import cargo management, export cargo management, and organization of hinterland transport services.

The Port of Rotterdam Authority and IBM are also collaborating to digitize the port's operations and host connected ships. This Internet of Things platform will create a "digital twin" of the port to mirror all the resources at the port, tracking ship movements, infrastructure, weather, geographical and water depth data.[56] Using "digital dolphin" Internet of Things sensors, Augmented Intelligence, and smart weather data, the port will be able to assess the condition and utilization of berthing terminals along with the water and weather conditions and help port operators determine their docking time and location.[57] This system is intended to pave the way for autonomous ships by 2025.

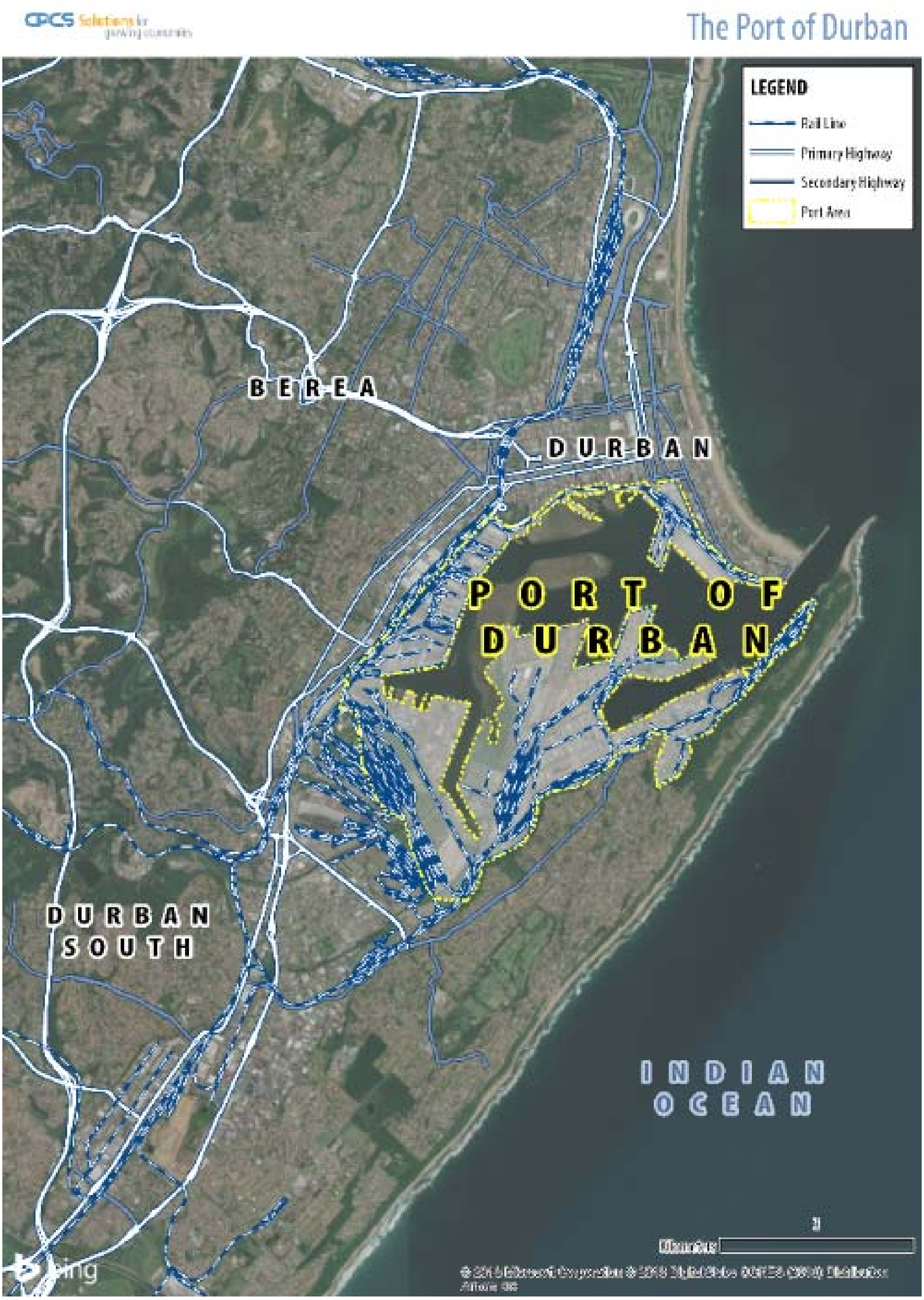
4.7.3 Port Evolution

In 1993, the Port of Rotterdam became the world's first automated port. At the time, this involved automated stacking cranes and automated guided vehicles. Since then, automated gates, yards, and pathways for trolley and quay cranes have also been introduced in the port. Truck drivers prohibited from overnight stays outside of truck parks through the General Municipal By-law of the City of Rotterdam.

[54] Port of Rotterdam "Truck Parks" https://www.portofrotterdam.com/en/doing-business/logistics/connections/intermodal-transportation/road-transport/truck-parks
[55] Truck Parking Rotterdam, "FAQ" http://truckparkingrotterdam.com/EN/Page/FAQ
[56] Campfens and Dekker, IBM "Turning Rotterdam into the 'World's Smartest Port' with IBM Cloud & IoT", January 31, 2018 https://www.ibm.com/blogs/think/2018/01/smart-port-rotterdam/
[57] Behdani, Wageningen University and Delft University of Technology, "Smart Port Logistics: Lessons from the Experience of Port of Rotterdam and Port of Hamburg" https://smartport.pmo.ir/en/filepool2/download/d0459091766c5598ddd98e87b5ca69b6d60eee51ae2e2c6db1f6b35e833c3aa2

4.8 Port of Durban

Figure 4-9. Port of Durban



Source: CPCS

4.8.1 Background

Durban is a coastal city with a population of 3.4 million people as of 2011.[58] The city is the largest city in the KwaZulu-Natal province, which borders three other provinces as well as Mozambique, Swaziland, and Lesotho. The Port of Durban is located in downtown Durban along the entire harbor.

The first harbor master was appointed to the port of Durban in 1839-1840. Since then, Durban has now become Africa's busiest general cargo port. Between 2013 and 2014, the Port of Durban handled 44.8 million tonnes of cargo.[59] The port is managed by Transnet Port Terminals and has 59 berths excluding fishing vessels and ship repair. The Port is open 24 hours a day, seven days a week, with the exception of restrictions on public holidays.[60]

4.8.2 Current Operations Improvement Program

Transnet Port Terminals is embarking on an Information Management Systems strategy based on surveys conducted in 2012. The main areas of its strategy include:

1. Governance and risk management
2. Innovation and optimization
3. Customer focus
4. Knowledge sharing

One key ICT solution at Transnet Port Terminals include “Navis Sparcs N4”, a web-based, real-time, 24 hour terminal operating system that allows customers to locate, track, and determine the status of their container at any time.[61] Planning and operational staff can also view, manage, and control multiple Terminals from a central location. This software helps the port to reduce operational overhead and is integrated across South African ports. The system began installations in 2006 at different South African ports. Navis Sparcs N4 was installed in the Durban Container Terminal in March 2011 and the Durban RoRo Terminal in April 2012.

The Navis platform cuts out the previously used “Container Terminal Orders”, a required document for the removal of any container from the terminal and for the delivery of any container to the terminal for export. Customers can provide an electronic message to remove the container or to deliver a container, through either the Electronic Data Interchange (EDI) system or through the Navis portal.

Another ICT solution at the Durban port is the General Cargo Operational System (GCOS), a comprehensive cargo operational system to facilitate administrative and operational processes in the terminals. This system was built specifically to support the Port business. GCOS supports vessel planning, import and export administration, booking lists, stack planning, weighbridge, cargo tracking, and financial reporting. Prior to GCOS, Transnet Port Terminals used excel spreadsheets to track cargo operations. Different departments reported information in different formats up until GCOS was created.

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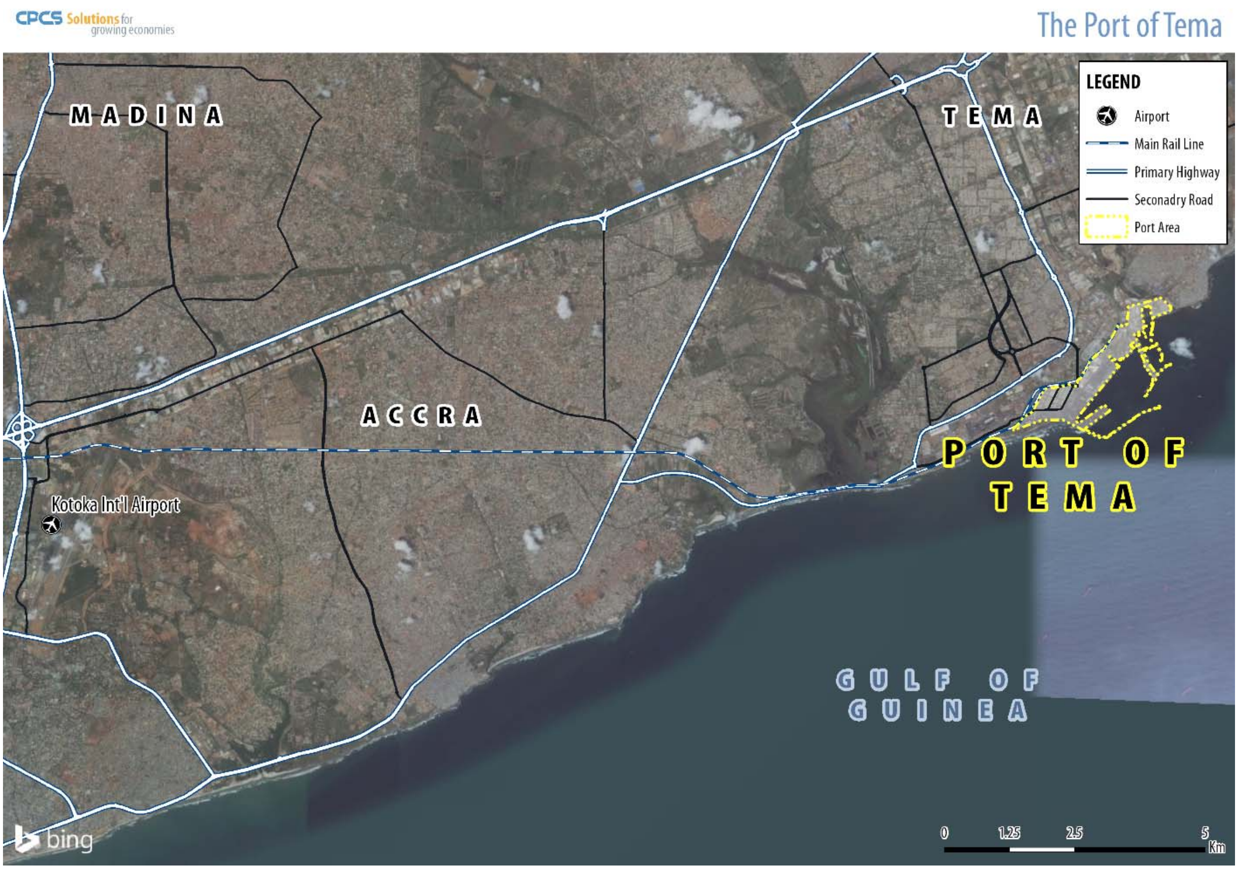
[58] Population City, “Durban” http://population.city/south-africa/ethekwini-durban/
[59] Port Management Association of Eastern and Southern Africa
[60] Ports and Ships: Shipping and Harbour News out of Africa, “Durban” https://www.ports.co.za/durban-harbour.php
[61] ICT at Transnet Port Terminals http://www.transnet-tpt.net/About/Pages/ICT.aspx

Electronic Data Interchange (EDI) is a third key technology which facilitates reporting cargo movements. This technology offers a high degree of consistency in exchanging data between stakeholders and regulators. Processes that EDI supports include equipment release orders, equipment acceptance orders, gate-in and gate-out confirmations, vessel load and discharge confirmations, and stowage instructions.

As of 2018, Transnet Port Terminals is also working on capital improvements to reconstruct, deepen, and lengthen berths in Durban to accommodate larger vessels.

4.9 Port of Tema

Figure 4-10. Port of Tema



Source: CPCS

4.9.1 Background

Tema is a port city on the Atlantic coast of Ghana, 16 miles east of Accra, the capital of Ghana. Tema has approximately 156,000 people and Accra has a population of 1.9 million.[62] The Port of Tema is the biggest seaport in Ghana with a total land area of 3.9 million square meters and handles cargo for Ghana, Burkina Faso, Mali, and Niger. The port is overseen by the Ghana Ports and Harbours Authority. The Port's mission is to "provide efficient port facilities and quality

[62] World Population Review, "Ghana Population" http://worldpopulationreview.com/countries/ghana-population/cities/

services to our clients and regulate logistics clusters in the port" and its vision is "to be the leading container hub and the beacon of trade and industry in West Africa."

4.9.2 Current Operations Improvement Program

The Tema Port uses a one-stop service revenue and data center and has an electronic gating system that uses an electronic cargo clearance process. This paperless port clearance process was introduced in September 2017 and reduced cargo clearance time and improved dwell time. Traders must register their business and/or products with regulatory agencies and fill out an Import Declaration Form online in order to obtain required import licenses, permits and certificates. Fees are also paid electronically through Ghana's Trading Hub Portal. A Risk Clearance System selects transactions for automatic Customs Release without scanning or physical examination while non-compliant transactions are subject to scanning and joint inspections.[63]

The Port is working on further expansion in port automation and to also upgrade their information technology systems, through a Port Management System, automated security and gate access systems, and a new Terminal Operating System. Tema is also working to expand capacity and is undergoing construction for a 3.5 million TEU container terminal with the first two berths scheduled to be completed in 2019.

The Port's future expansion plans include:

1. New Passenger Terminal
2. New Food and Fruit Terminals
3. New RoRo Terminal
4. New Tran-shipment Terminals
5. New Transit Terminal
6. New Break/Dry/Liquid Bulk Terminals
7. Oil rig and ship repair facility

4.9.3 Port Evolution

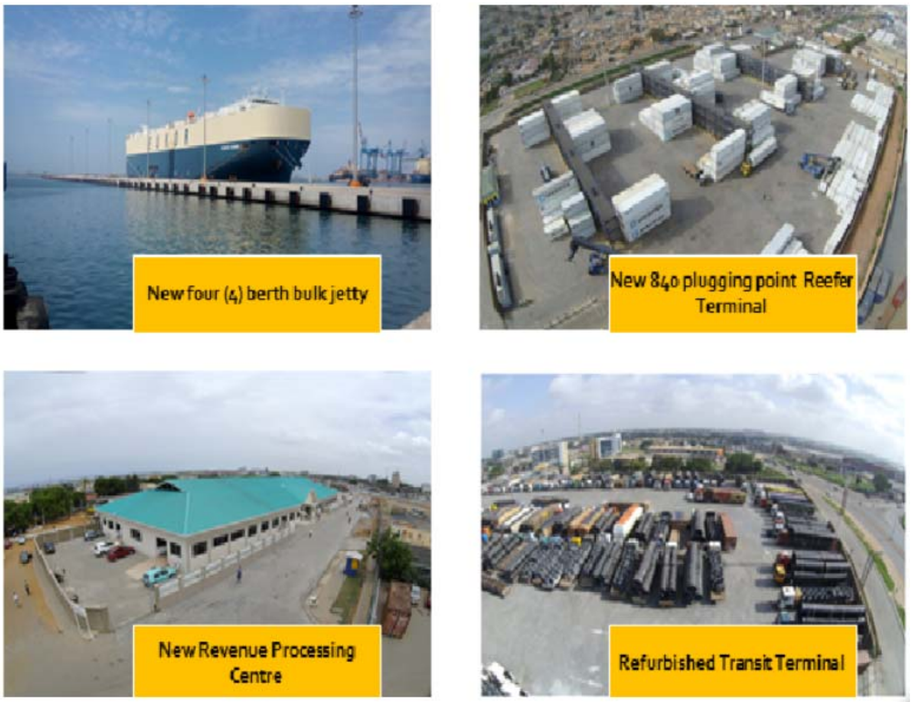
In 1954, the port began to be constructed with an original plan for 12 berths. Construction for a shipyard complex began in 1964. Development projects cooled off between the late 1970s and early 1990s. Expansion of quay two began in 2003 and the first phase of the dedicated container terminal was completed in 2005. Meridian Port Services Ltd. Was formed througha joint venture in 2004 to run the container terminal with Bollore and APM Groups owning 70 percent and the Port authority owning 30 percent. At around the same time, the port went through privatization of stevedoring and shore handling, ISPS Code implementation and compliance services.

In 2007, the second phase of the container terminal began and the Golden Jubilee Terminal covering 140 thousand square meters of land area was completed. This created an off dock devanning area to decongest the port. In 2008, 75 percent of stevedoring services were privatized with the Port Authority handling 25 percent. Expansion in other private services such

[63] Ghana Ports and Harbour Authority, "Official Paperless Process Flow Effective September 1st, 2017" https://www.ghanaports.gov.gh/Files/TEMAPORT/Official%20Paperless%20Process%20Flow.pdf

as off dock terminal activities, warehouses, bunkering, and ship chandlery services also occurred at this time.

Figure 4-11. Tema Port Completed Construction in 2016



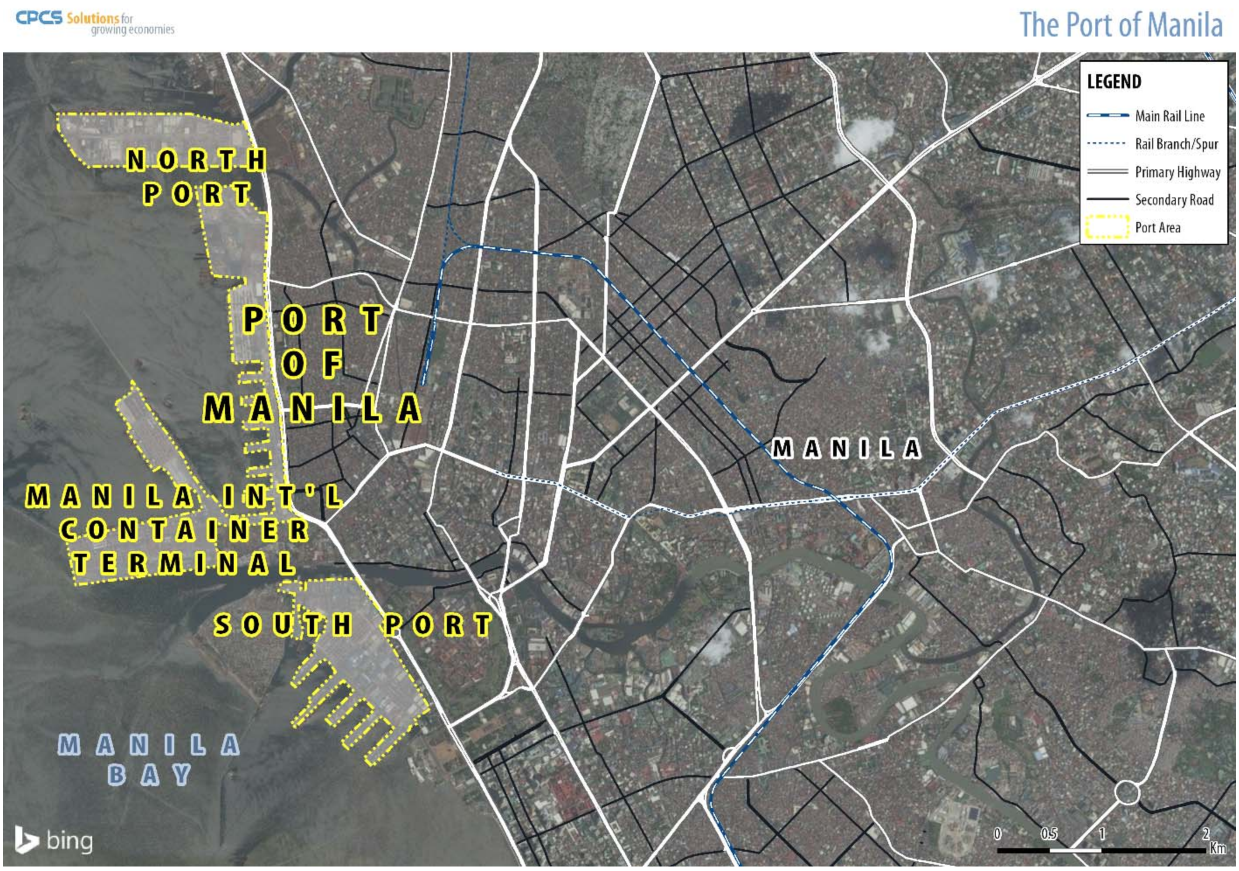
Source: Ghana Ports and Harbour Authority

The Tema Port continues to expand and in 2016 completed four major construction projects. The port completed a 450 meter long by 50 meter wide bulk jetty that can berth four vessels at the same time, which increased berthing capacity from 14 to 16 berths. A new 840 point reefer terminal was also completed and includes regulatory stakeholder offices. A new revenue center for one-stop processing of port payments was also constructed by the customs long room. Finally, refurbishments to the transit terminal was done by installing a solar lighting system to help local artisanal fishermen in fulfillment of the Port Authority's Corporate Social Responsibility Initiatives.[64]

[64] Ghana Ports and Harbours Authority, "Our History and Future" https://www.ghanaports.gov.gh/page/15/Our-History-And-Future

4.10 Port of Manila

Figure 4-12. Port of Manila



Source: CPCS

4.10.1 Background

Manila is the capital of the Philippines located at the estuary of the Pasig River which flows into the Manila Bay. The city has 1.8 million people in the city proper and 12.8 million people live in the metropolitan Manila region.[65] Manila consists of 16 administrative districts, one of which is the "Port Area" where the Port of Manila is located.

The Port of Manila dates back to the 9th century and is the largest international port in the Philippines. The port includes a domestic portion (Manila North Harbor) and two international terminals: Manila International Container Terminal (MICT) and Manila South Harbor. Between 2016 and 2017, container volumes increased 13.8% from 3.98 million TEUs to 4.52 million TEUs.[66] The South Harbor is operated by Asia Terminals Inc (ATI) and the International Container

[65] 2015 Census, World Population Review "Manila Population" http://worldpopulationreview.com/world-cities/manila-population/

[66] Philippines Port Authority, "Port of Manila leaps to 32nd spot among top 100 Container ports", October 29, 2017 http://www.ppa.com.ph/content/port-manila-leaps-32nd-spot-among-top-100-container-ports

Terminal is operated by International Container Terminal Services Inc. The Manila port is regulated by the Philippines Port Authority.

4.10.2 Current Operations Improvement Program

Previously in Manila, as a vessel arrived at the port, all trucks with a container would arrive at the port at the same time. This caused extreme congestion with trucks queuing for days. In 2014, an expanded truck ban was put in place during peak times which negatively impacted freight movement and the overall economy. The ban resulted in vessels waiting up to 17 days for a berth.[67]

In September 2015, the Terminal Appointment Booking System (TABS) was put in place to mitigate congestion issues. TABS is a terminal capacity management "Software as a Solution" (SAAS) system by Australia-based 1-Stop Vehicle Booking System that uses the port's Terminal Operating System to determine when the container has been lifted to the ground. Once this has been determined, a push notification is sent through the system to advise a shipper, carrier, or freight forwarder on where the container is. Once the container has been cleared, another message flows through the system to allow the container to be picked up. Security cards are also scanned through the gates for the carrier to enter the yard.[68]

TABS requires cargo trucks schedule in advance when they arrive or leave the port. There are also fees for using TABS with higher fees during peak hours (P1,000, $19 USD) and lower fees during non-peak hours (P300, $5.71 USD). Rebates are granted for trucks that leave the port between 10:00pm and 4:00am Monday through Saturday. Late or no-show fees are also incurred by truckers that do not show up within a two-hour grace period.[69] Fines for trucks coming two hours after their appointment time is P1,625 ($30.91 USD) while trucks arriving three hours or later after their appointment time are fined P3,251 ($61.84 USD).

4.10.3 Port Evolution

Manila has had a history of congestion issues, some of which is related to the port. In the late 1970s, the Metropolitan Manila Authority first implemented a truck ban in the metropolitan region's eleven major routes for cargo trucks weighing more than 4,000 kilograms. There have been different truck bans implemented in the region since then. In 2014, another truck ban was applied to trucks along the main streets during peak times. The Terminal Appointment Booking System was implemented in September 2015 to streamline operations at the port.

Since implementation of the Terminal Appointment Booking System (TABS) at the port, the system has been able to handle bookings 24 hours a day, 7 days a week. Trucks are thus able to arrive at the allocated time and terminals are able to match trucks to the resources available. This increased efficiency during peak periods by 25%, allowing the port to service an extra

[67] The Load Star, "Record Volumes Through Philippines Port and No Return of Congestion", August 22, 2017 https://theloadstar.co.uk/record-volumes-philippine-ports-no-return-congestion/

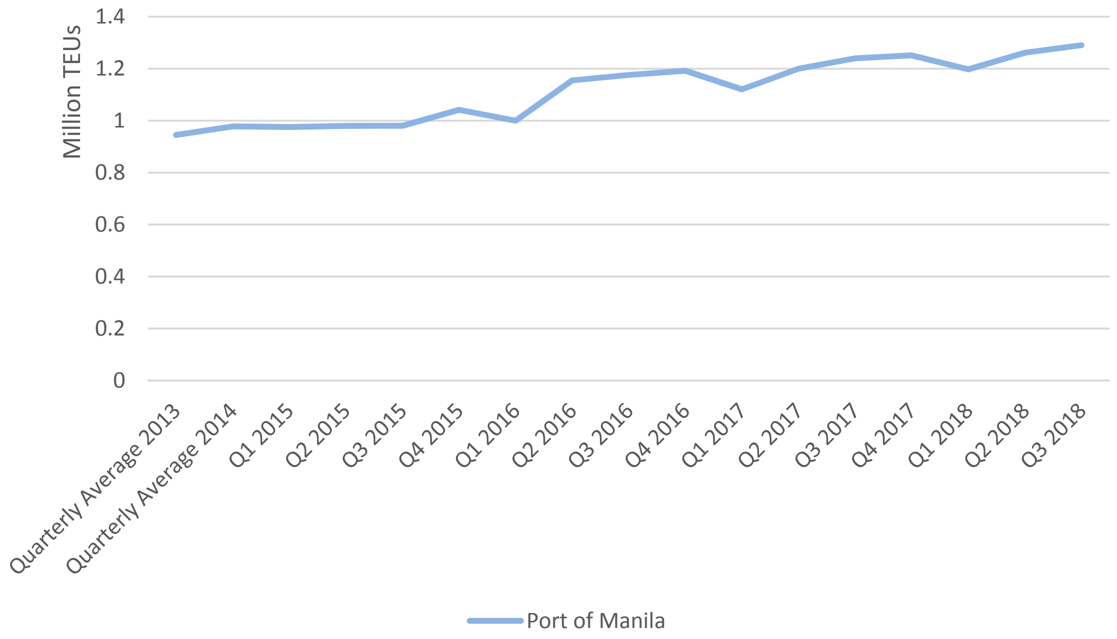
[68] 1 Stop Connections, "The Future of Terminals" https://www.1-stop.biz/the-future-of-terminals-battling-increased-capacity-manila-case-study/

[69] Remitio, Rex, CNN Philippines "Truckers, brokers oppose port booking system", March 1, 2016 http://cnnphilippines.com/metro/2016/02/29/truckers-brokers-oppose-port-booking-system.html

20,000 trucks per month due to a more streamlined process.[70] This system also removed cash payments and eliminated paper processes.

Figure 4-13 below depicts the growth in container traffic between 2015 and 2018, with TABS implementation occurring in Quarter 3 of 2015.

Figure 4-13. Port of Manila Container Traffic 2015-2018



Source: CPCS Analysis of Philippines Ports Authority, Quarterly Ports Statistics for 2015, 2016, 2017, and 2018

The system also had the effect of decreasing container storage charges. While storage charges for the Port of Manila a not available, the port handles the vast majority of traffic in the country.

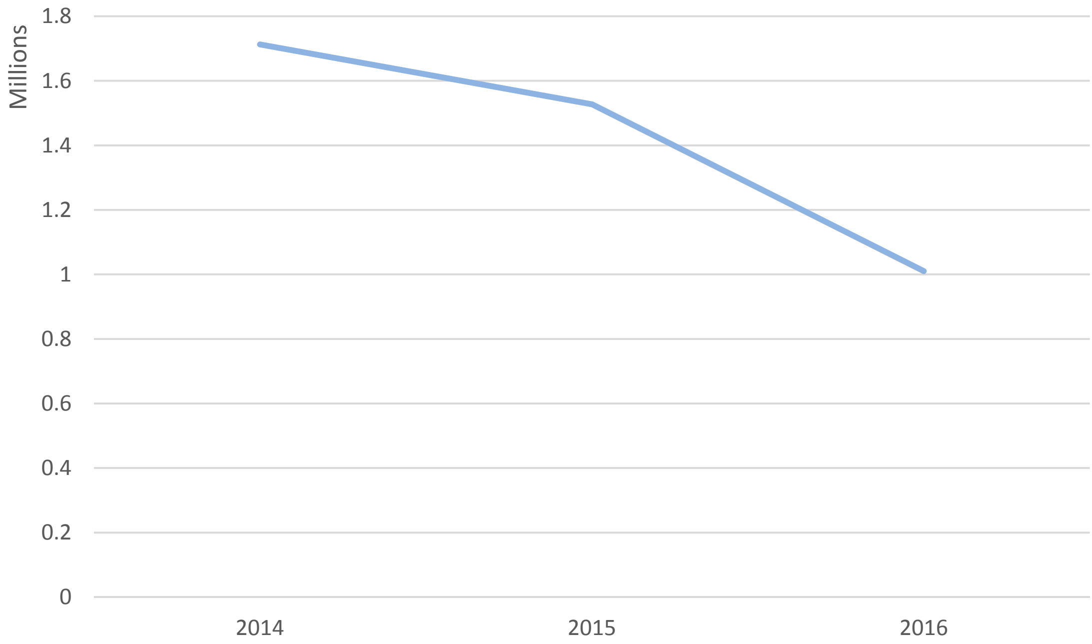
Figure 4-14 depicts the dramatic decline in storage charges between 2015 and 2016 from P1.5 million ($28,531 USD) to P1.0 million ($19,020 USD).

Other results of TABS implementation include:

1. Truck dwell time went from 130 minutes and 48% served within 2 hours down to 100 minutes with 72% served within two hours
2. Load factor went from 1 per trip to 1 each way with 60% of trucks carrying two[71]
3. No terminal congestion during the 2016 peak season[72]

[70] 1 Stop Connections, "The Future of Terminals" https://www.1-stop.biz/the-future-of-terminals-battling-increased-capacity-manila-case-study/
[71] APAC Insider, "The Port to Success" 2016 https://www.apac-insider.com/2016-the-port-to-success
[72] The Load Star, "Record Volumes Through Philppines Port and No Return of Congestion", August 22, 2017 https://theloadstar.co.uk/record-volumes-philippine-ports-no-return-congestion/

Figure 4-14: Storage Charges Across all Philippines Ports



Source: CPCS Analysis of Philippines Ports Authority Annual Reports 2015 and 2016

The appointment system was not without controversy. In March 2016, truckers and custom brokers went on strike to protest the system due to the increase in terminal and storage fees under TABS and the difficulty for truckers to reach the port within a short grace period of two hours. The fees are perceived as being cost inhibitive to commerce rather than enhancing the flow of trade. Additionally, many customs brokers and truckers have voiced concerns over waiting times of up to 24-hours for trucks to enter the ports despite the appointment system due to the rush to avoid truck ban hours and penalties.[73] Traffic is still a concern in the Manila metropolitan region which also creates additional difficulties for meeting reserved booking times.

The Philippines Port Authority is also working on other modernization and development projects at its other ports (Davao-Sasa, Iloilo, Cagayan de Oro, General Santos, and Zamboanga). The Port Authority is also working on Quality Management System (QMS) compliance in its processes to ensure high quality at an agency level.[74]

[73] Excelsior, "Terminal Appointment and Booking System (TABS): Problem or Solution to Faster Customs Releasing", May 4, 2017 https://excelsior.ph/2017/05/04/terminal-appointment-booking-system-tabs-problem-solution-faster-customs-releasing/

[74] Philippines Port Authority, "Port of Manila leaps to 32nd spot among top 100 Container ports", October 29, 2017 http://www.ppa.com.ph/content/port-manila-leaps-32nd-spot-among-top-100-container-ports

4.11 Port of Djibouti

Figure 4-15. Port of Djibouti

Source: CPCS

4.11.1 Background

Djibouti City is the capital and largest city of the Republic of Djibouti with a population of 623,891 people.[75] The Port of Djibouti is located at the southern entrance of the Red Sea and serves as a regional hub for the Red Sea and Indian Ocean, at the intersection of the continents of Europe, Africa, and Asia. The port handles all of landlocked Ethiopia's maritime traffic. The beginnings of the port occurred during the construction of Ethiopia's railway, which has now been replaced by the fully electrified Addis Ababa-Djibouti Railway.[76]

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[75] World Population Review, "Djibouti Population" http://worldpopulationreview.com/countries/djibouti-population/cities/

[76] BBC, "Ethiopia Djibouti Electric Railway Line Opens" October 5, 2016 https://www.reuters.com/article/ethiopia-railway/ethiopia-signs-djibouti-railway-deal-with-china-idUSL6E7NH07M20111217

In 2016, the port handled 987,189 TEUs.[77] The port has been operated by DP World since June 2000[78] and is managed by the Ports of Djibouti SA. China Merchant Holding International (MHCI) has a share in the port as well.[79] The port has a container terminal with two berths and a RORO berth.

4.11.2 Current Operations Improvement Program

The Port uses a Computerized Maintenance Management System (MAXIMO) to manage assets, stores, material control, purchasing, and other sectors at the Doraleh Container Terminal. Djibouti also uses NAVIS N4 for its terminal operations system and Sage as its finance system.

The Djibouti Port Community System (DPCS) also provides an electronic single point of entry for importers and exporters and was launched in July 2018. Previously, companies needed to handle processes themselves through email, fax or telephone such as pre-reporting vessels, status of shipments, export documentation, loading/unloading papers. Managed by the Djibouti Ports and Free Zones Authority, the DPCS aims to increase the productivity and efficiency of sea and airport operations and customs regulatory documentation.

4.11.3 Port Evolution

Djibouti is undergoing a ports expansion project to develop specialized terminals by encouraging private sector investments. Over the last ten years, Djibouti has constructed new specialized platforms, a grain and fertilizer terminal, an oil terminal, and a container terminal.

In 2018, the port also launched the Djibouti International Free Trade Zone (DIFTZ) which covers 4,800 hectares and is aimed at increasing the access for the international business community to create a global trading hub in the Horn of Africa. The DIFTZ Project Preparatory Group consists of the Djibouti Ports and Free Zones Authority, and three Chinese groups – China Merchants Group, Dalian Port Authority, and IZP Technologies.[80]

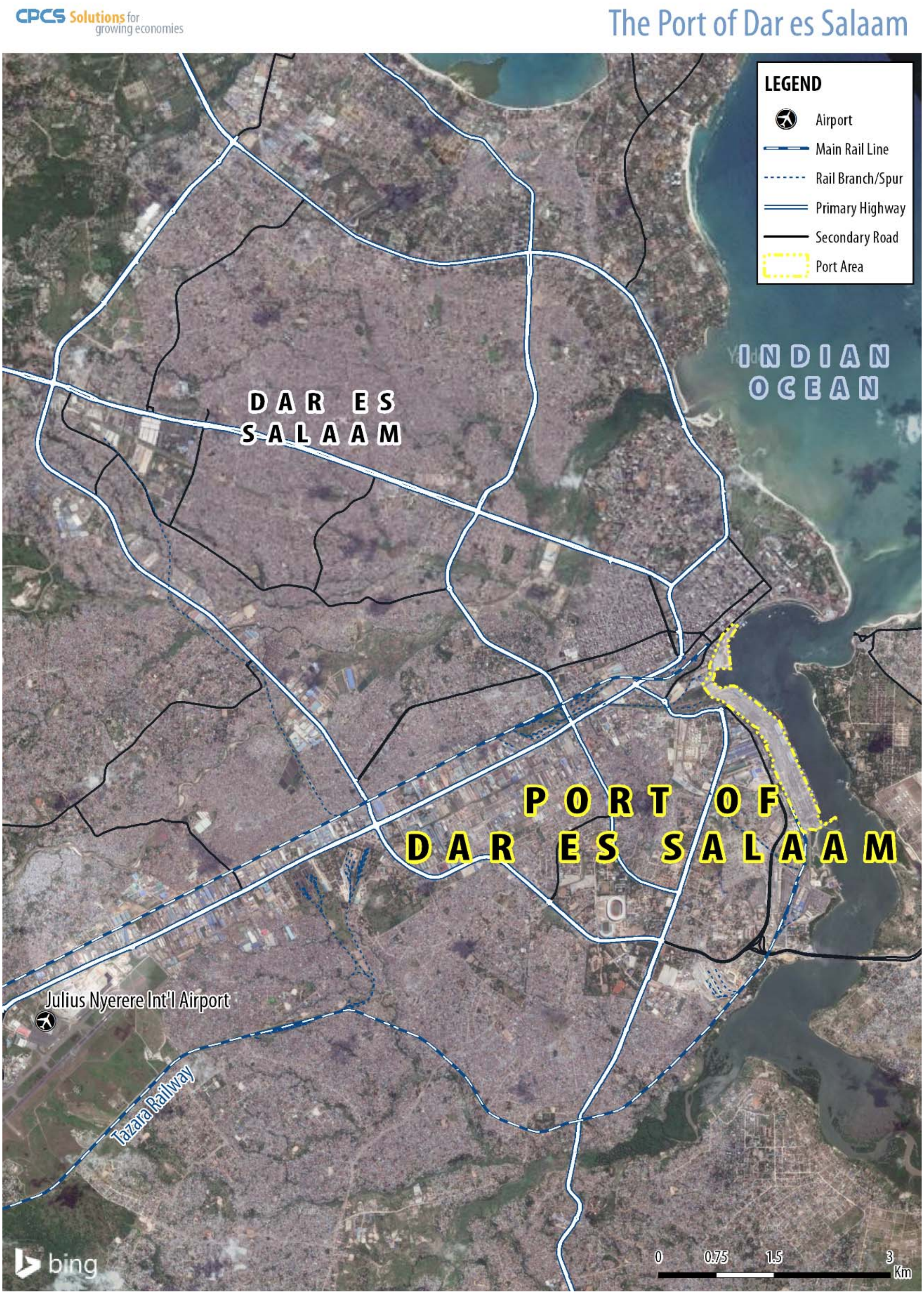
The Port of Djibouti SA is also working on expansion projects with a new facility at the Port of Tadjourah focused on bulk commodities, a new terminal at the Port of Ghoubet for the export of salt, and a new livestock terminal at Damerjog.

Upgrades to the Doraleh Multipurpose Port (DMP) are being financed by Djibouti Port SA and China Merchant Holding to enhance the port to four terminals that will facilitate handling of vehicles and rolling cargo.

[77] Port de Djibouti S.A., “Statistics” http://www.portdedjibouti.com/statistics/
[78] Port de Djibouti S.A., “Port History” http://www.portdedjibouti.com/port-history/
[79] Port Strategy, “Djibouti Unveils Grand Expansion Plans”, September 7, 2015 https://www.portstrategy.com/news101/world/africa/djibouti-expansion-plans
[80] Port Technology, “Port of Djibouti Opens to Global Trade”, July 6, 2018 https://www.porttechnology.org/news/port_of_djibouti_opens_to_global_trade

4.12 Port of Dar es Salaam

Figure 4-16. Port of Dar es Salaam



Source: CPCS

4.12.1 Background

Dar es Salaam is the largest city in Tanzania and East Africa with over 5.5 million people as of 2017.[81] The Dar es Salaam Port is the fourth largest port on the Indian Ocean coastline of Africa and is approximately 8 miles away from the downtown region of the city. The port is Tanzania's principal port facility and provides access to the Indian ports for Zambia and DR Congo, handling 14.3 million tons of cargo in 2015.

The facility includes 11 berths totalling 2,000 meters in length. The Tanzania Port Authority manages berths 1-7 and berths 8-11 are operated by Tanzania International Container Terminal Services Ltd (TICTS) owned by Hutchinson Port Holdings (HPH) in Hong Kong. TICTS handles approximately 80% of all throughput at the port. The company also manages Inland Container Depots (ICDs) at Kurasini and Ubungo which has capacity of 2,500 TEUs to help ease congestion at the main port.[82]

4.12.2 Current Operations Improvement Program

Dar es Salaam uses an Electronic Single Window System (eSWS) to eliminate the requirement for physical cargo clearance through a single ICT interface. The eSWS system with the Integrated Electronic Payment System was implemented in 2015 and was supported by the World Bank but opposed by port government officials due to redundancy concerns with the Tanzania Customs Integrated System (TANCIS). As part of eSWS, the Integrated Electronic Payment System (IEPS) began in 2015 and allows customers to make online and branch payments for port fees online. The system currently accepts Visa cards and two of Tanzania's largest domestic retail banks, and the eventual aim is to allow payment from mobile banking facilities.

The Tanzania Customs Integrated System (TANCIS) was introduced in 2014 and helps improve cargo clearance times and reduces fees. The system allows companies to submit all documentation through the platform and for customs clearance payment to be settled online. The Tanzania Bureau of Standards and the Tanzania Food and Drugs Authority can also process these documents in a central location to issue permits and clearances. TANCIS is estimated to reduce expected clearance times from five days to "less than half that amount".[83]

A One Stop Center (OSC) adjacent to the port facility was installed in 2016 and brings all government officials under a single roof to help with documentation processing efficiency. The building will include the Tanzania Port Authority, Ministry of Works, Transport and Communication, Government Chemist Laboratory Agency, Atomic Energy Commission, Food and Drug Authority, and Weights and Measures Agency.

An Integrated Security System (ISS) with a 486-strong CCTV camera network and control room is also in place at the port as of 2016. All license plate numbers for vehicles entering the facility are also recorded and employees and visitors must provide electronically-identified ID cards in order to enter and exit the facility. Scanners were also introduced at main gates to check for

[81] Population of 2018, "Dar Es Salaam Population 2018" http://populationof2018.com/dar-es-salaam-population-2018.html
[82] Elliot, European Union, "Policy Briefing: Port Operations in Dar es Salaam", 2016 http://www.eubgtz.com/uploads/5/7/5/8/57583457/policy_brief_ports.pdf
[83] 2016-17 Tanzania Ports Handbook, published February 2016 by Land & Marine Publishing.

prohibited items and can ascertain the weight, quantity, or size of cargo inside a container. This system is primarily aimed at reducing the high incidence of theft and illegal business activity.

4.12.3 Port Evolution

As of 2016, more than 800 vehicles leave and enter the facility daily and 98 percent of containers leave the port by road, which causes significant road congestion in the city. The TPA is also looking to reduce congestion by releasing vehicles at off-peak times.

The Dar port has been perceived as bureaucratic with multiple government agencies involved in the clearance process through certification, verification, and processing of goods. Corruption and extortion are issues that importers face in some instances. The port also does not allow pre-declaration of cargo value.

The port is also more expensive than key regional competitors due to a burdensome tax and wharfage fee system. As of 2013, storage fees were $5.4 per ton given a storage cost of $20 per day for a 20 foot container after a free storage period of seven days for local imports and 15 days for transit. Wharfage fees are charged in proportion to the value of merchandise instead of a flat fee charged in ports like Mombasa in Kenya. The Dar port's storage and other fees are approximately 75 percent higher than Mombasa in Kenya.

The Dar es Salaam Maritime Gateway Project (DMPG) is a $750 million project funded by the World Bank, the UK Department for International Development, and others and is intended to improve the intermodal interface with road and railway transportation links and also to streamline permit processing. This project is expected to double capacity to 28 million tonnes by 2020 and more than triple capacity to 34 million tonnes by 2025. Specific phases include:

1. Phase 1: the project began with demolition of Sheds 2 and 3 in the port to accommodate more containers. Five sheds will also be demolished to decrease congestion, with road upgrades. A single traffic flow system and integrated security and scanning system will be installed as well.

2. Phase 2: this phase includes dredging the channel and turning basin in the port to strength, widen, and modernize Berths 1-7 for handling larger vessels.

The DMPG project also envisages constructing two additional berths for continuing container trade growth by extending berth 11 and removing an existing pipeline.

Access infrastructure also requires investment that has been committed to by the World Bank and its partners. These projects include upgrades to three access roads – Kilwa, Nyerere, and Mandela, along with a Southern bypass between the port and Kibaha.

Anti-corruption initiatives are being undertaken by President Magufuli in order to improve performance and accountability. In late 2015, the port's board of directors were dissolved and the director-general was let go due to over 2,700 shipping containers that disappeared. In 2016, the Chief Executive Officer of the Weights and Measures Agency was suspended as the agency decided not to use oil flow meters to verify import volumes, and the Prevention and Combating of Corruption Bureau and police are investigating the matter. The government has also focused on cracking down on smuggling and tax evasion.

4.13 Challenges experienced in Port-Truck Interface programs

While implementation of these programs varies based on the context for each port, there are common challenges associated with these programs.

Truck Fleet Tracking

Although truck GPS technology has significant benefits for congestion mitigation and operational efficiency, there are fair labor practice concerns in many contexts, as tracking trucks is tantamount to tracking the whereabouts of drivers. Fleet tracking allows information recording such as truck speed, number of stops a truck makes, and location. Using this information, it is possible for trucking companies to track when drivers spend excessive time at a service call, lunch breaks, and so on. Labor regulations should be addressed prior to implementation of GPS technology so that truck drivers are given adequate rest time.

Truck Licensing System and Environmental Requirements

Licensing systems can result in more sustainable and efficient drayage trucks and engines. However, prior to implementing licensing systems, appropriate technology must be implemented to facilitate efficient checking of driver licenses or operating permits at the gate. Additionally, licensing requirements for trucks cannot be overly burdensome, and should strive to accomplish minimum safety and competence characteristics. Requirements that are difficult to fulfill may also be perceived as favoring certain companies over others and should be avoided.

Truck Appointment System and Extension of Gate Hours

When deciding between a truck appointment system and gate hour extensions, most terminal operators typically implement an appointment system due to labor cost considerations. However, an appointment system does not assure timely processing of each transaction and does not reduce the duration of each transaction (truck turn). The appointment system also does not prevent against missed or late appointments, but can assist with more easily rescheduling appointments.

Additionally, accommodations for cargo pickup and delivery outside normal weekday hours are typically not the practice due to unionized longshore labor costs outside of normal operating hours. In order to maximize labor productivity, terminal operators typically restrict cargo activity to one-day shift, while restricting evening and weekend hours to special arrangements and preferred customers with large numbers of containers.

Extended gate hours are also unpopular due to an industry shift to off-peak hours. Truck drivers must be available to work extended work days or evening shifts. These drivers are typically private contractors without significant bargaining power against terminal operators and their trucking companies. Warehouses, distribution centers, manufacturers, and other entities must also be available to process cargo during off-peak hours. In local areas that prohibit night or weekend truck deliveries, zoning regulations must also be changed.

Construction Projects to Improve Capacity

Ongoing construction projects are many times necessary to improve capacity at the ports. These projects can be fairly capital-intensive and may also impose environmental damage. Ports should ensure to engage the public and conduct reviews of the projects to minimize negative impacts on the surrounding community. This becomes especially important when ports are in the proximity of large metropolitan regions.

Port Automation

Some critiques of port automation include the significant capital investments and equipment maintenance costs incurred to both launch and sustain operations. Automation may also attract labor conflicts due to the loss of job positions. Additionally, flexibility for operational planning may be reduced as new operating scenarios must be planned beforehand and exceptions are more difficult to accommodate. Another limitation of automated systems is that they rely on information availability and accuracy in order to interact between different systems. In environments where data are error-prone or unreliable and records are not systematically updated, automation may not have the intended benefits.

4.14 Lessons for Ports in Lagos

In summary, we looked at the programs of ten major metropolitan ports across North America, Europe, Africa, the Middle East and Asia. Each of these programs is multi-pronged, and consist of:

- Updated rules and regulations on the part of the public sector for functions such as driver licensing and operating authority requirements.
- Coordinated single window / clearance / gate processing approaches that require public and provide coordination between public entities, shipping lines, terminal operators, and cargo owners
- Changes to operating hours, queueing processes, and fee structures for drayage and container moves
- Fleet tracking and truck identification solutions to locate trucks as the move about the port, or within the vicinity
- Quayside and yard area automation, and increased reliance on electronic transaction and identification data

None of these measures provide a silver bullet to addressing congestion. The evolution of these ports shows that mechanisms such as automation, tracking, electronic transaction management depend on fundamental structures of diver and truck licensing and registration, electronic transactions, etc. being gradually phased in over time. Port-truck interface automation continues to be an area of emerging techniques and solutions, and is yet to become mature and standardized, although many ports seem to already be capturing significant benefits. Scheduling and buffering using ICT should therefore be thought of as an advanced scheme for Lagos area ports with a number of pre-requisite steps to set the stage for implementation.

5 Facility Configuration and Service Design

Key Messages

Solution Architecture

The state of the art in managing truck movements for dray operations is the scheduling and buffering approach. This approach most often leverages modern ICT capabilities. Under a "do nothing" or business as usual scenario, truck parking supply and demand will not reach any other equilibrium than the one observed today: lengthy queues of parked trucks on the port access roads. Any overall solution must therefore influence and rebalance the behavior of trucks near the port facilities. A Truck Appointment System aligns incentives by reducing the ambiguity around when a truck needs to report to a terminal, thereby reducing indiscriminate demand for parking in the interim.

Operating Logic for Lagos

A high-level process logic for a truck appointment system was developed based on the case studies evaluated, our assessment of the most common truck booking systems, and targeted consultations with vendors. It shows how four key actors exchange information about operations in real-time and near real-time to coordinate truck movements. The actors are: (i) Terminal Operator, (ii) Port Access Control, (iii) Truck Park Operator, and (iv) Truck Drivers. A Truck Appointment System serves as a clearing house for the coordinated exchange between them. The process involves a series of triggers and events among the actors

Business Rules

The overall logic and "business rules" for coordination must precede the choice of any technology or ICT-based system. These rules or additional process design factors can significantly enhance or diminish the efficiency of both dray trucking operations and also terminal productivity. In fact, the rules will largely dictate the desired capabilities and functional requirements and help scope the right set of enabling technologies for the TPPAF.

ICT Needs

Five types of components are needed to develop an ICT-based solution for truck operations and parking at the ports. These are (i) location-based sensors, (ii) embedded hardware, (iii) communications, (iv) databases, and (iv) decision-making dashboards.

Key Implementation Issues

Accomplishing ICT-enabled truck and port operations management in the LMA will require that stakeholders gradually climb a steep learning curve. In addition to the design and investment effort early on, the process of ramp up and eventual operations present a challenging but feasible proposition. Only a handful of port systems in the world have begun to integrate ICT in the manner envisioned, mostly in the last five to ten years. Further, maintenance of such ICT systems is a specialized activity, and the port, fleets, and terminals will have to contend with specialist vendors, service providers, and operators.

Buffering Sites

We performed a site suitability analysis and evaluated four short-listed sites as buffering (short-term parking sites): Site 1 – Orile, Site 2 – Kirikiri, Site 3 – St. Matthew Daniel, Site 4 – FMPWH TCI Gate 2. The first three are analyzed further at the conceptual design stage.

5.1 Background

The objective of developing a Truck Parking and Port Access Facility (TPPAF) is two-fold:

- → To alleviate truck traffic and queue lengths that result in congestion, pollution, and related externalities on the network of port access roads in the LMA, and
- → To streamline operations at the port-hinterland interface to improve truck turns (i.e. the duration of truck presence within the port, between arrival and departure through the access gates)

The TPPAF concept envisions a solution that can simultaneously help mitigate queues, as well as serve as the point of coordination for truck-port access requirements.

This chapter discusses the factors, considerations in the design of such a TPPAF and presents a site-specific analysis for the available truck park sites in the LMA.

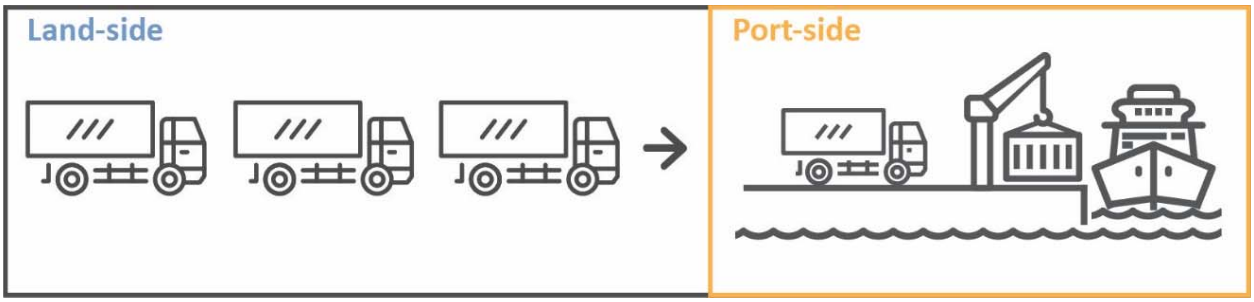
5.2 Global Best Practice – Scheduling and Buffering for Dray Operations

The state of the art in managing truck movements for dray operations is the **scheduling and buffering** approach, as defined earlier. This approach most often leverages modern ICT capabilities.

5.2.1 Concepts

Scheduling dray moves (appointment windows) is a common practice in operations, and it works well in ideal or close to ideal conditions. When there is little to no congestion, and port-side operations are on time, dray trucks can drive from the highway or local facility directly to the port gate and eventually enter the yard (Figure 5-1). Once the load is delivered / transferred trucks can quickly exit the yard. Travel time reliability is high under idealized conditions, implying that trucks will predictably arrive on time even for their appointments even as they traverse the local road network. Port operations are also predictable and streamlined, and trucks do not need to wait. Scheduling provides the coordination needed to deliver "just in time" dray operations and balance container handling across the operating hours of the port. In other words, scheduling is sufficient and the right operational fix for ideal conditions.

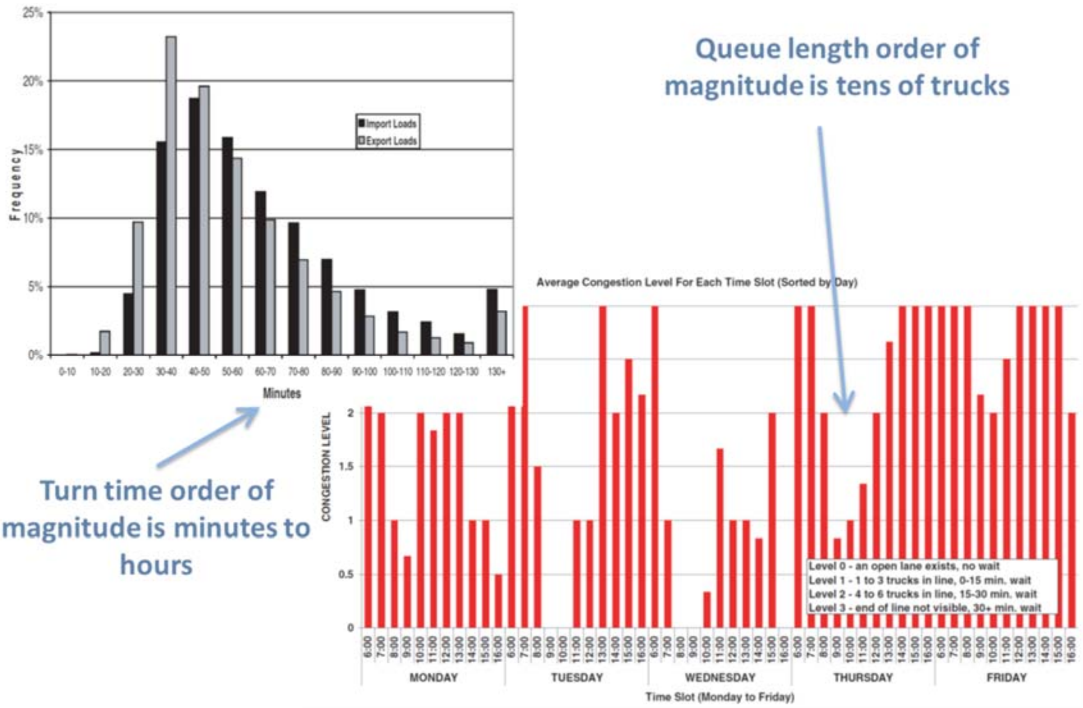
Figure 5-1. Dray appointment scheduling under ideal conditions – trucks proceed directly to the port yard



Source: CPCS

In reality however, travel time on the local road network is rarely reliable around the clock in metropolitan port areas, and port-side operations also fluctuate and vary depending on a number of operating procedures such as vessel unloading, container handling, customs clearances, etc. Even if trucks were to arrive at the port gates at the appointed hour, it is often likely that minor delays will ensue before trucks are admitted to the yard, as a result of port-side operational fluctuations. Conversely, if port operations run on schedule and trucks are caught up in last mile traffic, it will cause trucks to "miss" appointments and stress yard-side operations. As shows, the data on truck turn times and queue lengths from other ports reflect this inevitable natural variation.

Figure 5-2. Dray appointment scheduling under ideal conditions – trucks proceed directly to the port yard

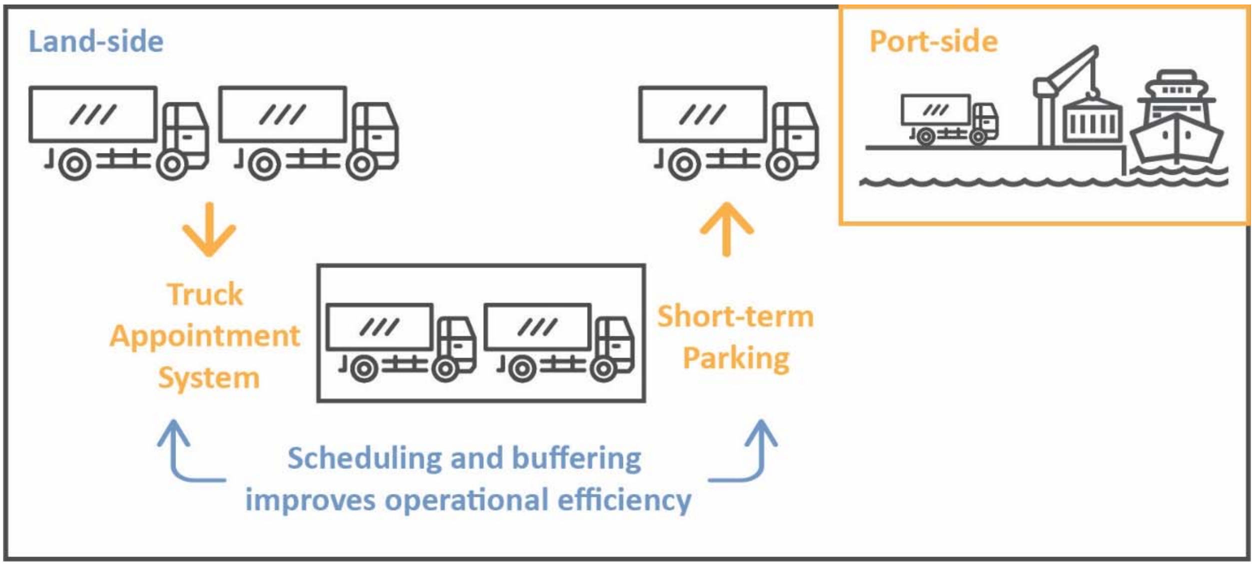


Source: CPCS synthesis of Transportation Research Board NCHRP Report 14 results

The NPA does not publish hourly or daily statistics, making this type of distribution analysis infeasible. However, it is important to note that at ports where trucks experience dwell times (on the order of minutes to hours) and congestion (on the order of several to tens of trucks), parking is not a necessary provision for coordinating operations. As the discussion below shows, buffering is more important when variance in turn times and the likelihood of disruptions is high.

The global best practice at leading ports is to build in a **buffering** mechanism (in addition to scheduling) to mitigate the possible disruptions of natural variation in operating conditions. Trucks that have already arrived for their appointments, but cannot be admitted to the port yet are re-routed to short-term holding lots to await their appointment time. Alternatively, trucks are asked to first report to the holding facility to await their appointment time (Figure 5-3). Buffering accommodates possible delays on both the yard-side and the land-side, as it provides a greater likelihood that trucks will be in place to perform the dray operation in conjunction with the flow of port operations.

Figure 5-3. Dray appointment scheduling under real conditions – trucks rerouted through short-term parking when needed



Source: CPCS

5.3 TPPAF Scheduling Architecture for Lagos

The TPPAF solution is a scheduling and buffering system which combines a Truck Appointment System with a short-term holding lot(s) / truck marshalling yard to account for variance in timing of operations. An ICT-enabled scheduling and buffering approach for the TPPAF can be an important tool, and the best practice case studies showed that many urban / metropolitan ports around the world have already implemented variants of such systems. This section develops the concept for the Lagos Ports Complex and Tin Can Island Ports Complex. We first describe the scheduling aspect of the concept including the rationale, operating logic, and business rules necessary for successful operation.

We have evaluated both implicit "demand" for truck parking (truck queues, gate operations, etc.) as well as potential supply of truck parking (site-specific analysis). Our root cause analysis shows that the Lagos ports area has neither short-term nor long-term dedicated parking space. As demand far exceeds supply, trucks choosing to remain in the vicinity of the ports are forced to queue on streets. In other words, under a "do nothing" or business as usual scenario, truck parking supply and demand will not reach any other equilibrium than the one observed today: lengthy queues of parked trucks on the port access roads. Any overall solution must therefore influence and rebalance the behavior of trucks near the port facilities.

5.3.1 Rationale for Truck Appointments -- Influencing "Demand" for Parking

Current congested conditions near the port gates reflect a poor alignment of incentives for trucks to provide services reliably as and when they are needed. Based on our survey results, a sizeable proportion (12%) of trucks in queues are vying for new business. These numbers combined with their long dwell times -- some waiting for five to ten days or more – exacerbates inefficiencies. In contrast, ports highlighted in the best practice case studies do not allow for this type of opportunistic behavior, and dwell times are on the order of hours, not days!

Strictly speaking, these trucks are being opportunistic and do not need to be accommodated. However, their presence in the queues speaks to the underlying ambiguity of not knowing when their services will be required. This ambiguity is driven by the lack of visibility (from a landside operations perspective) on terminal and quayside operations. Schedules for vessel calls, berthing, loading / unloading operations wait times, customs clearance time requirements, etc. are not transparent. The consequence of this for truckers is missed service opportunities -- the opportunity cost of not being at or near the gates when their service is needed for drayage or hinterland deliveries is higher than if the truck drivers were to simply spend their idle time near the ports.

A Truck Appointment System aligns incentives by reducing the ambiguity around when a truck needs to report to a terminal, thereby reducing indiscriminate demand for parking in the interim.

In addition to the technologies and processes of a TAS, re-aligning incentives also requires (1) the design of appropriate guidelines and restrictions on how and when trucks should access port facilities and the surrounding network of access roads, and (2) enforcement of restrictions for trucks who are incompliant, with the possibility of penalties that are stringent enough to balance out the opportunity cost of idling near the port.

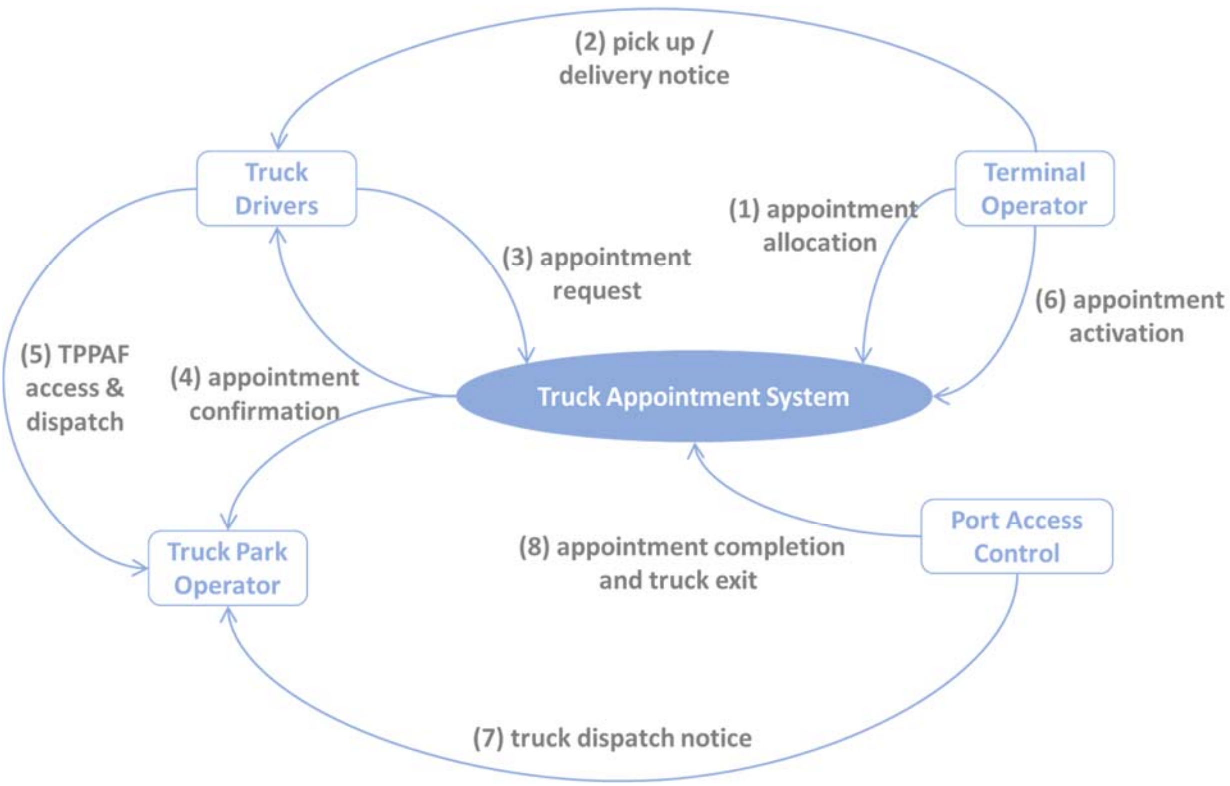
For this approach to work, the demand-side cannot be influenced in isolation. The incentive for truckers to utilize a TAS system must be “sticky” and strong enough to where truckers find it in their interest to participate in the process flow that is envisioned in the TPPAF solution architecture. Additional coordination is needed on the supply side of the parking equation, i.e. the between vessels, terminal operators, port access controls, and truck park operators.

5.3.2 Operating Logic for Coordinating Truck-Port Access

“Supply” in this context is the availability of truck parking spaces in land-side lots, and a priority allocation of parking spaces to those trucks that imminent delivery / pick up trips to complete. A truck appointment system is one best practice approach for coordinating truck parking, staging, and port access.

Figure 5-4 shows the proposed high-level process logic for a truck appointment system that was developed based on the case studies evaluated, our assessment of the most common truck booking systems, and targeted consultations with vendors. It shows how four key actors exchange information about operations in real-time and near real-time to coordinate truck movements. The actors are: (i) Terminal Operator, (ii) Port Access Control, (iii) Truck Park Operator, and (iv) Truck Drivers. A Truck Appointment System serves as a clearing house for the coordinated exchange between them.

Figure 5-4. Operations Logic for Truck Appointment System



Source: CPCS

The process involves a series of triggers and events among the actors, and can be explained as follows:

(1) **Terminal Operators** trigger the **Appointment System** by allocating batches of appointments based on yard and quayside operations, and also (2) notify **Truck Drivers** of the need for pick-ups / deliveries.

(3) **Truck Drivers** then ping / query the **Appointment System**, to request an appointment time based on the declared needs and availability of appointments across various time slots. The **Appointment System** (4) responds with confirmations, or other supporting details.

With an appointment confirmation in hand, **Truck Drivers** can (5) request access at an assigned truck park in preparation for their appointment window, and check in with the **Truck Park Operator** who can verify the confirmation with the **Appointment System**.

As soon as the **Terminal Operator** (6) activates the batch of appointments, **Port Access Control** (7) notifies the **Truck Park Operator** for dispatch of the specific **Truck Drivers** (who are also simultaneously notified by the system). **Port Access Control** admits the **Truck Driver** to the port facility.

When the **Terminal Operator** has closed the operation (and the appointment is completed in the **Appointment System**), **Port Access Control** also (8) verifies that the **Truck Driver** has exited the port facility.

This architecture does not fully represent all necessary interactions (eg. customs checks) or administrative procedures which might be specific to a particular terminal or port. There are also many variants of this type of architecture. However, as we highlight above, any variant will require the actors to coordinate in a similar manner for this type of process to be effective. For example, a number of coordination and enforcement procedures will likely to be in place and enforced such as turning away trucks who are returning empty containers without an appointment, or denying access to trucks without appointments. Further, since the buffering lots are intended for short-term use, other complementary strategies are required to address the issue of longer-term truck presence in the LMA.

5.3.3 Business Rules to Align Incentives

In principle, this type of solution architecture does not require sophisticated ICT arrangements. The logic for information flow is common to many queueing and operations models with stocks (parking capacity) and flows (trucks, event-driven information).

We emphasize that the overall logic and "business rules" for coordination must precede the choice of any technology or ICT-based system. These rules or additional process design factors can significantly enhance or diminish the efficiency of both dray trucking operations and also terminal productivity. In fact, the rules will largely dictate the desired capabilities and functional requirements and help scope the right set of enabling technologies for the TPPAF.

The business rules include, but are not limited to:

- → **Windows**: The discrete time windows for appointments (ex. 6 – 9am) which are agreed upon based on adjustments to regulations, vessel calls, labor practices, etc.
- → **Slots**: The number of appointments within each time window, adjusted by vessel calls, operations loadings etc (ex. 100 in an off-peak hour, but 125 in a peak hour) and terminal and port access handling capacity
- → **Incentives**: Trucks that have reported to a buffering lot with a confirmed appointment are not penalized for a missed appointment because of urban area congestion or longer travel times from the buffering lot to the port on a particular day.
- → **Flexibility**: options for appointment overflow or accommodation for trucks that miss a slot
- → **Dynamic Pricing**: time-based pricing for certain services and fees for load shifting, peak spreading
- → **Bundling of Charges**: including the fee for use of the truck appointment system in the list of mandatory fees and charges that truckers are still responsible for as a part of doing business at the port.
- → **Lead-time**: advance scheduling / rescheduling / appointment modification to ensure utilization of capital equipment, truck capacity, parking lot capacity, labor shift allocation, etc.

Business rules can be prioritized and phased in so the essential requirements are activated first – appointment windows and slots, missed appointment accommodation, for example –

whereas dynamic pricing can be deferred to a later stage as an advanced feature. Even implementing the minimum requirements, and gradually increasing compliance over time can have significant benefits for the system.

5.4 ICT Architecture

Five types of components are needed to develop an ICT-based solution for truck operations and parking at the ports. These are (i) location-based sensors, (ii) embedded hardware, (iii) communications, (iv) databases, and (iv) decision-making dashboards.

1. **Location-based sensors**: Location-based sensors (LBS) communicate the identity and location of the truck, tractor and/or the container. Trucks enabled with an LBS can automatically share their location or be recognized by a tracking system in near real-time, i.e. every few seconds. LBSs can either be active or passive. Active sensors "beam" out their location over a wide area of operation, whereas passive sensors must be within the range of a corresponding scanner. Passive sensors tend to be cheaper than active, however they still need associated hardware to be embedded in the port environs. The two most prevalent types of LBSs for port operations are Geographic Positioning System (GPS) (active) and Radio Frequency Identification (RFID) (passive or active). The choice of sensor is dependent on the overall system architecture, as the associated hardware, and databases are different.
2. **Embedded hardware**: These hardware are scanner / receiver devices that scan their environment within a short range for a LBS-enabled vehicle, or for the presence of the truck in a particular part of the port. They are usually part of the port's built infrastructure and continuously operational in the background, and therefore called embedded. RFID scanners mounted on gate posts / gantries, inductive loops in truck lanes, and weigh-in-motion sensors are examples of embedded hardware. They are usually deployed in combination as part of a broader architecture, rather than be used in isolation.
3. **Communications**: Both LBS and embedded hardware ultimately depend on communications infrastructure to be able to "shake hands" with each other and record theses interactions by "talking" to databases. There are many possible communications protocols that are well suited for the harsh industrial conditions of port environments, including fiber-optics, low-energy Bluetooth, dedicated short-range communications (DSRC), WiFi, and cellular / GSM. The choice of communications protocol in part depends on the volume of handshakes/observations data, the preferred latency (i.e. the reliability of recording most or all of these interactions, and the potential for using these protocol for other operational purposes. All communications protocol typically have provisions for security and encryption as a safeguard.
4. **Databases:** Port transactions data, vehicle operator clearances, identity information, and data on truck whereabouts, interactions / "handshakes" can be stored in relational databases. As the name suggests, these databases relate attributes from one part of the system, e.g. truck identity, to a separate part of the system, i.e. bookings for containers, customs clearances, etc. Such databases are the backbone of "single window" approaches adopted by many port systems. By querying databases from time to time, decision-makers obtain visibility into the separate but inter-related parts of port

operations. This “enterprise” view of the port and related operations can be scaled to suit the level of automation desired and the types of operations that will be ICT-enabled.

5. **Operator dashboards for decision-making**: The complexity of port operations, and the sheer volume of interactions and transactions occurring can easily overwhelm a human operator. In reality, an operator does not need continuous access to all stored data, and rather needs to be alerted to only those decisions and operations that are imminent. Further, these data are not very useful in their raw form, and can assist in decision-making only when they are transformed into some type of performance measure, for e.g. the queue-length at a gate, or the average processing time for container operations. The solution architecture for truck and related port operations therefore includes customizable performance dashboards to highlight for each port operator the types of information and performance that are needed for decision-making.

The possible permutations and combinations of the five types of components discussed above is quite large. Vendors, systems integrators, and service providers offer different capabilities, and have their preferred partners / solutions in place. Consequently, there are number of trade-offs involved in the choice of any ICT solution architecture.

As the case study discussions show, the same technologies can often be used as platforms to address multiple efficiency and operations objectives. The solutions are often designed comprehensively to integrate both truck and port facility / terminal operations to optimize performance and maximize benefits for participating stakeholders.

5.5 Other Enabling ICT Requirements and Cross-Functions

From a technology capabilities’ perspective, there are a number of specialized functions that must be enabled and activated for the system to work as envisioned. These include methods to store, manage, and use data to make decisions, and then communicate them. The four specialized capabilities that must be integrated for a functioning Appointment System are described below.

5.5.1 Electronic Data Interchange (EDI)

An EDI is an automated system that links different organizations through automatic transfer of certain types of data. Administrative records such as vehicle registrations, company certificates, licenses to operate, and transaction records such as container (or other asset) identification, inventory, shipping records, customs clearances, etc. must be shared electronically.

EDI uses data standards such as ANSI or EDIFACT to ensure that information is shared between parties in a manner that is compatible for the automated computer network to read and instantly populate / update the database. The information sharing rules can be pre-designed.

The EDI is thus the information backbone of the appointment system as all queries and checks must be performed against this database. All participants in the system must therefore follow protocols to ensure that their contributions to the system are up to date.

5.5.2 Automated Identification

Physical identity verification is an important aspect of the Appointment System. Verification is required in a number of specific instances, including truck park entry / dispatch, port access and egress, operation (pick up / drop off). Further, in addition to verifying the driver's identity, the truck, chassis, and container also need to be verified as registered in the Appointment System.

Using Optical Character Recognition (OCR) technology deployed in the form of Automated License Plate Readers (ALPR) is one typical solution for identifying trucks, tractors, chassis, or containers. Stationary ALPR cameras are mounted in the form of a network to identify a vehicle (asset) and its movement over a limited spatial area, i.e. port access and yard area. Similar cameras can also be mounted on security vehicles at gates and other moving objects such as cranes, depending on the number of and location of verification instances.

Radio Frequency Identification is the other mainstream approach for automatically verifying identity, or determining the location and movement of a vehicle (asset). RFID can also be deployed on gantries, posts or on slow moving objects.

Both ALPR and RFID are mature and reliable solutions, and the associated software systems can easily process thousands of records every minute. The choice often depends on other design consideration such as the ability to mount cameras versus scanners, line of sight obstacles (for cameras), distance between sensor / camera and identifying information (tag / license plate), overall cost of the solution, and the organization's expertise with different tools and data systems.

Figure 5-5. Mounted and moving ALPR cameras for vehicle (asset) identification, and (below) combination scanners for trucks and containers

Source: Electronic Frontier Foundation; Certus Port Solutions

5.5.3 Event-based Decision Support

As illustrated in the process flow model presented earlier, the Truck Appointment System is driven by event-based triggers. For example, the truck arrival at the TPPAF is an individual event, which is separate from the next event in which the truck might be dispatched to port access control. The system must therefore be able to not only record but also make these events visible to each of the four actors. An event messaging and dashboard display is thus one key component of the TPPAF ICT solution.

The events and messages are typically visualized on screens to give operators a spatial knowledge of vehicle / asset location, movements, speed, and when decisions must be triggered. The system can be used for exception handling, i.e. prompt the operator or access controller to take a corrective action when an error is observed, but otherwise allow mostly automated operations.

For the TPPAF, dashboards at main locations for the event-based systems will likely be customized differently to prioritize and emphasized some information over others. For example, the truck operator will see parking lot occupancy, appointment calls, and other messages, whereas port access control will see rolling appointment schedules, truck and asset ID verification confirmations, etc.

Figure 5-6. Event-based dashboard displays for decision-support at a port facility

Source: Port of Antwerp

5.5.4 Messaging and Communication

A communications system unites the three other technical capabilities of Electronic Data Interchanges, Automated Identification, and Event-driven Decision Support. Without a communications network to connect actors at disparate locations in real time, the Truck Appointment System will not be able to accomplish real-time operations.

A combination of communications infrastructure is likely needed, based on the criticality of messages / information passed, and associated security requirements. For example, it is common to embed fiber in the yard to link terminal operator data transfers and messaging with port access control, whereas communication between access control and trucks could be wireless through Dedicated Short Range Communication (DSRC) or similar protocols. Further, communication between truck drivers and the Appointment System could be accomplished through a simple system such as SMS (GSM) based message passing. More complex solutions include app-based communications with associated data standards.

5.6 Costs

There are two cost perspectives on the ICT-based Truck Appointment System under a PSP model.

The first is the total cost of service delivery borne by the private participant (i.e. the TAS and park operator), inclusive of any capital and operating costs. These TAS costs should be priced separately from the cost of developing the physical TPPAF facilities, and the park operators will have some discretion in the nature and magnitude of these costs as they are integral to the design of the service offering itself. These costs will also depend on the specific solutions chosen for the Electronic Data Interchange, the Automated Identification system, Event-based Decision Support system, and the Messaging and Communication System. To the extent that the operator trades-off more technology-intensive solutions (heavily automated, using mobile apps, etc.) with labor-intensive approaches, the total cost of service will vary along a spectrum. Other factors that drive the cost of service include the degree to which "bespoke" or heavily customized software is implemented and the specific vendors and providers. An order of magnitude estimate is that the annual total cost of service could exceed a hundred thousand dollars, based on experiences at similar facilities in other port systems.

An estimate of the capital cost of a TAS and necessary components including hardware, software and initial integration and deployment costs is shown below.

Figure 5-7. ICT-related System Installation and Upfront Costs

Cost Component	Upfront Cost (USD)
Superstructure, including IT Networks, automated kiosks, road monitoring, IT equipment, RFID	3.5 million
Software licensing and databases	3.5 million
Setup costs such as training, deployment, etc	3 million
Total	**10 million**

Source: vendor outline business case

The second cost perspective is the "user cost" or the charges incurred by users of the ICT-based truck park and Appointment System, i.e. trucks and truck drivers. Truck drivers and fleets will almost surely pass these through as a supply chain cost, as part of the total cost of logistics (TCL) to receivers of beneficial cargo or shippers. Thus user fees for truck parks must be designed so that they fit with the competitive dynamics of the local trucking sector while ensuring revenues (cost recovery) for the private participant.

Under a PSP model, the cost for ICT facilities would initially be incurred by the truck park operator and recovered through a fee structure levied on the users of the truck park. We would further evaluate the extent to which port operators would be able/willing to share the cost considering that they too would derive some benefit if the truck parks and ICT systems work well.

Some typical elements of a fee structure for an ICT-based Truck Appointment system are shown below.

Figure 5-8. Possible Components for a User Charge structure for the TPPAF with Truck Appointment System

Fee Component	Rationale and Implications
Subscription fee	To create incentives for easier access to parking capacity, ensure "stickiness" and regular use of the service, and to cover
Booking fee	To ensure that bookings are seen as a valuable service, and cover some portion of the cost of service
Rescheduling fee	To discourage wanton "hold and release" behavior as well as cover the additional transaction costs of rescheduling
Congestion / surge fee	To limit the amount of dwell time for individual trucks in the TPPAF, similar to a demurrage fee / congestion charge especially during peak hours

Fee Component	Rationale and Implications
Late Fee / No show fee	To increase the likelihood of appointment fulfillment. Must take into account the reality of traffic near the port and implement associated buffer periods.
Service Fees	Value-based pricing for services provided to drivers within the truck park

Source: CPCS analysis

5.7 Key Implementation Issues

As our diagnostic analysis, consultations, and case studies have shown, it is unlikely that an isolated/individual truck parking and port access facility will be able to systematically provide the desired truck congestion mitigation benefits, even if it is ICT-enabled. What may be needed is a coordinated solution architecture that includes the built infrastructure of a managed parking facility, along with the integration of key systems such as port access gates and clearance systems, parking site operations, container / transaction management, and fleet management systems. The same platform of ICT technologies may be configured to meet a variety of objectives and purposes, allowing the port-related stakeholders with flexibility in scaling up over time.

Accomplishing ICT-enabled truck and port operations management in the LMA will require that stakeholders gradually climb a steep learning curve. In addition to the design and investment effort early on, the process of ramp up and eventual operations present a challenging but feasible proposition. Only a handful of port systems in the world have begun to integrate ICT in the manner envisioned, mostly in the last five to ten years. Further, maintenance of such ICT systems is a specialized activity, and the port, fleets, and terminals will have to contend with specialist vendors, service providers, and operators.

Avoiding lock-in to today's technologies is also an imperative. As technology evolves rapidly, upgrades and new capabilities become available. It will be important to select a solution architecture that is robust, yet flexible enough to incorporate new modules, capabilities and upgrades over time.

For the reasons above, it should be ensured that the vendor or private sector service provider should be a firm that has demonstrated success with the implementation of a scheduling / Truck Appointment System solution, with accompanying ICT infrastructure and operations and management expertise. Some examples of such entities are listed below, based on our satisfactory consultations with them.

Entity	Example of Successful Demonstration
1-Stop Vehicle Booking Systems (https://www.1-stop.biz/solutions/)	Port of Manila
QLess Appointment Systems (https://www.qless.com/case-study-dp-world)	Port of Hamburg
GE Transportation Port Optimizer (https://getransportation.com/portoptimizer)	Ports of Los Angeles – Long Beach

Source: CPCS

Finally, as we have pointed out in a number of respects, the benefits of such a TAS scheme will be rapidly eroded in the absence of good quality road infrastructure that can deliver reliable travel times.

5.8 Site Availability for Parking Facilities

In previous chapters, we presented an assessment of congestion and truck queues lengths based on published truck traffic observations and forecasts. Our subsequent field data collection estimates through truck surveys were reconciled with both truck traffic forecasts and with NPA's operational gate return summaries in order to evaluate truck parking demand and capacity requirements. In this section, we also evaluate this information together with data on land availability to determine the most appropriate parking site candidates.

5.8.1 Availability Analysis

To understand the possibilities for parking sites in the LMA, we conducted a broad scan to identify where land might be available for any type of parking facility. Note that at this stage, the broad scan does not assume the need for ICT related development. In contrast, the focus is on understanding land availability, the relative location of those sites, and the capacities of those sites to accommodate large numbers of trucks. In our evaluation, we accordingly applied several criteria such as:

→ open / undeveloped land availability (greenfield)
→ pre-existing urban properties for rent or sale within real estate comparables (brownfield)
→ facility configuration technical requirements (design)
→ desired accessibility thresholds determined from travel time estimates between selected sites and the port interface or main gates.

We used data based on satellite imagery, along with road network properties, and real estate records to filter available land and identify candidate sites.

Figure 5-9. Land Cover Classification categories in the LMA, based on satellite imagery analysis

Color	Type	Description
	Evergreen Forest	Trees >3 meters in height, canopy closure >35% (<25% inter-mixture with deciduous species), of species that do not lose leaves (includes coniferous Larch regardless of deciduous nature).
	Shrub / Scrub Land	Woody vegetation <3 meters in height, > 10% ground cover. Only collect >30% ground cover.
	Grassland	Herbaceous grasses, > 10% cover, including pasture lands. Only collect >30% cover.
	Barren or Minimal Vegetation	Land with minimal vegetation (<10%) including rock, sand, clay, beaches, quarries, strip mines, and gravel pits. Salt flats, playas, and non-tidal mud flats are also included when not inundated with water.
	Agriculture	Cultivated crop lands.
	Wetland	Areas where the water table is at or near the surface for a substantial portion of the growing season, including herbaceous and woody species (except mangrove species)
	Mangrove	Coastal (tropical wetlands) dominated by Mangrove species
	Water	All water bodies greater than 0.08 hectares (1 LS pixel) including oceans, lakes, ponds, rivers, and streams

	High Density Urban	Areas with over 70% of constructed materials that are a minimum of 60 meters wide (asphalt, concrete, buildings, etc.). Includes residential areas with a mixture of constructed materials and vegetation where constructed materials account for >60%. Commercial, industrial, and transportation i.e., Train stations, airports, etc.
	Low - Medium Density Urban	Areas with 30%-70% of constructed materials that are a minimum of 60 meters wide (asphalt, concrete, buildings, etc.). Includes residential areas with a mixture of constructed materials and vegetation, where constructed materials account for greater than 40%. Commercial, industrial, and transportation i.e., Train stations, airports, etc.

Source: CPCS

The land use dataset selected for this analysis was taken from BaseVue 2013 Land Cover Global Dataset at 30m resolution, developed by MDA Information Systems LLC. The dataset is built up from Shuttle Radar Topographic Mission (SRTM) photos. Land cover data is a descriptive thematic definition of the topographic surface of any given area. It defines areas by density and type of area.

The LMA has 10 different categories of land cover classification within its limits, as listed above in Figure 5-9. The area of the LMA (within administrative boundaries) is about 122,500 Ha. However, a significant portion of this land is comprised of islands, waterways, or otherwise restricted property. The land use detail is shown below in Figure 5-10. Removing non-accessible islands, area within the international airport limits and main inland waterways, leaves about 77,500 Ha. The largest classifications, low-high density urban or "existing built up" area represent 71% of the 77,500 Ha of accessible land.

Water, wetlands and mangroves that could be "reclaimed" but deemed too expensive or would likely have high environmental significance for the LMA were dropped from the potential site selection approach. These categories represented 6% of the total area.

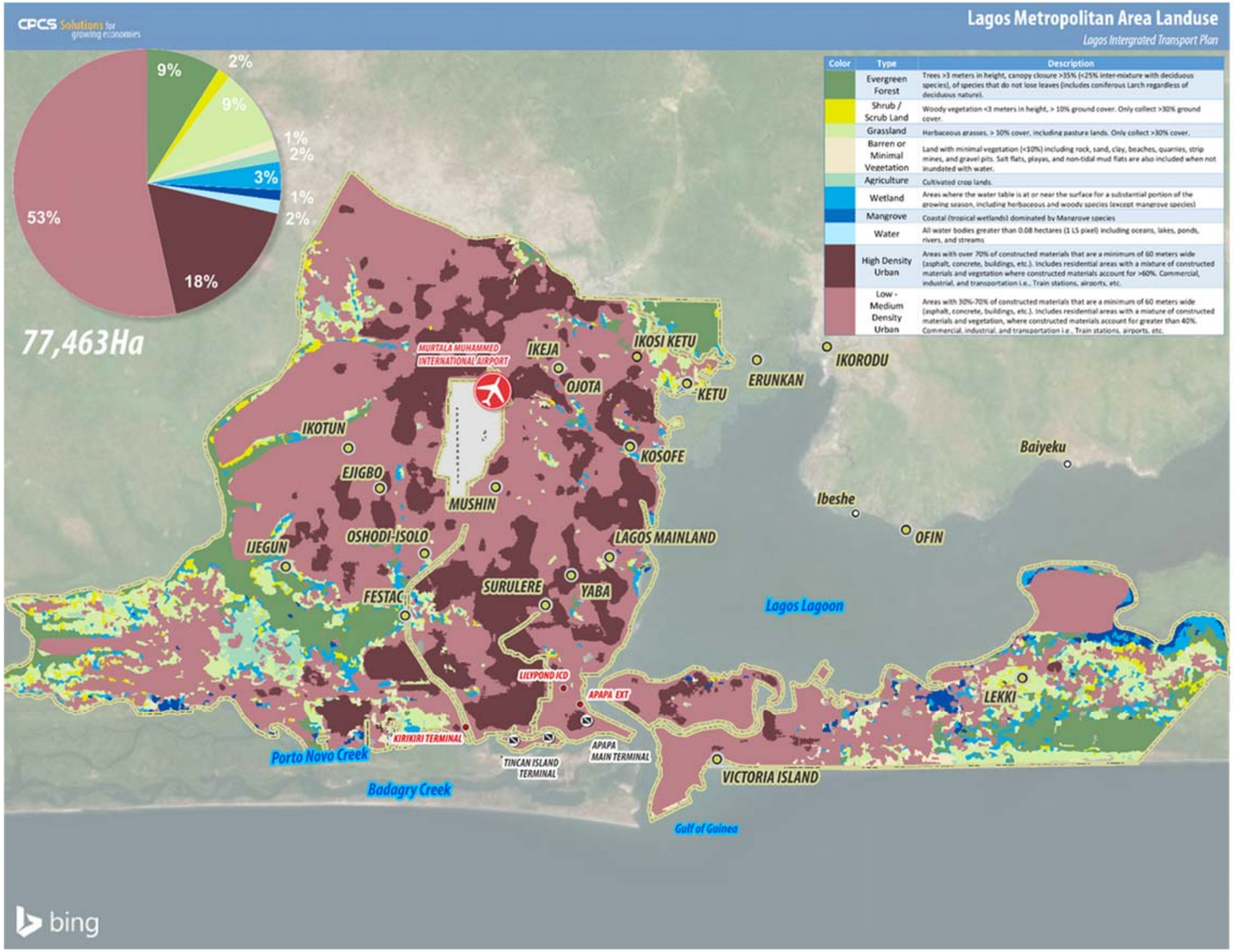
Any open / non-built up land (evergreen forest, shrub/scrub land, barren or minimal vegetation and active cultivated crop land) - was considered suitable for truck parking in a first pass analysis. This land amounts to about 17,400 Ha, as shown in Figure 5-11.

5.8.2 Network Travel Time Analysis

We overlaid the Lagos road network on the land use data, to identify the travel time to various locations in the LMA from the port facilities. The result is a set of network travel time bands.

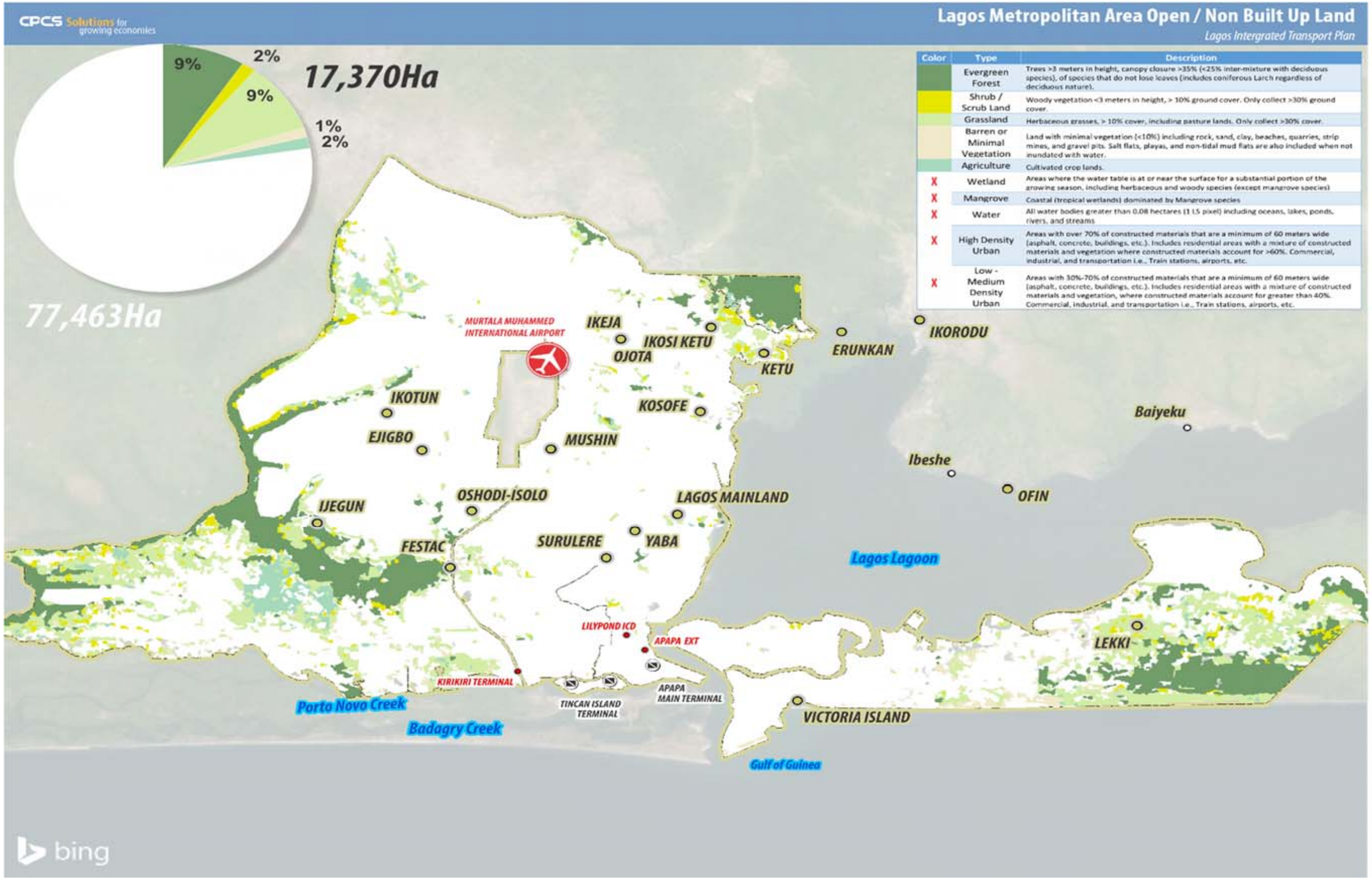
The network travel time bands are enclosed areas in which all roadway links on a network are within a specified travel time impedance, or value limit, of a designated origin. In this case, impedance on the LMA roadway network is defined by the time required to travel on various roads. The network bands are based on a codified network that uses the length of any given roadway segment and the observed travel speed to compute the time required to bypass said segment. In other words, network travel time distance bands are travel time contours or **travel time isochrones**. The map visualization thus shows lines at periodic intervals (20 minutes, 30 minutes, 40 minutes etc) to denote locations that are "equidistant" in terms of the time taken to reach those locations under ideal travel speeds, i.e. without congestion (Figure 5-12).

Figure 5-10. BaseVue 2013 30m resolution land cover classification of LMA



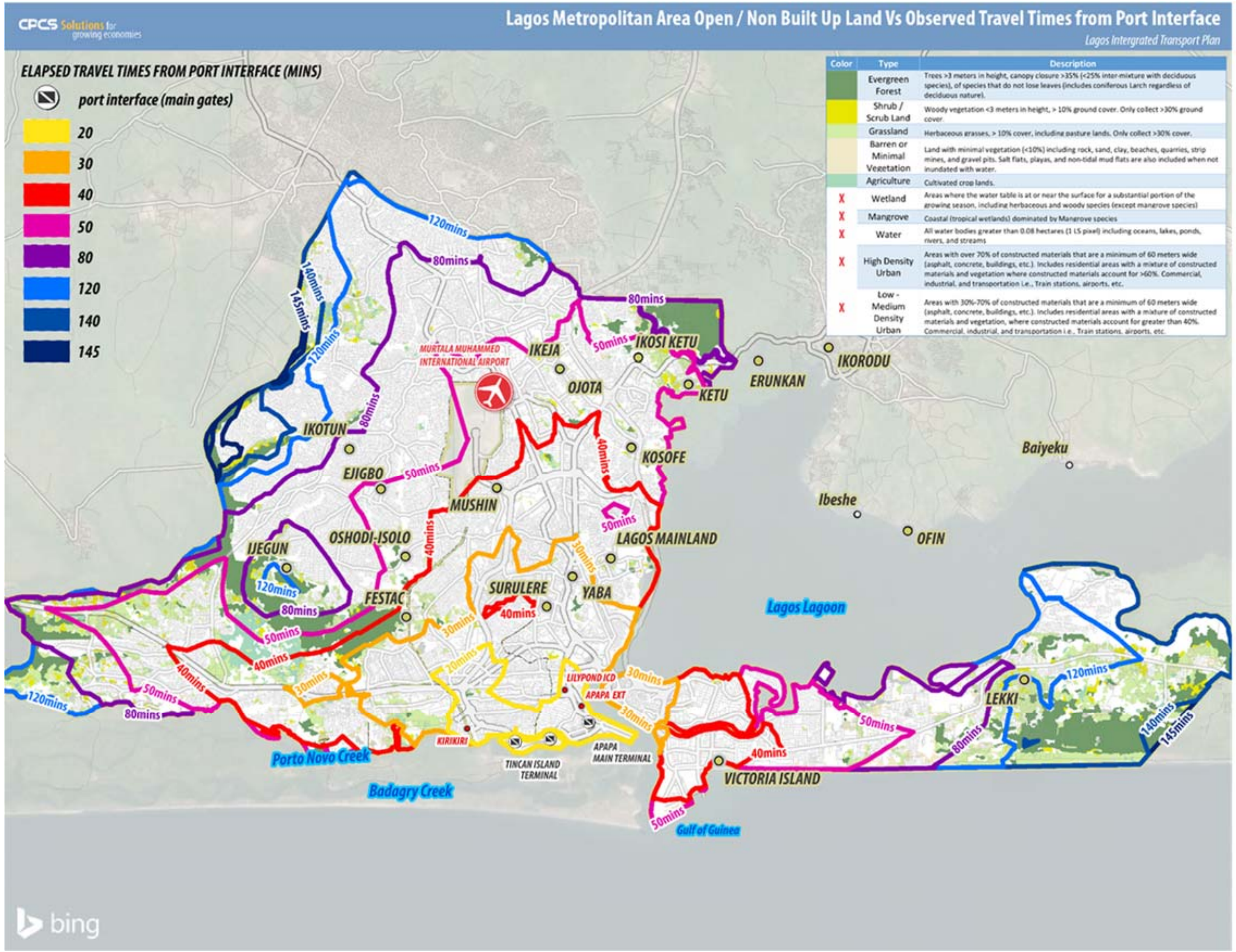
Source: CPCS

Figure 5-11. Open Undeveloped Land in the LMA ~ 17,400 hectares



Source: CPCS

Figure 5-12. Network Travel Time Isochrones across the extent of the LMA under ideal travel speeds



Source: CPCS

5.8.3 Real Estate Attribute Analysis

An additional component of this approach dealt with assessing and overlaying the local real estate listings from CASTLES, a database of property attributes such as ownership, land use zoning, estimated market price, size, etc.[84] By combining this information with the satellite-based land use data, and travel time isochrones analysis, we further refined the suitability analysis.

Almost 10,000 properties were captured from this database. We filtered out all properties except the following (number of listings in parentheses):

- Open / non-built land zoned / agricultural land (406);
- Commercial properties (14), and
- Industrial / warehouses sites / tank farms (31)

Within the 451 listing subset, each were assessed for price, size, zoning and property description.

While maintaining proper facility configuration proportions (i.e. allowing for administrative and operational infrastructure, basic amenities, and site access roads), a **two-hectare (Ha) site can accommodate about a 110 truck stalls** with a dimension of 5.4m width and 20m length. This assumption is warranted for sites less than 10ha. Once the site surface area exceeds 10 Ha, the proportion of truck stalls versus other elements shifts greatly (to accommodate turning radius, access roads, facilities) and the number is significantly reduced to an average of 15-20 stalls per 1Ha.

5.8.4 Results of Site Availability Analysis

Based on the multi-criteria assessment described, only 11 locations across the LMA were deemed suitable as truck parking facilities. Only 5 of these locations had a relative size equal or greater than 2ha. The map in Figure 5-13 pinpoints the 11 locations with proper land use zoning in relation to the travel time distances from the port, and current land uses, divided into two categories of sites of about 2 Ha, and 5 Ha or greater.

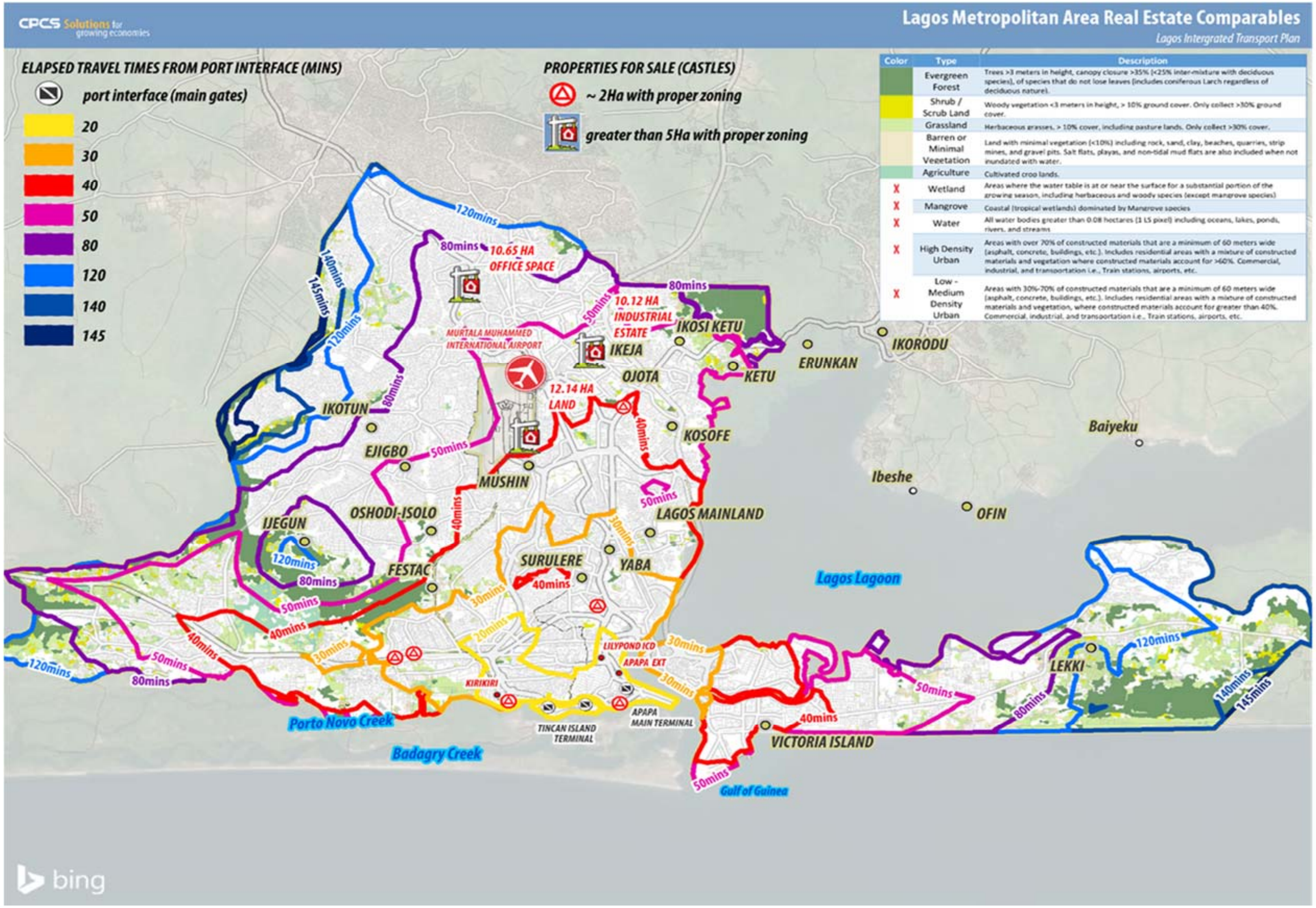
A few suitable properties with area greater than 5Ha are located between 40 to 80 minutes from the port under ideal conditions, but these travel times for trucks under typical conditions could exceed 2 to 3 hours.

Other small sites (requiring brownfield development) are located within a 20 to 30-minute travel time window of the ports. Figure 5-14 zooms in to better show these locations.

Attributes of a variety of locations considered are shown in Figure 5-15. The sites highlighted in yellow were deemed particularly convenient for buffering lots. Greyed out sites are less suitable because of a combination of their size, travel time from ports, or because of current use conditions.

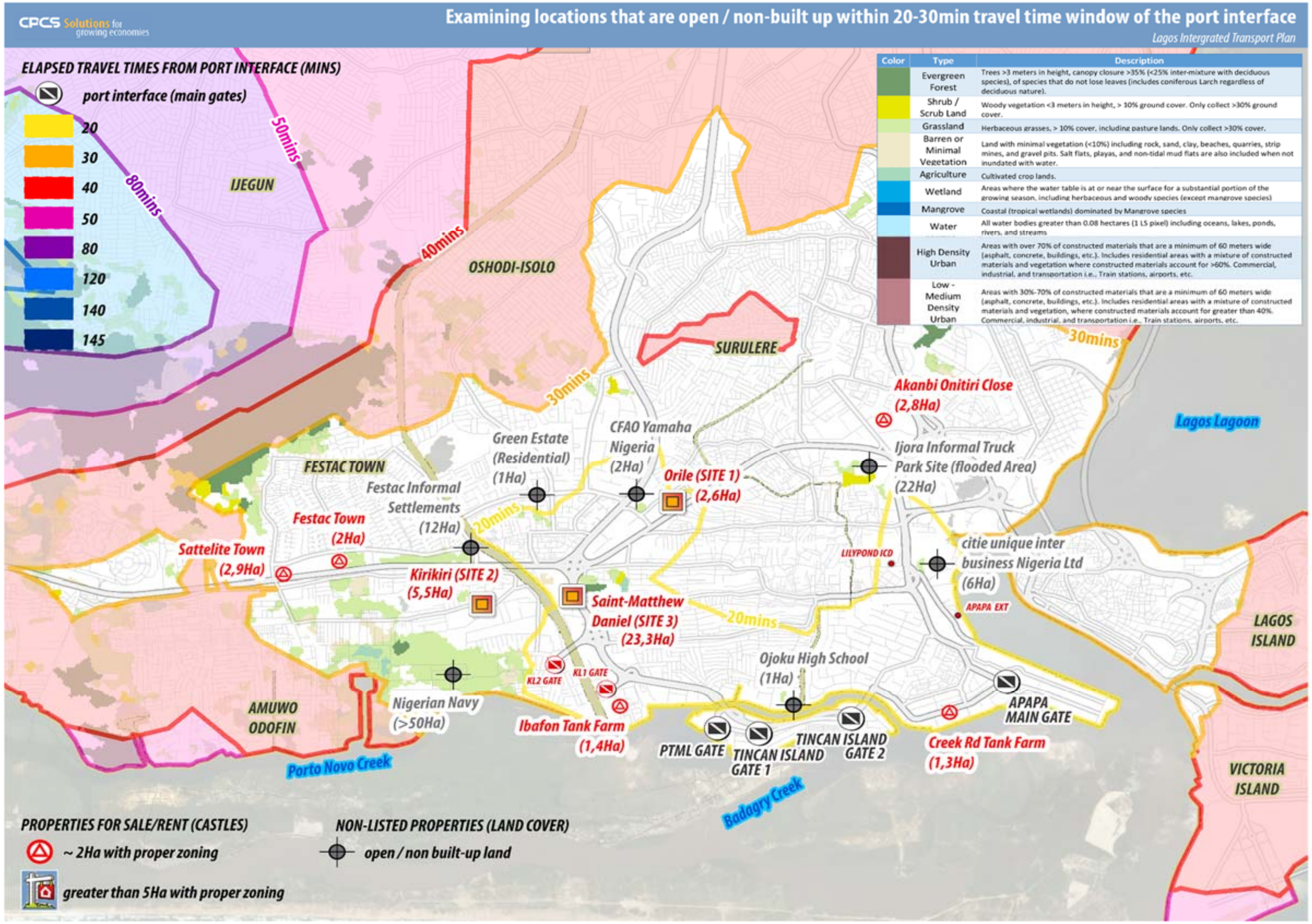
[84] Real House Communications Ltd. Castles Lifestyle Real Estate Website (2018). https://castles.com.ng/property/. Site listings retrieved in June, 2018

Figure 5-13. All other parking site candidates within the LMA



Source: CPCS

Figure 5-14. Parking site candidates within 20-30 minutes of port gates



Source: CPCS

Figure 5-15. Most suitable truck parking sites in the LMA, with three buffering site candidates highlighted in yellow

TYPE	NAME	PRICE (₦)	CURRENT OWNERSHIP	SIZE (HA)	ESTIMATED NUMBER OF TRUCK STALLS	TRAVEL TIME FROM PORT (MINS)
LAND	**St. Matthew Daniels**	**14,555,640,000**	**Chief Francisca Adeyemi And St. Matthew Daniel's Family (Nigerian Army control)**	**23.3**	**1,958**	**< 20**
WAREHOUSE & LOT	**Orile - Coker Rd Terminal Lot (Site 1)**	**2,382,917,475**	**Chief Peter Okocha**	**2.5**	**138**	**< 20**
LAND	Festac Settlement /Town (Along Expressway)	not listed	*unknown*	12.0	660	< 20
LAND	CFAO Yamaha Nigeria (Lot North East of Business)	not listed	*unknown*	2.0	110	< 20
TANK FARM	Ibafon Tank Farm	12,000,000,000	Demand Property & Investment Ltd	1.4	77	< 20
TANK FARM	Creek Rd Tank Farm	20,000,000,000	Demand Property & Investment Ltd	1.3	71	< 20
LAND	**Kirikiri (Site 2)**	**5,389,052,175**	**Elkali Group of Companies**	**5.5**	**348**	**< 30**
LAND	Nigeria Navy Vacant Lots	not listed	Nigerian Navy	50.0	2,750	< 30
LAND	citie unique inter business Nigeria Ltd (Surrounding Lot)	not listed	*unknown*	6.0	330	< 30
LAND	Satellite Town By Alakija Bus-Stop, Badagry Expressway	1,500,000,000	Sunbo Onitiri & Company	2.9	159	< 30
LAND	Ijora Informal Truck Park (Flooded Areas)	not listed	*unknown*	22.0	1,210	< 30
LAND	Ojoku High School (Lot South of School)	not listed	*unknown*	1.5	82	< 30
INDUSTRIAL ESTATE	Akanbi Onitiri Close (Off Eric Moore Street)	2,300,000,000	Imperial Facilities Limited	1.1	62	< 30
LAND	Near Concord Newspapers. Airport Road, Lagos Mainland	7,500,000,000	Wunmi Odusola & Co	12.1	667	< 40
INDUSTRIAL ESTATE	Warehouse and Buildings at Ikeja Industrial Estate	10,000,000,000	Nedfield Property	10.1	556	< 50
INDUSTRIAL ESTATE	Oregun Industrial Estate 5B	5,000,000,000	Abiodun Bewaji	2.0	111	< 50
INDUSTRIAL ESTATE	Ikorodu Rd - Maryland Industrial Warehouse	3,500,000,000	Nedfield Property	1.2	66	< 50
OFFICE SPACE	Lagos Abeokuta Exp Abule- Egba Lagos	7,500,000,000	Freeman Global Estates	10.7	585	< 60

Source: CPCS

Three candidate sites for long term truck parks, of about 10 hectares (approximately 500 to 600 trucks) were identified. Under ideal (uncongested) travel time conditions these lie around 40 – 80 minutes away from the ports, but at least 2 hours under moving current conditions with moving traffic, in the absence of traffic jams.

We conclude that suitable long-term truck parking facilities would have to be located at the periphery of the LMA or outside it, allowing for at least 2 to 3 hours of travel time to the port facilities.

In comparison, sites highlighted in yellow such as Kiri Kiri (~350 trucks or 700 tankers) and the St Mathew Daniel (~1,950 trucks) sites are far more promising as they are located within 20-30 minutes of the ports. These sites we examined in greater detail as buffering lots.

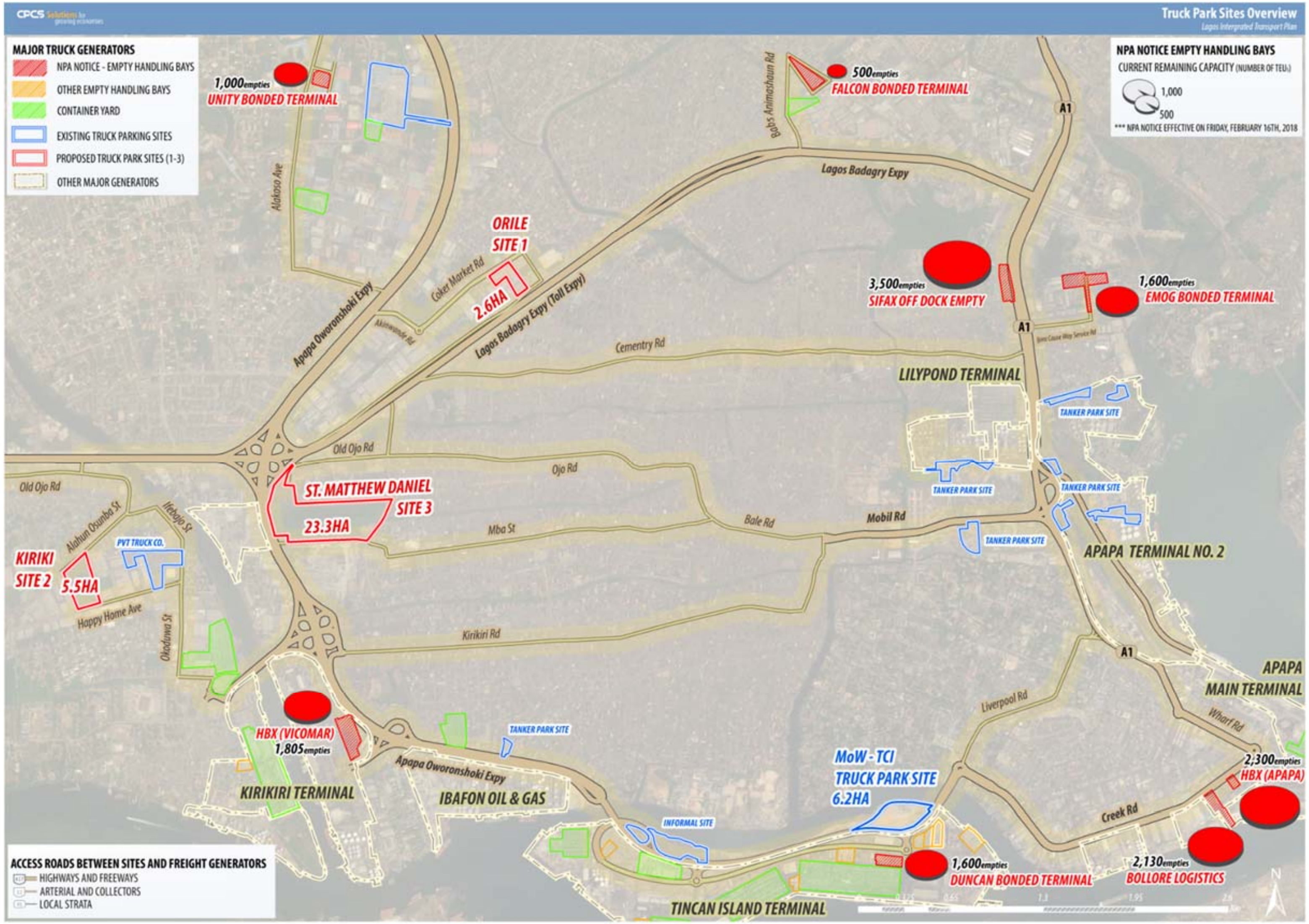
5.9 Buffering Site Analysis

Site availability analysis suggests four potential buffering sites in Lagos. These sites are:

- Site 1 – Orile
- Site 2 – Kirikiri
- Site 3 – St. Matthew Daniel
- Site 4 – FMPWH TCI Gate 2

Since Site 4 on TCI has been developed to about 90% completion, we assume that it will soon be operational and focus on the first three sites. The location of these sites relative to port facilities is shown below.

Figure 5-16. Proposed Truck Park Sites and Transport Logistics Infrastructure in Relation to LMA Port Interface



Source: CPCS

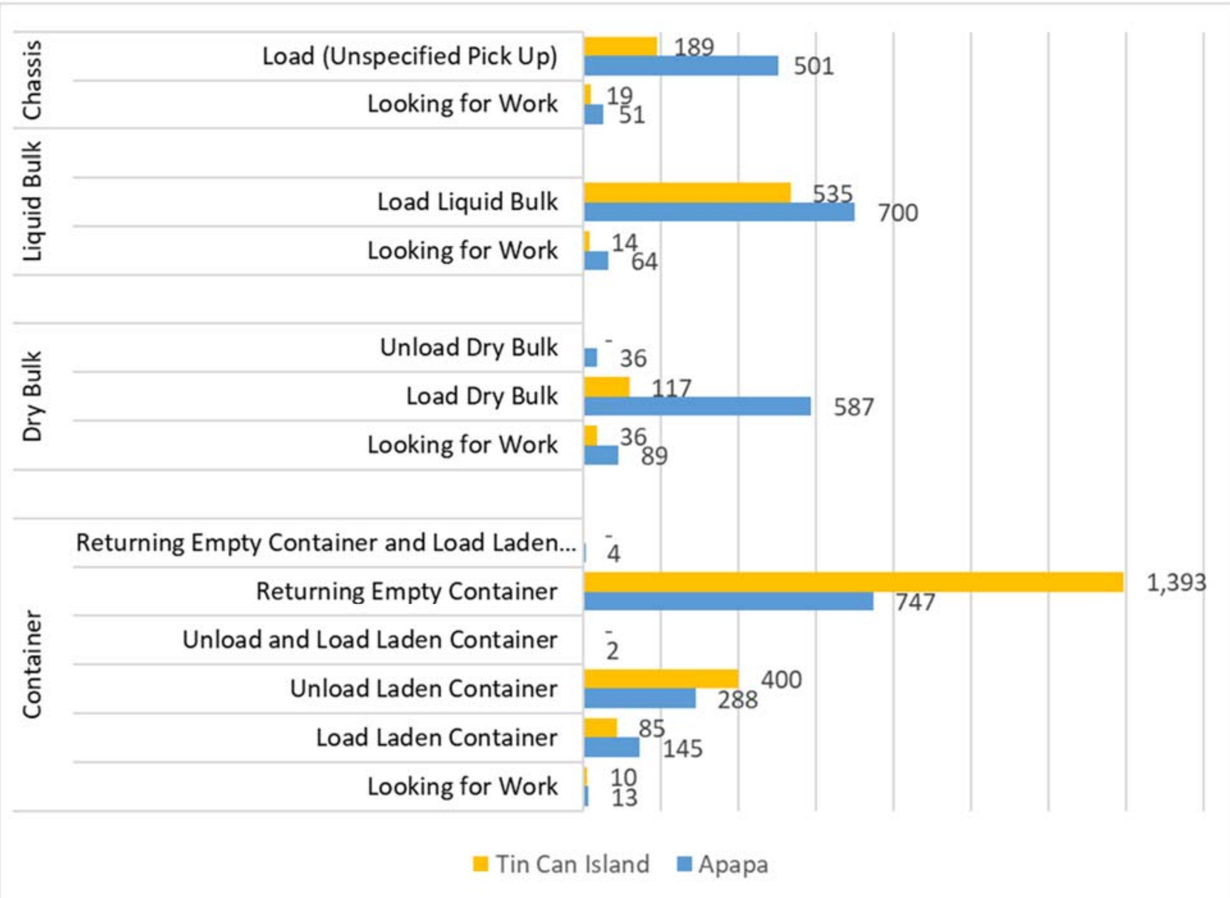
5.9.1 Congestion on routes to sites

Our assessment of current road conditions within the LMA reported on the identification of major trucks queues, their lengths, number of occupied lanes and their effects on current road capacity. Roads where truck queues occurred had significant reductions in hourly service volumes (greater than 60%) due to the number of truck-occupied lanes and general road condition. The primary roads utilized for trucking queues are Creek Rd, Wharf Rd, Aerodrome Rd and the A1 at Apapa port and Apapa-Oworonshoki Expy and Access Rd at Tin Can Island port. In all cases, truck queues occupy all but one lane. Additionally, the road condition on Apapa-Oworonshoki Expressway and Creek Rd is extremely poor. Appendix F describes the current capacity and condition of access roads serving both major ports. Under current conditions, we estimated an average reduction in road capacity of 70% at Apapa and 84% at Tin Can Island. The capacity measurement is a measurement taken from the expected hourly service volume (HSV), which is the maximum number of vehicles that can pass over a given section of a roadway during a lapse of time (1 hour) while operating conditions are maintained at level of service C, synonymous with a congested yet uninterrupted flow of traffic.

5.9.2 Assessment of capacity constraints, impacts caused by bottlenecks

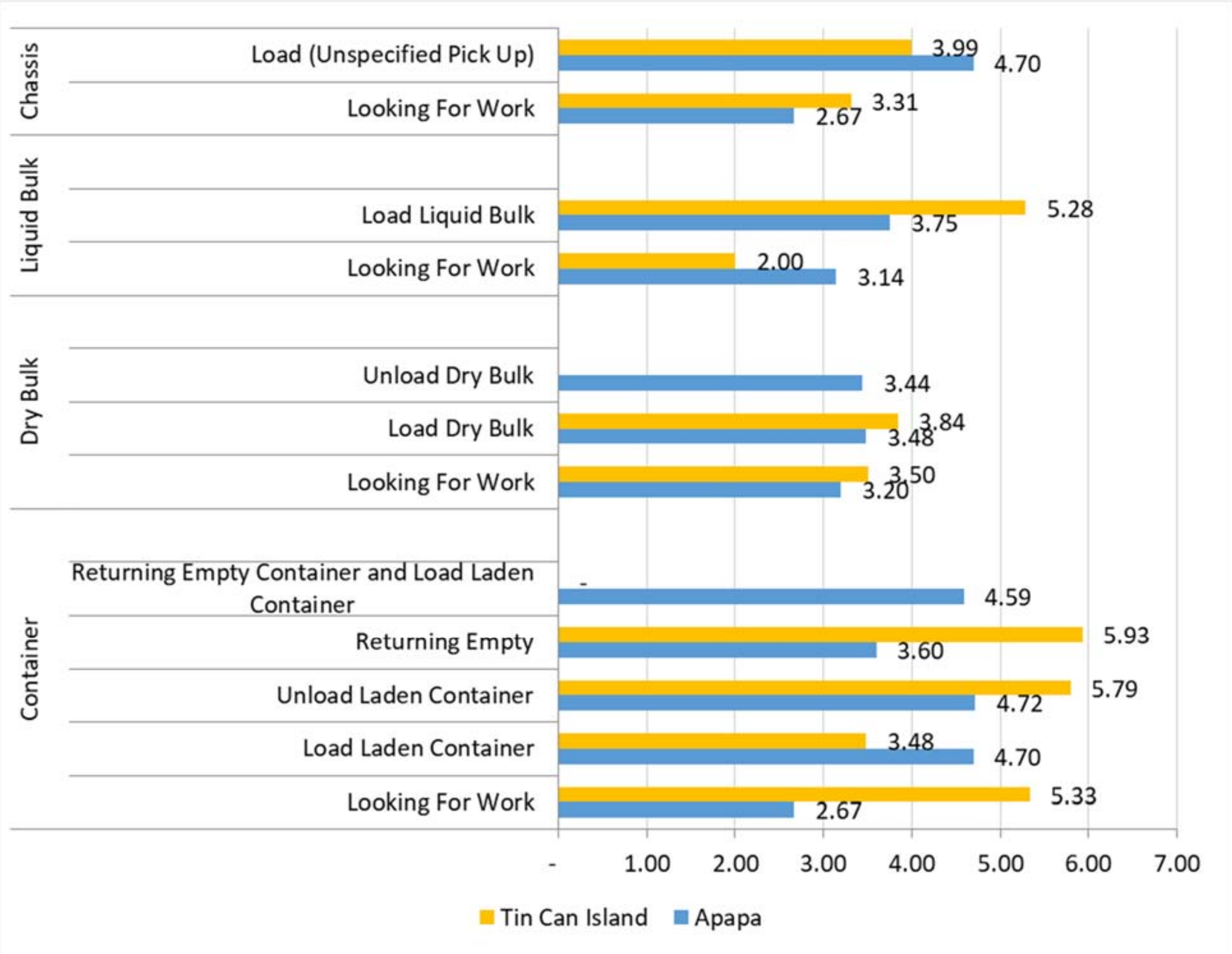
Our assessment of capacity constraints is based on our field data collection as detailed earlier. The results of 6,025 trucks counts and 1,388 interviews undertaken during our field data collection (on Monday 5th and Tuesday 6th of March, 2018) are summarized below.

Figure 5-17. Composition of the truck queues observed during our field collection process



It is observed that 34% (2,100) of the trucks are seeking to return empty containers. The NPA indicated that returning empties at the port increased the chances of a driver exiting the port with a full load for delivery. This is why NPA recently issued a notice that trucks are no longer to return empty containers directly to the port, but instead to 9 separate offsite handling bays (each of these terminal specific). It is still too early to tell if the notice will reduce the number of observed trucks, but our view is that the new arrangement is only likely to change the composition of the queues. Instead of 2,100 trucks with empties, there will be 2,100 chassis trucks looking for their next load. On the other hand, a solution based around a TPPAF and ICT will greatly improve the situation by dispersing and shifting traffic to the 9 separate handling bays followed by their respective transit to a designated truck park site. Another critical observation, as reported in the diagnostic report and confirmed during field collections, was that another 22% (1,313) of the queues composition are liquid bulk tankers, which access the oil and gas jetties at Kirikiri, Ibafon, Creek and the A1 road, rather than the container terminals. We recommend utilizing the Kirikiri Truck Park site exclusively for tanker trucks. Based on our concept drawings, we estimate that Kirikiri could remove 56% of the tanker trucks from the roads.

Figure 5-18 Number of days spent in truck queues by truck type & purpose



In addition, field collections revealed that the average dwell time for trucks in the queue is 4 to 6 days. Based on our 1,388 survey interviews the average time spent in the queues for Apapa and Tin Can Island ports by truck type and purpose is reflected above. The dwell time exhibited by liquid bulk tankers can be associated in large part with the long time spent on pre-load vehicle inspections for the movement of refined petroleum products. A major incentive for private oil and gas operators would be to offer them pre-load vehicle inspections and flagging of tankers at Kirikiri. This would definitely increase efficiency at oil and gas terminals and remove more tankers from LMA roads.

5.9.3 Assessment of truck parking capacity at proposed locations

The NPA gate operational return summaries from Apapa (December, 2017) and Tin Can Island (January 2018) revealed daily gate transits of 498 trucks and 706 trucks respectively. Our field surveys counted 6,025 trucks per day in queues. The NPA consultations confirmed these numbers with the caveat that occasionally the numbers can shoot up to 10,000 trucks per day. Our assumption based on our field observations suggest that 1 in 5 trucks successfully interface with the port terminals on a daily basis.

If all three sites were developed, we estimate that together they would remove 3,115 trucks off the roads. Our estimates are conditional on the following:

- The number includes the 323 truck parking spaces from the nearly operational FMWPH TCI truck park; and
- Kirikiri site would cater solely to liquid bulk tankers, based on our estimate that two tankers can occupy the planned stall dimensions of 20m x 5.2m.

These estimates still leave us with a daily shortfall of 1,706 spaces. This shortfall can be reduced by NPA implementing a cross-cutting initiative, where empty containers are delivered to "off-dock" empty holding bays acquired by terminal operators and shipping lines. Upon delivery of goods to importers, drivers are to return their empties to one of 9 designated terminals. The map in Figure 5-16 shows the locations of 7 of the 9 holding bays. The current capacity of these holding bays are given in Figure 5-19.

Figure 5-19. NPA notice of current capacities at selected empty container handling bays

Shipping Company	EMOG Bonded Terminal	Bollore Transport And Logistics	HBX (Vicomar)	Unity Bonded Terminal	HBX (Apapa)	Falcon Bonded Terminal	Joelith Holdings	Port Express Service	Sifax Terminal	Total TEUs
PIL	-	380	-	-	400	-	-	-	-	780
CMA CGM	1,600	800	-	-	-	-	-	-	-	2,400
GAC	-	350	-	-	-	250	-	-	-	600
Blue Funnel	-	300	-	-	-	-	-	-	-	300
Messina	-	300	-	-	-	-	-	-	-	300
MOL	-	-	855	-	-	-	-	-	200	1,055
Hull Blyth	-	-	950	-	1,500	-	-	-	-	2,450
Cosco	-	-	-	-	400	-	-	-	-	400
Lansal	-	-	-	-	-	250	1,000	600	-	1,850
MSC	-	-	-	1,000	-	-	-	-	3,300	4,300
Maerskline	-	-	-	-	400	-	-	-	-	400

5.9.4 Distances & travel times from port access gates and identification of prefered routes

This is summarized in Figure 5-20.

Figure 5-20: Distances and travel times for preferred routes from our proposed truck parking sites to selected port interfaces

Originating	Destined	Route Selection	Distance (km)	Google Time (Mins)	Google Average Speed (kph)	Time @ 60kkph (Mins)	Time @ 35kkph (Mins)	Time @ 20kkph (Mins)
Orile (Site 1)	Apapa	via Coker Market Rd - Akinwande Rd - Apapa Oworonshoki Expy - Creek Rd	11.59	**30**	23.18	11.6	19.9	34.8
		via Orile Mile 2 Service Rd - Apapa Oworonshoki Expy - Creek Rd	11.72	**31**	22.68	11.7	20.1	35.2
	Tin Can Island	via Coker Market Rd - Akinwande Rd - Apapa Oworonshoki Expy - Tin Can Island Access Rd	7.13	**18**	23.77	7.1	12.2	21.4
		via Orile Mile 2 Service Rd - Apapa Oworonshoki Expy - Tin Can Island Access Road	7.10	**18**	23.67	7.1	12.2	21.3
Kirikiri (Site 2)	Apapa	via Alahun Osunba - Old Ojo Rd - Lagos Badagry Expy - Apapa Oworonshoki Expy - Creek Rd	11.40	**35**	19.54	11.4	19.5	34.2
		via Happy Home Ave - Okoduwa St - Berger Car Depot Bridge - Apapa Oworonshoki Expy - Creek Rd	10.30	**29**	21.31	10.3	17.7	30.9
	Tin Can Island	via Alahun Osunba - Old Ojo Rd - Lagos Badagry Expy - Apapa Oworonshoki Expy - Tin Can Island Access Rd	7.00	**25**	16.80	7.0	12.0	21.0

Originating	Destined	Route Selection	Distance (km)	Google Time (Mins)	Google Average Speed (kph)	Time @ 60kkph (Mins)	Time @ 35kkph (Mins)	Time @ 20kkph (Mins)
		via Happy Home Ave - Okoduwa St - Berger Car Depot Bridge - Apapa Oworonshoki Expy - Tin Can Island Access Rd	5.90	**20**	17.70	5.9	10.1	17.7
. Matthew Daniel (Site 3)	Apapa	via Otto-Wolf Rd - Awodi Ora Service Rd - Apapa Oworonshoki Expy - Creek Rd	11.30	**24**	28.25	11.3	19.4	33.9
		via Otto-Wolf Rd - Cardoso St - Mba St - Bate Rd - Mobil Rd - A1 - Wharf Rd	7.70	**31**	14.90	7.7	13.2	23.1
		via Otto-Wolf Rd - Awodi Ora Service Rd - Lagos Badagry Expy **(tolled)** - A1 - Wharf Rd	11.30	**24**	28.25	11.3	19.4	33.9
	Tin Can Island	via Otto-Wolf Rd - Awodi Ora Service Rd - Apapa Oworonshoki Expy - Tin Can Island Access Rd	6.40	**18**	21.33	6.4	11.0	19.2
		via Otto-Wolf Rd - Cardoso St - Sholade St - Okito St - Rotimi Cres - Wilmer Cres - Apapa Oworonshoki Expy - Tin Can Island Access Rd	5.70	**24**	14.25	5.7	9.8	17.1

5.9.5 Existing site conditions

This assessment was undertaken to determine the ease of getting each individual site from its current state to operational readiness.

Out of the three sites, Orile was more of a brownfield rehabilitation project as the site is technically ready to operate as is. The tarmac, fence and tower lights were in favorable condition while the only impediment was the removal of the existing warehouse/administrative building. Although Orile is likely the easiest site to implement and least expensive in terms of capital spend required, it is also the smallest with room for only 138 truck stalls.

On the Kirikiri site, some civil works have been undertaken in the past but unfortunately the site still suffers from major drainage problems. The project would be treated as a greenfield development, and we expect it to be used primarily for oil and gas tankers. Within this context, the site may require specialized drainage infrastructure and civil works.

Lastly, St. Matthew Daniel would be the most expensive to develop. The project would be entirely greenfield development in its current state with its surface area heavily forested and the encroachment of one of the branches of the Lagos canal system.

5.9.6 Maximum holding capacity

This is summarized in Figure 5-21 below.

Figure 5-21. Estimated surface areas and maximum holding capacities of proposed truck parking sites

Site Number	Site Name	Total Area (Ha)	Existing Buildings (Ha)	Site Roads (Ha)	Gate, ICT and Administrative Buildings (Ha)	Amenities and Services (Ha)	Total Area Designated to Truck Stalls (Ha)	Total Truck Capacity
Site 1	Orile	2.58	- 0.13	1.35	0.02	0.03	1.18	**138**
Site 2	Kirikiri	5.53	-	2.40	0.10	0.12	2.91	**348 (696 tanker trucks)**
Site 3	St. Mathew Daniel	23.29	-	6.24	0.47	1.47	15.11	**1,958**

5.9.7 Alternative Models

One alternative to large buffering lots that has been touted by NPA is the development of multiple smaller private sector led buffering lots. These lots could hold anywhere between 10 and 20 trucks. This solution raises a number of questions, in particular as it concerns the beneficial impact it would have on the overall system and the incentives truckers would have to use them.

In terms of incentives, an appropriate fare structure, including some fees for missed/delayed arrivals, would by itself encourage the use of buffering lots if their location does increase the likelihood of respecting the appointment. This could be further reinforced by waiving the fee for trucks using approved/licensed buffering lots (see section 5.3.3). If this model is to be explored further, the following elements would need to be considered:

- **Minimum licensing requirements**: these would include providing a computer with internet to interact/record truck movements as part of the TAS system, having appropriate and safe areas for parking trucks (e.g. including fencing, paving), and being located at a short distance from the port.
- **Coordination with parking enforcement authorities**: it will be important to ensure the route between these buffering lots and the port gate is as unencumbered as possible to maximize the likelihood that appointments will be met.

Licensing would have to be managed by the SPV created for the TAS. In the absence of larger, more coordinated solutions, this approach could unlock some of the private sector ingenuity while supporting the overall implementation of the TAS.

6 Conceptual Design and Layouts

Key Messages

Site Design and Preparation

Short-term buffering truck park sites must be designed by applying the dimensional and movement characteristics of trucks and semi-trailers. The explicit factors to be considered are truck lengths, widths, front and rear overhangs and the minimum turning radius.

Site Attributes

Orile is more of a brownfield rehabilitation project as the site is technically ready to operate as is. The tarmac, fence and tower lights are in favorable condition while the only impediment is the removal of the existing warehouse/administrative building. Although Orile is likely the easiest site to implement and least expensive in terms of capital spend required, it is also the smallest with room for only 138 truck stalls of dimension 20x5.2m.

On the Kirikiri site, some civil works have been undertaken in the past but unfortunately the site still suffers from major drainage problems. The project would be treated as a greenfield development, and we expect it to be used primarily for oil and gas tankers (696). Within this context, the site would require specialized drainage infrastructure and civil works.

Lastly, St. Matthew Daniel would be the most expensive to develop. The project would be entirely a greenfield development, since the site has no existing infrastructure on it. The entire area is heavily forested and one of the branches of the Lagos canal system terminates there. However, it is the most promising because it can hold more than 1,950 trucks at a time and is reasonably proximate to both Tin Can and Apapa facilities, as well as a number of holding bays.

Recommendation

Of the sites available as buffering lots, St Mathew Daniel is the most promising for container trucks, while the KiriKiri site might be best repurposed as a dedicated tanker truck facility.

6.1 Site Preparation and Civil Works needed

In order to move trucks off the road in an efficient manner, the truck park sites must be designed by applying the dimensional and movement characteristics of trucks and semi-trailers. The explicit factors to be considered are truck lengths, widths, front and rear overhangs and the minimum turning radius. In this case, the truck park stall must meet the requirements of the largest possible vehicle. The stall angles are offset from 90 degrees by +/- 34.5 degrees into a “herringbone” pattern and is used most often in situations where space limitations are a factor or where a site is trying to increase its capacity to meet the current demand. The major flaw with this pattern type is that it creates two types of leftover space (the first is the leftover space within each stall because of the angle of entry and the second, are the ends of each truck park stall island). Additionally, the pattern requires the use of directional one-way traffic and planned circulation within the site. Inversely, these flaws are also benefits as they generally make parking simpler for drivers and the mandatory planned circulation increases the efficiency and safety within the site. The empty space at each end of park stall islands can be used for services, small buildings and amenities.

With regards to circulation, the site should be free-flowing with the least amount of stops, turns and elimination of dead-ends via outer ring collector roads. In fact, in a perfect situation, the only location with designated stops within a truck park site should be the gates and check-in-out areas.

Circulation for entrance and exit gates should prevent left turn "exiting" vehicles from impeding right lane "entering" vehicles. This can be achieved through enforcement (signage), spreading out both enter and exit gates, or having a large enough area within the gate and processing area to act as a buffer.

We used the following assumptions for laying out truck stalls, site preparation and civil works.

Figure 6-1. Assumptioms for Developing Layouts

	MoW Truck Stall Size
Truck Stall Length	20x5.2m
SQ M	104
Ha	0.01
	Halterm (Halifax) Size
GATE, ICT and Building	54x150m
SQ M	8,100
Ha	0.81
	MoW Truck Park Site Roads
Total Road Length (m)	2788
Road Width (m)	7.5
Truck Turning Radius (m)	7.5 - 13.26m
Truck Stall Angle Direction	+/- 36.4754
SQ M	20,910
Ha	2.09
Road Width (m)	7.5
Truck Turning Radius (m)	7.5 - 13.26m
Truck Stall Angle Direction from 90	+/- 36.4754
Truck Stall Length	20x5.2m
Truck Stall Area (Ha)	0.0104

6.1.1 Orile Site

The Orile site was previously a bonded warehouse and terminal yard operated by Michelle Bonded Terminals Ltd. Because of this, the site offers significant savings on infrastructure costs. The area has a reasonable concrete paved surface, is a secured space enclosed by a concrete cinder block fence (826m), has some functioning tower lights (quantity unknown), has access to utilities and to power, and has a warehouse/administrative building (dimensions 30mx60m). Because of the location of the existing building, we recommended dismantling it. The site has a 2.576Ha surface area and we estimate that the site could hold 138 separate truck stalls with a dimension of 5.2mx20m each. The site has not yet been acquired by NPA, but consultations in that regard are said to be on-going.

The site can be accessed from its northern side by eastbound traffic via Coker Market Rd and from its southern side by westbound traffic via the Orile-Mile 2 Service Rd. Construction of the Lagos-Badagry Expy is currently ongoing and this is proposed to be a toll road. The tolling booths will be located just southeast of this site. We believe that once tolling on the expressway starts, it will dissuade drivers from utilizing the southern exit even though the service road is not tolled. However, since entering the site can be accessed by circumventing the westbound tolling booth, we do not foresee any accessibility issues.

We recommend the following investments in order to improve site access.

→ Two controlled intersections north of the site on Coker Market Rd. Traffic lights and the removal of a portion of the concrete barriers would allow trucks to enter and exit the site from either direction. This would also provide the site with a dedicated route to Apapa-Oworonshoki Expy via Akinwande Rd Roundabout.

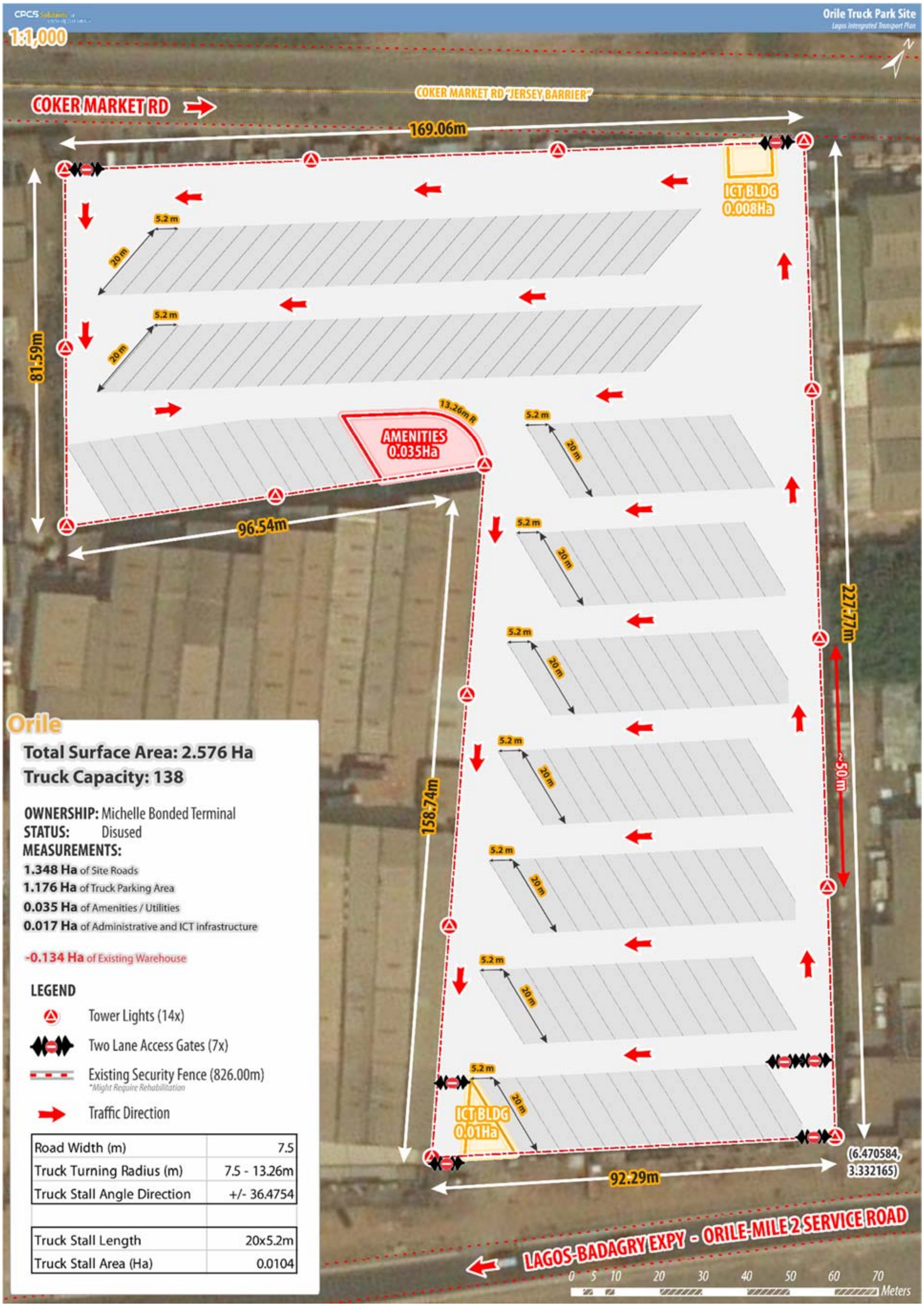
Cost estimates for the Orile site acquisition, preparation and rehabilitation are shown below.

Figure 6-2. Bottom up cost estimation for Orile

S/N	ITEM	COST IN NIGERIAN NAIRA (₦)	COST IN USD ($)[1]
0.1	Land Acquisition and Purchase	2,382,800,000.00	6,618,888.89
1	Civil Works: Land Preparation	289,791,952.50	804,977.65
2	Civil Works: Site Infrastructure	74,920,872.06	208,113.53
3	Administrative and ICT Buildings	91,518,487.27	254,218.02
4	Amenities Building	36,482,154.98	101,339.32
	TOTAL	**2,875,513,466.81**	**7,987,537.41**
5	Civil Works: Off Site Road Rehabilitation and Accessibility Infrastructure	9,087,775.58	25,243.82
	RUNNING TOTAL	**2,884,601,242.39**	**8,012,781.23**

1. Assumes a 360 Naira/USD exchange rate
Source: CPCS

Figure 6-3. Orile Truck Park Site (1) Terminal Layout Concept



6.1.2 Kirikiri Site

The Kirikiri site, owned by 7UP bottling Co., is disused in large part due to poor drainage. Some land reclamation efforts were undertaken but were insufficient to properly drain the surface area. Currently the site is secure and completely fenced in by concrete cinder block walls (999m), and has access to utilities and power. The total surface area of the site is 5.527Ha and could potentially accommodate 348 stalls 5.2mx20m in dimension. If used exclusively for tanker trucks, the average length would allow the parking of at least 2 vehicles in each stall. We estimate the site has a capacity to hold 696 tanker trucks.

Since the site is disused, the area is completely overgrown with shrubs. Although grading was undertaken, the site still suffers from heavy waterlogging and pooling. The site would require more grading and civil works in order to create “positive” drainage whereby the grading allows for water to flow away from the site. In addition, the minimum allowable slope required for large open concrete surface areas must not exceed 0.75% rise.

Because of its location, the site would ideally serve tanker traffic generated from Kirikiri and Ibafon Oil and Gas Jetties. The site resides within Kirikiri town, with access to Berger Car Deport Bridge via its southern side using Happy Home Ave and Lagos Badagry Expy on its northern side via Alahun Osunba St. The site can also make use of two unpaved streets running parallel of the site that may be used to travel between Happy Home Ave and Alahun Osunba St. The condition of the unnamed side streets is poor.

As it is proposed that the site would only be used by tankers, this would pose the greatest environmental risks. As per Federal environmental provisions regarding the general containment requirements for facilities involved in oil and gas, a site should have “appropriately” designed containment and/or diversionary structures to prevent discharge in quantities that may be harmful. Additional civil works may be required to mitigate and lessen the impacts of refined petroleum products spillages. Typically, civil works include the construction of a system of berms and swales around the site in order to direct and contain the flow of liquids. In addition, the drainage outfall location may require additional investments in a capture and store system in order to prevent the runoff of materials into the Lagos sewer system, catch basins and consequently streams, rivers or larger waterbodies.

Cost estimates for the KiriKiri site acquisition, preparation and rehabilitation are shown below.

Figure 6-4. Bottom up cost estimation for KiriKiri

S/N	ITEM	COST IN NIGERIAN NAIRA (₦)	COST IN USD ($)[1]
0.1	Land Acquisition and Purchase	5,388,825,000.00	14,968,958.33
1	Civil Works: Land Preparation	622,567,430.41	1,729,353.97
2	Civil Works: Site Infrastructure	94,953,741.17	263,760.39
3	Administrative and ICT Buildings	198,219,708.70	550,610.30
4	Amenities Building	298,873,231.29	830,203.42
	TOTAL	**6,603,439,111.56**	**18,342,886.42**
5	Civil Works: Off Site Road Rehabilitation and Accessibility Infrastructure	811,584,291.71	2,254,400.81
	RUNNING TOTAL	**7,415,023,403.27**	**20,597,287.23**

1. Assumes a 360 Naira/USD exchange rate

Source: CPCS

Figure 6-5. Kirikiri Truck Park Site (2) Terminal Layout Concept

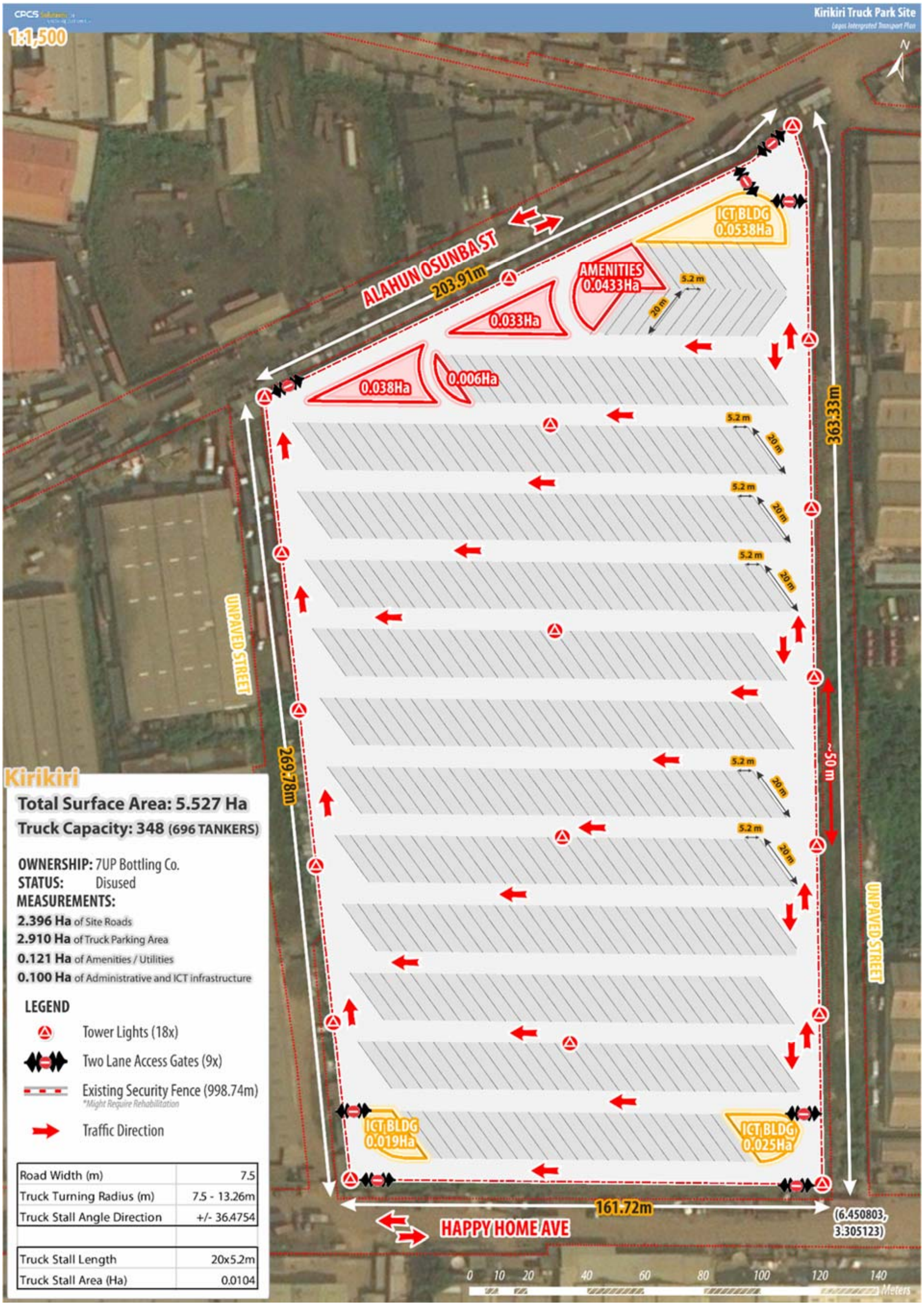
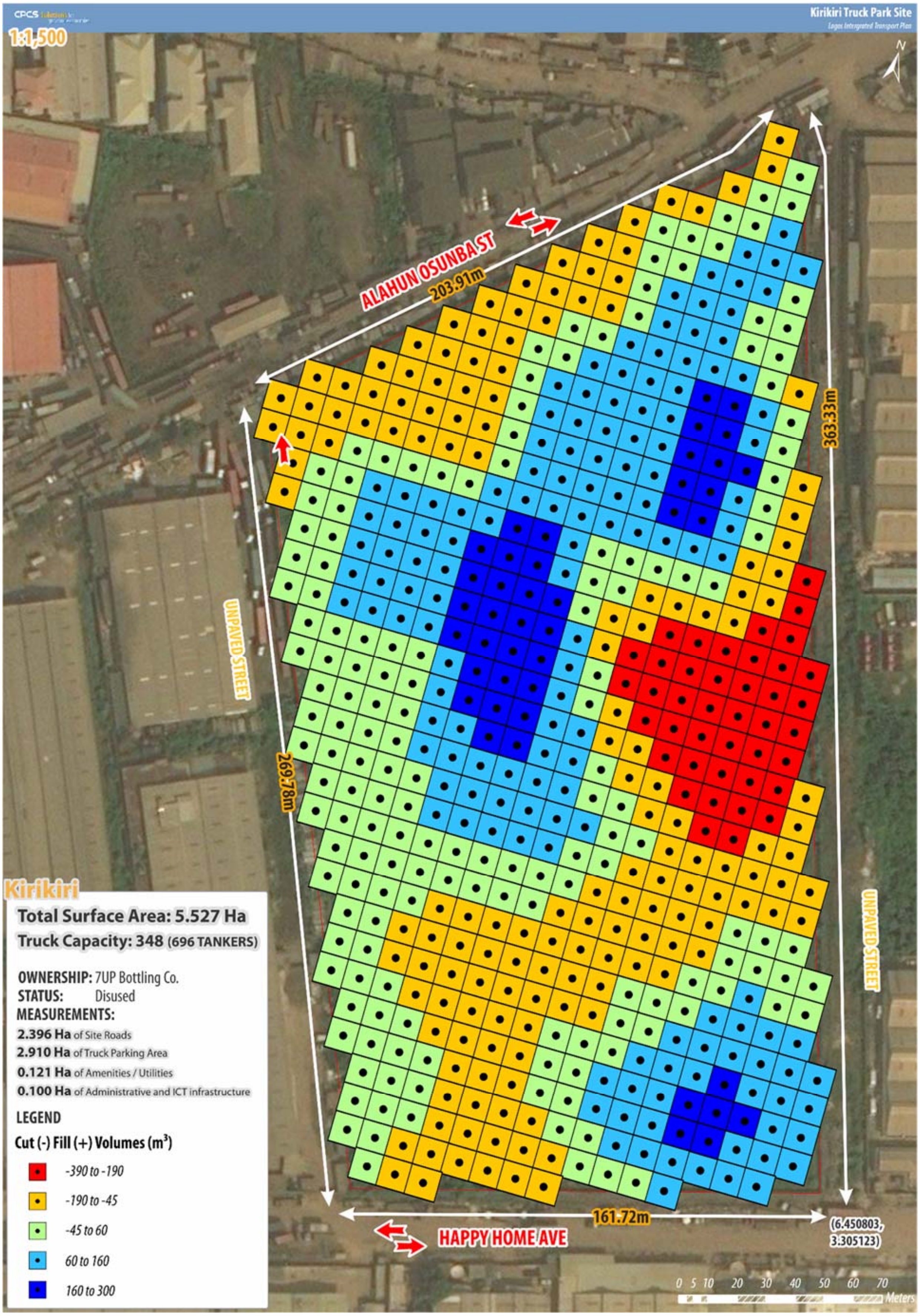


Figure 6-6. Kirikiri Truck Park Site (2) Terminal Layout – Site Preparation



6.1.3 St. Matthew Daniel Site

The largest of the three sites (23.3Ha), St. Matthew Daniel will arguably be the most difficult site to acquire. As reported by the Federal Gazette, the site was recently released back to St. Matthew Daniel's family but is currently occupied by the Nigeria Army Signal Barracks. Since the land is primarily untouched and overgrown, NPA is hopeful in seeking a compromise between all parties.

The site is heavily overgrown with shrubs and trees, and is the terminus for one arm of the Lagos water canal. The canal crosses the site in the middle and would require major civil works in the form of "stream channel modification", essentially efforts in diverting, forwarding or holding back the course of the water canal.

From observations, St. Matthew Daniel's also has the most challenging grade, with the easternmost side of the site exhibiting elevation variances in excess of 3m and slope in excess of a 3.5% rise.

The site location is ideal for access to both port interfaces, with several routing possibilities through Otto-Wolf Rd and direct access to Apapa Oworonshoki Expy and the Mile 2 Oke Interchange via Awodi Ora Service Rd. The largest of three proposed sites, the site could comfortably accommodate 1,958 trucks and would be twice the size of the largest North American Truck Parking Site (i.e Iowa 80 Truckstop which holds 900 truck parking stalls).

Cost estimates for the St Mathew Daniel site acquisition, preparation and rehabilitation are shown below.

Figure 6-7. Bottom up cost estimation for St Mathew Daniel

S/N	ITEM	COST IN NIGERIAN NAIRA (₦)	COST IN USD ($)[1]
0.1	Land Acquisition and Purchase	14,555,000,000.00	40,430,555.56
1	Civil Works: Land Preparation	2,514,142,850.34	6,983,730.14
2	Civil Works: Site Infrastructure	184,839,586.25	513,443.30
3	Administrative and ICT Buildings	956,643,174.90	2,657,342.15
4	Amenities Building	3,830,702,395.81	10,640,839.99
	TOTAL	**22,041,328,007.29**	**61,225,911.13**
5	Civil Works: Off Site Road Rehabilitation and Accessibility Infrastructure	188,849,025.00	524,580.63
	RUNNING TOTAL	**22,230,177,032.29**	**61,750,491.76**

1. Assumes a 360 Naira/USD exchange rate

Source: CPCS

Figure 6-8. St. Matthew Daniel Truck Park Site (3) Terminal Layout Concept

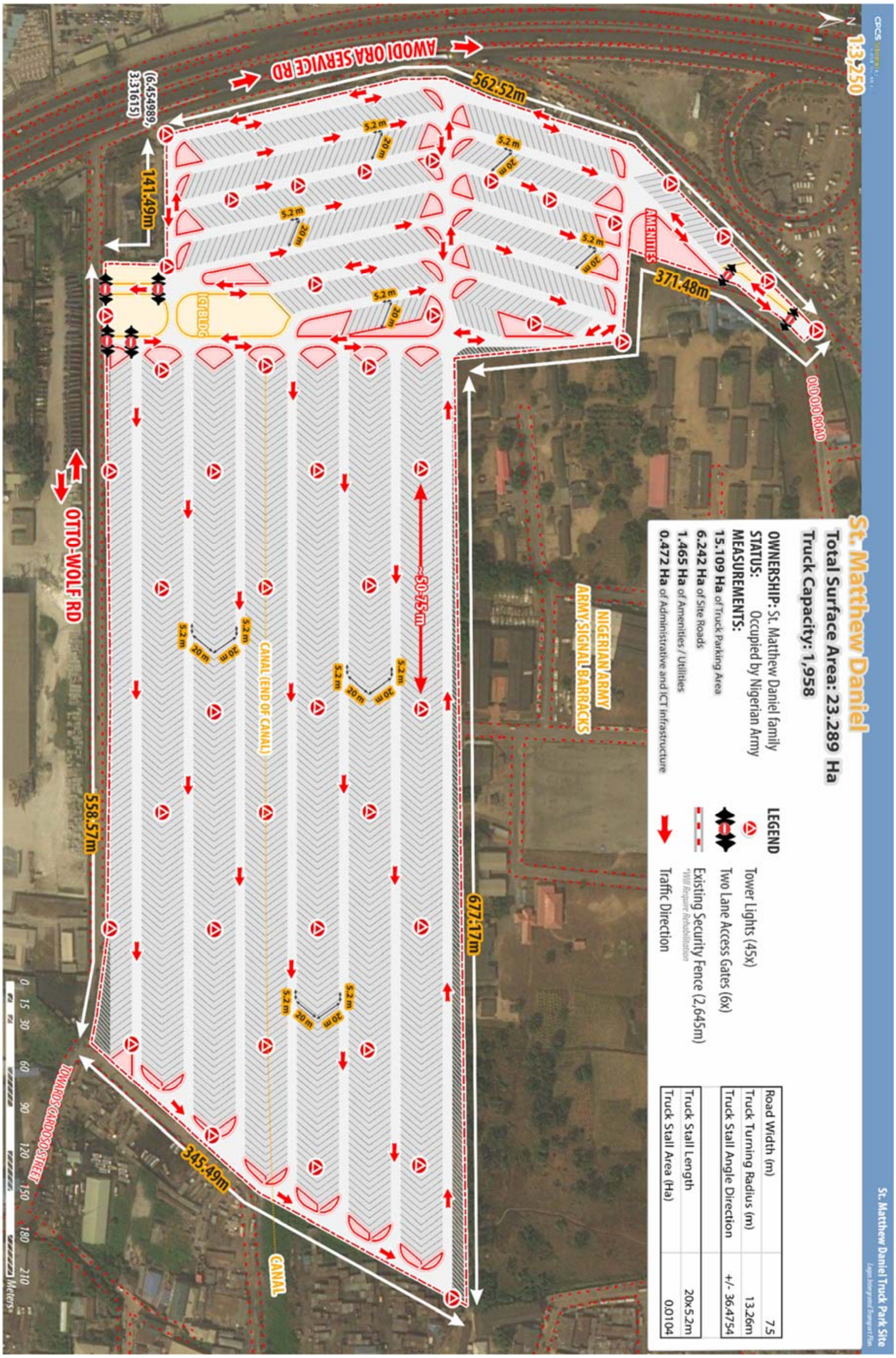
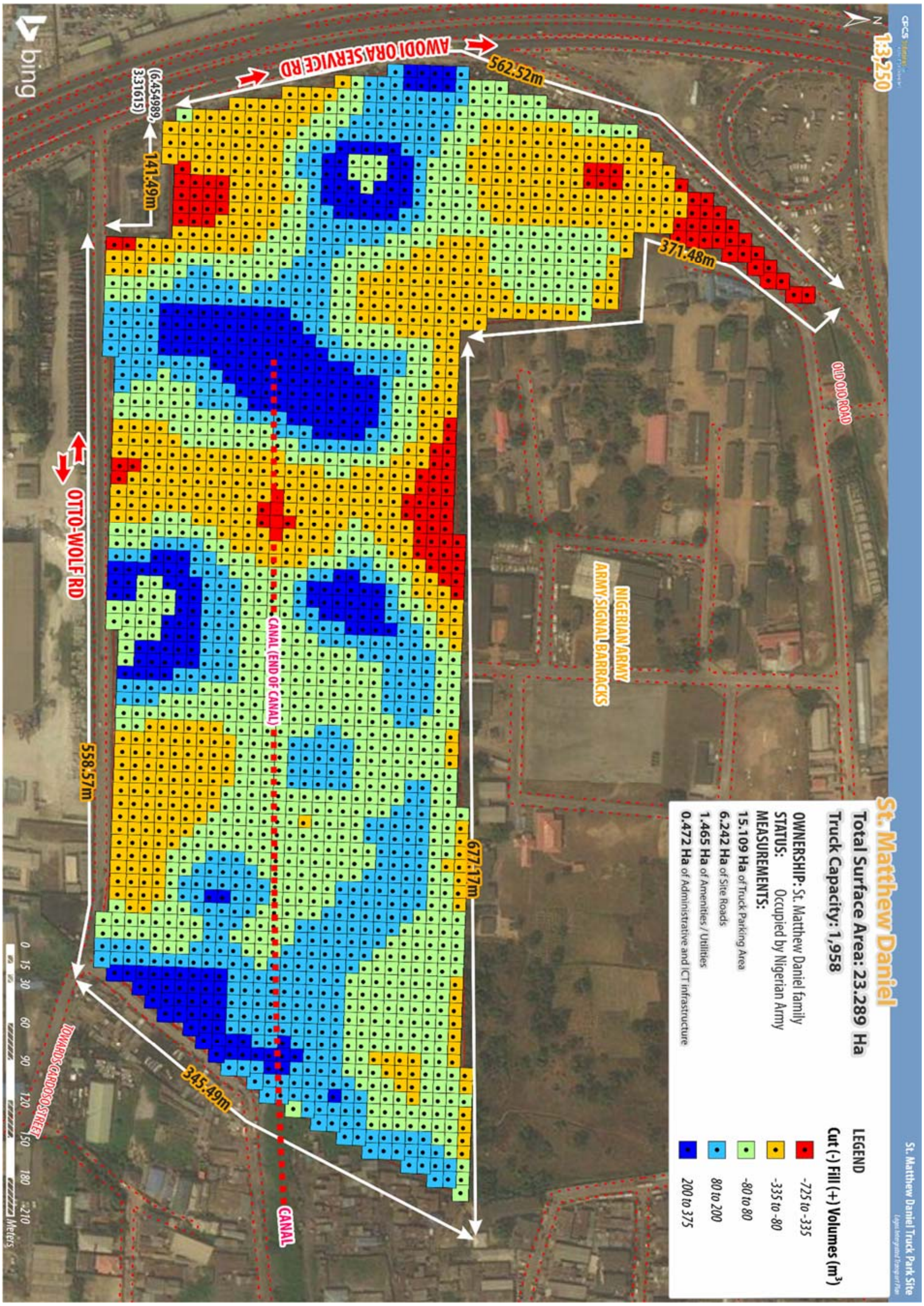


Figure 6-9. St. Matthew Daniel Truck Park Site (3) – Site Preparation



7 Financial and PPP Analysis

Key Messages

Revenue

Revenue to the project comes from one main source – appointment fees paid by trucks or truck fleets. The typical approach based on the best practices we reviewed are to charge truck per appointment (port transaction) on a TEU basis (container) and not necessarily for the use of a buffering lot.

Costs

Modelled capital costs are captured from the "bottom up" cost items for buffering site acquisition and development. Land acquisition costs are significant component. The St Mathew Daniel site is the most expensive because of its size, while the unit rate is highest on the KiriKiri site. Other civil works elements such as site preparation works, built elements, buildings, amenities, and road rehabilitation for site access are also included. Given the low degree of automation at Lagos area ports, significant investments will be incurred to develop a functioning automated system for the Truck Appointment System. Operating expenses for the buffering lots are primarily related to labor (salaries). Operating costs for the TAS relate to licensing and service payments to the vendor providing the system.

Economic Analysis

The economic appraisal was based on international best practice, using a standard approach normally applied by the World Bank and other multi-lateral institutions. The Economic Internal Rate of Return (EIRR) for the TPPAF ranges from 62% to 71% across low through high scenarios, which is accompanied by GHG emissions reductions of 0.82 to 1.34 million tons CO_2.

Financial Project Structuring Analysis

We used sensitivity analysis to study the performance of four project structures. In project structure Option 1, where the private sector is responsible not only for scheduling and integrated management and operations, but also for land acquisition and site preparation, the breakeven fee required ranges from about \$45-\$65 / TEU. The breakeven fee level falls considerably in project options where the public sector assumes responsibility of either land acquisition (Option 2), or both land acquisition and site preparation (Option 3). The range in Option 2 is \$20-30 / TEU and \$6-10 / TEU in Option 3. Commercial viability for private sector participation goes up, as public responsibility for the buffering function increases. Option 3 emerges as the most commercially viable structure with both scheduling and buffering features. In this project structure, the private sector would be entrusted with the role of integrating and managing the scheduling system, and overall operations including the use of any buffering lots that are commissioned. If buffering lots are indeed commissioned, then the responsibility for this aspect of the project is best retained with a public sector entity.

Market Sounding

Stakeholders affirmed two main ideas. There was overwhelming support for the objective that the queue removal in the Lagos ports envelope and better coordination of truck movements (including the management of empties) must be addressed. The private sector would focus their efforts on the scheduling component and corresponding operational protocols, business rules, and management mechanism as these are the sector's main areas of expertise. The buffering element (short-term holding lots) is best unbundled and allocated to the public sector as it might be in a better position to acquire land, provision the buffering lots, maintain environmental and social impact standards, and provide the overall enabling environment.

7.1 Financial Model Assumptions and Structure

The purpose of financial modeling at this stage of project preparation is to provide an indication of project-level commercial returns which further informs likely viable PSP structures in order to implement the project. It should be noted that financial modelling at this stage sets the foundation for identifying and assessing viable structures to be further developed and finalized at the feasibility stages and prior to tendering.

The model that was developed for this project is capable of assessing the project as a whole, i.e. across all the proposed project structures, with a standalone Truck Appointment System and in combination with one or more buffering lots. The figure below provides a summary of key model assumptions which can readily be adjusted in the model.

Figure 7-1. Key Model Assumptions

Assumptions	Input
Model Currency	USD
Start Date	January 1, 2019
Construction Period[85]	1 year
Maximum Modelled Operating Period	18 years
Concession Period	19 years
Current Exchange Rate	360 Naira/USD
Operating Days per Year	365
US Inflation	2.00% per annum
Nigeria Inflation	12.00% per annum
Nigeria Corporate Tax Rate	30%

7.2 Revenue

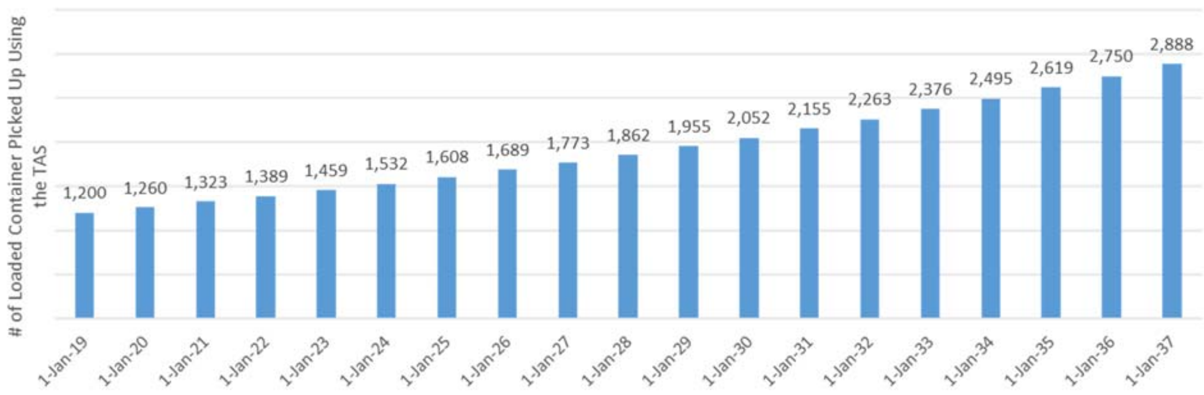
7.2.1 Overall Revenues

Revenue to the project comes from one main source – appointment fees paid by trucks or truck fleets. The typical approach based on the best practices we reviewed is to charge truck per appointment (port transaction) on a TEU basis (container) and not necessarily for the use of a buffering lot. The truck is thus paying for the service of a scheduled appointment, and does not incur separate charges for the checking in at a buffering lot while waiting to complete its appointment.

Revenue is thus a function of the **fee level ($/TEU)** and the number of **TEUs (transactions)** that the port incurs.

As discussed earlier, roughly one in five trucks assembled in queues transacts with the port on a daily basis, based on gate operation returns published by the NPA. The forecast of truck transactions (i.e. number of appointments) over the project horizon using assumptions documented in Annex for the base case, is shown in the figure below. At current levels the *average* daily number of appointments is about 1,200 trucks, however this number grows to an *average* of about 2,900 trucks daily by 2037.

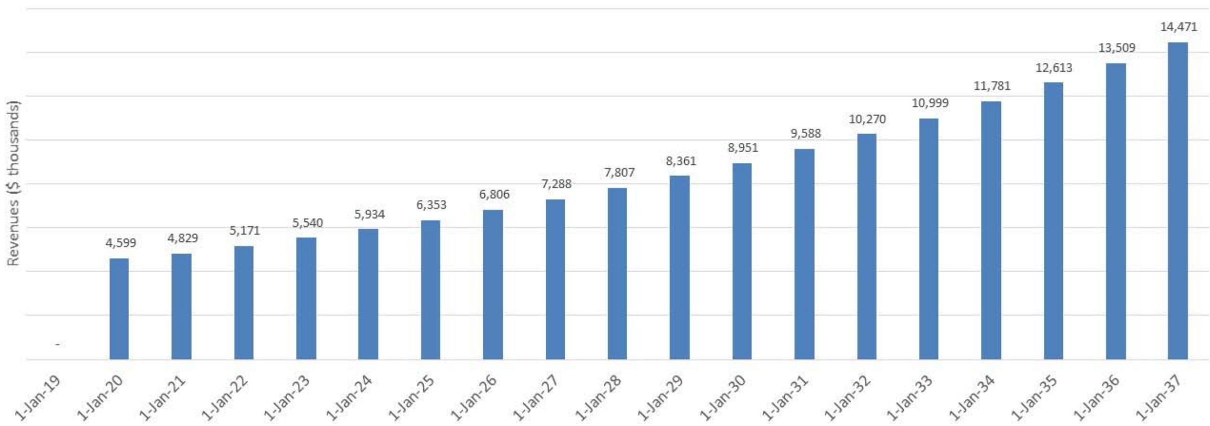
Figure 7-2. Base Case Daily Truck Appointments Forecast (2019 – 2037)



Source: CPCS Analysis

Using a starting value of USD 10 per truck appointment, with a 2% annual escalation rate in fee level, we get the forecast shown below. Revenues begin at about USD 4.6 million in year 2020 allowing for system integration and ramp up, and reach about 14.4 million per year in 2037.

Figure 7-3. Base Case Annual Revenues to the Project (2019 – 2037)



Source: CPCS Analysis

7.3 Costs

7.3.1 Capital Costs

The two main elements of the project – scheduling and buffering – each have their own capital cost structures.

ICT and Scheduling System Costs

Capital costs of scheduling systems depend to a large extent on the solution architecture, and also on the degree to which ICT is already deployed and used by terminals and port authorities in their operations.

The Truck Appointment System is a software system that requires a number of hardware, software and database components including electronic data interchanges, automated sensing gantries, scanners, communication network and systems. These are independent of the ICT equipment required at buffering lots, which are priced separately.

Based on our vendor research, for ports that have already deployed ICT extensively with sensors, databases, and dashboards, the incremental addition of a Truck Appointment System needs only on the order of a few hundred thousand US dollars for integrating and commissioning the remaining hardware and software components of the TAS. On the other hand, for ports with little to no automation, a full build out of sensors, scanners, databases, and dashboards can cost on the order of tens of millions of dollars.

The financial valuation analyses described in Section 7 assume the cost of a full system build out, as there is little to no automation, sensing, and digitalization today at Apapa and TCI port facilities. We summarize the approximate capital costs of those components below, based on discussions with a leading operator. Given the low degree of automation at Lagos area ports, significant investments will be incurred to develop a functioning automated system. Based on NAFITH's outline business case, and discussions with vendors, we estimate a capital cost of about USD 10 million for the TAS.

Figure 7-4. ICT-related System Installation and Upfront Costs

Cost Component	Upfront Cost (USD)
Superstructure, including IT Networks, automated kiosks, road monitoring, IT equipment, RFID	3.5 million
Software licensing and databases	3.5 million
Setup costs such as training, deployment, etc	3 million
Total	**10 million**

Source: vendor outline business case

ICT systems have an accelerated depreciation schedule compared to other built infrastructure, as technologies tend to become obsolete every five to seven years.

Buffering Lots (parking facilities)

Modelled capital costs are captured from the "bottom up" cost items for buffering site acquisition and development, as described in detail in Section 6. Land acquisition costs are significant component and summarized in the figure below for all three candidate sites. The St Mathew Daniel site is the most expensive because of its size, while the unit rate is highest on the KiriKiri site.

Figure 7-5. Site Land Acquisition Costs

	NGN 000 000 / Per Ha	Truck Parking Area (Ha)	Site Roads (Ha)	Amenities / Utilities	Administrative / ICT Infrastructure (Ha)	Total Space Requirement (Ha)	Land Acquisition Cost (NGN 000 000)	Land Acquisition Cost (US 000)

Orile	925.00	1.18	1.35	0.04	0.02	2.58	2,383	7,802
KiriKiri	975.00	2.91	2.40	0.12	0.10	5.53	5,389	17,645
St Mathew Daniel	625.00	15.11	6.24	1.47	0.47	23.29	14,555	47,659

Source: CPCS Analysis

Other civil works elements such as site preparation works, built elements, buildings, amenities, and road rehabilitation for site access are summarized below. Once again St Mathew Daniel has the largest costs because of its size.

Figure 7-6. Site Capital Costs

	Civil Works: Land Preparation	Civil Works: Site Infrastructure	Administrative and ICT Buildings	Amenities Building	Civil Works: Offsite Road Rehab and Access	Total Terminal Infrastructure Capital Cost (NGN 000 000)	Total Terminal Infrastructure Capital Cost (US 000)
Orile	289,791,952	74,920,872	91,518,487	36,482,155	9,087,776	501.80	1,394
KiriKiri	622,567,430	94,953,741	198,219,709	298,873,231	811,584,292	2026.20	5,628
St Mathew Daniel	2,514,142,850	184,839,586	956,643,175	3,830,702,396	188,849,025	7675.18	21,320

Source: CPCS Analysis

7.3.2 Operational Costs

Modelled operational costs are as summarized below. Operating expenses for the buffering lots are primarily related to labor (salaries). Operating costs for the TAS relate to licensing and service payments to the vendor providing the system, based on our discussions.

Figure 7-7. Project Operating Parameter and Costs

	Terminal Manager (Units)	Terminal Manager (Unit Salary US$)	Admin Officer (Units)	Leasing Officer (Unit Salary US$)	Cleaning Staff (Contracted Out) per Ha	Cleaning Staff for Public Areas (Contract Cost per Ha)	Park Control (# of Gates)	Parking Control (Unit Salary US$)	Security Personnel (Contracted Out) per Ha	Security Gaurds (Unity Salary US$)	Total Cost (US 000)
Orile	1	15,000	1	9,000	2.58	1,130	7	1,700	2.58	420	120
KiriKiri	1	15,000	1	9,000	5.53	1,130	9	1,700	5.53	420	144
St Mathew Daniel	1	15,000	2	9,000	23.29	1,130	6	1,700	23.29	420	238
TAS Licensing & Service	-	-	-	-	-	-	-	-	-	-	100

Source: CPCS Estimate

The remaining operating parameters that are modelled are captured in the figure below.

Figure 7-8. Operating Parameter and Cost Assumptions

Cost Assumption	Rate
Yearly Infrastructure Maintenance Costs	1.0% of CAPEX (not including land) in the first 10 years and 2.0% thereafter/
Other Costs (Insurance, Certifications, etc.)	15.0%
Accounts Receivable Turnover	30 days
Inventory Turnover	30 days
Accounts Payable Turnover	30 days

Source: CPCS Experience and Industry Research

7.3.3 Financing Costs

Conducting a PSP valuation requires assumptions on financing parameters both from the perspective of the private and the public sector. These parameters and related assumptions are summarized in Table 7-1 and Table 7-2.

Table 7-1: Private Sector Financing Assumptions

Financing Parameter	Assumption	Commentary
6-month USD LIBOR Rate	2.75%	Based on a review of current 6-month LIBOR rates from the Federal Reserve Bank of St. Louis
Private Lending Spread on US Denominated debt	6-month USD LIBOR + 7.85%	The spread and tenor estimate is based on a review of confidential term sheets (as available) for Build-Operate-Transfer type transport projects in West Africa in the past ten years
Private Lending Tenor on US Denominated debt	15 years	
Private Lending Rate on Naira Denominated debt	23%	The Naira denominated lending rate is based on a review of the June 29, 2018 publication made by the Central Bank of Nigeria on lending rates obtainable in all Deposit Money Banks in Nigeria. The review is specific to lending rates in “Transportation and Storage”
Private Lending Tenor on Naira Denominated debt	7 years	This is based on feedback from the World Bank
Gearing Assumption	65% - 70%	The low-end estimate (65%) is assumed under a PPP structure whereby the private sector is engaged on a Build-Operate-Transfer type of basis, whether it is ‘at-risk’ or backed by Government Subsidy The high-end estimate (70%) is assumed under a PPP structure whereby the private sector is engaged on an O&M concession type of basis and thus, the private sector’s upfront

Financing Parameter	Assumption	Commentary
		capital commitments are limited to items such as furniture, fixtures and equipment.
Private Sector Leveraged Hurdle Rate (Return on Equity Benchmark)	16% to 18%	The low-end estimate (16%) is assumed under a PPP structure whereby the private sector is engaged on an O&M concession type of basis and thus, the return on equity benchmarks do not include premiums related to large private capital outlays The high-end estimate (18%) is assumed under a PPP structure whereby the private sector is engaged on a Build-Operate-Transfer type of basis and thus, the return on equity benchmarks include premiums related to large private capital outlays
Private Sector Unlevered Hurdle Rate (Weighted Average Cost of Capital Benchmark)	10% - 11%	Derived based on above return on equity benchmark and gearing assumptions

Source: CPCS Experience, Market Consultations and Industry Research

Table 7-2: Public Sector Financing Assumptions

Financing Parameter	Assumption	Commentary
6-month USD LIBOR Rate	2.75%	Based on a review of current 6-month LIBOR rates from the Federal Reserve Bank of St. Louis
Public Lending Spread on US Denominated debt	6-month USD LIBOR + 1.50%	This is based on the IBRD Flexible Loan Pricing Basics note (Updated April 2018) and specifically, the fixed spread loan with an average repayment maturity of 18 to 20 years (see page 2).
Public Lending Tenor on US Denominated debt	20 years	
Public Lending Rate on Naira Denominated debt	Central Bank of Nigeria (CBN) Prime Lending Rate (16.6%) + 1.40% spread	The Public Lending Rate on Naira denominated debt is based on a review of the CBN's prime lending rate (as at September 2018). Added to this is a 1.40% concessional premium. Furthermore, it is assumed that such a concessional loan would be made available from the Federal or Lagos State Government.
Public Lending Tenor on Naira Denominated debt	7 years	This is based on feedback from the World Bank

Source: CPCS Experience, Market Consultations and Industry Research

Naira/USD Exchange Rate Forecast

Noting that the modeled currency is USD while the acquisition currency of capital items is to be in Naira and USD (see Table 7-3 for related assumptions), a Naira/USD exchange rate forecast is required to account for exchange rate gains and losses as part of debt servicing. Or Naira/USD forecast is provided in Table 7-4.

Table 7-3: Acquisition Currency for Capital Outlay Items

Capital Outlay Item	Currency of Acquisition
Truck Terminal Infrastructure including Pre-operating Expenses	USD
Truck Appointment Program	USD
Land Acquisition	NGN
Terminal Furniture, Fixtures and Equipment	NGN

Source: CPCS Estimate

Table 7-4: Naira/USD Exchange Rate Forecast

Year	Naira/USD Forecast
2019	370
2020	385
2021 onward	390

Source: Trading Economics Nigerian Naira Forecast (reviewed on October 22, 2018)

7.4 Economic Analysis

A high level economic assessment of the project was undertaken. While the financial analysis focused on the financial costs and revenues of the project (i.e. those which affect the project cash flow), the economic analysis focusses on the wider economic costs and benefits. These are non-financial benefits and many of them are not realized in cash terms. The economic appraisal was based on international best practice, using a standard approach normally applied by the World Bank and other multi-lateral institutions.

The economic appraisal consists of the following elements:

- Economic costs – capital and operating costs
- Economic benefits (avoided cost of delays, total logistics costs improvement, avoided emissions)
- Economic assessment parameters – ENPV and EIRR

7.4.1 Social Discount Rate

The choice of an appropriate Social Discount Rate (SDR) for use in an economic analysis can be quite controversial, as it can have a significant impact on the results. Unlike the financial discount rate, which reflects the opportunity cost of capital, the economic discount rate (or social discount rate) should reflect how society values current costs and benefits versus future costs and benefits.

There are significant variations in public discount rate policies practiced by countries around the world, with developing countries in general applying higher SDRs (8%-15%) than developed countries (3%-7%). The divergence reflects differences in the perceived social opportunity cost of public funds across countries and in the extent to which the issue of intergenerational equity is taken into consideration in setting the SDR.

Up to 2015 the Nigerian economy grew at a steady rate of 6%-7% per annum. After the economic downturn in 2015, the GDP growth rates fell and are now expected to grow at around 2% per annum. However, economic appraisal of projects in developing countries are normally undertaken using a SDR of 12%, and hence this is the value we have used for this analysis.

7.4.2 Economic Costs

The financial costs consist of capital and operating costs. These have been adjusted to reflect their actual economic value (i.e. the social opportunity cost of the resources), rather than their market price. Markets often incorporate significant price distortions created, for example, by market barriers (e.g. tariffs or subsidies), social policies (e.g. minimum wages) or simply due to market imperfection, macroeconomic unbalances or rigidities (e.g. wage rigidities); these distortions have been removed where encountered. Financial estimates are transformed into economic values by applying appropriate conversion factors.

For the purpose of this high-level analysis, a uniform conversion factor of 0.9 has been applied to all financial costs (both capital and operating costs) to arrive at the economic costs.

7.4.3 Economic Benefits

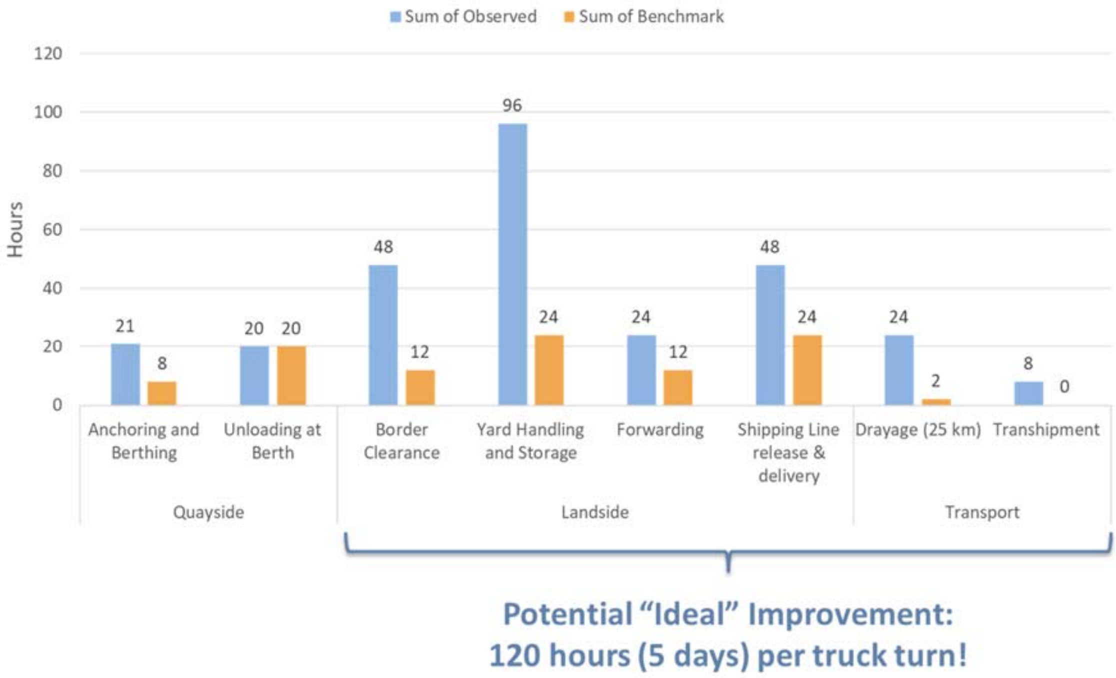
The economic benefits of alleviating congestion are likely to be significant, given the dire forecast of congestion and also because of the significant benefit available for every truck operation. The main outcome of reduced congestion is increased throughput, and this forms the basis of calculating available economic benefits.

From an operations perspective, throughput is measured by truck turn time, as defined earlier. Based on detailed published data[86], we estimate that truck turn times could be improved by as much as 5 days in the ideal, by improving the efficiency of both port landside operations, as well as dray operations over the last mile network in Lagos, i.e. moving containers to and from area facilities (Figure 7-9). The time saving translates to a potential ideal cost savings of US$1,200 per truck turn. While these (unit) benefits are large, only a fraction might be capturable in practice.

The map in Figure 7-10 shows how reducing congestion in the port vicinity by eliminating extensive queues will enable improved throughput and port access. The main performance metric used is an improvement in Volume to Capacity Ratio (VCR). As VCR decreases (negative percent change), capacity and throughput on port access roads increases. Roads with significant potential improvement are highlighted in green, and those with little to no improvement (as a result of reduced congestion) are shown in blue / gray.

[86] NEXTT (2015)

Figure 7-9. Potential Ideal Economic Benefits per Truck Turn (Hours and Dollars)



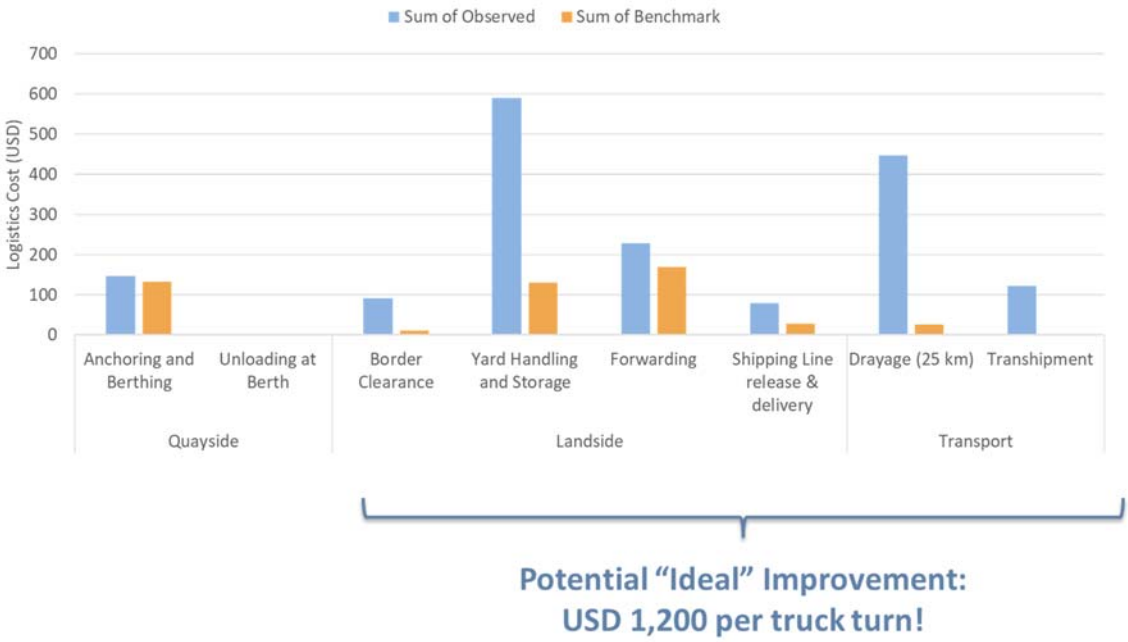
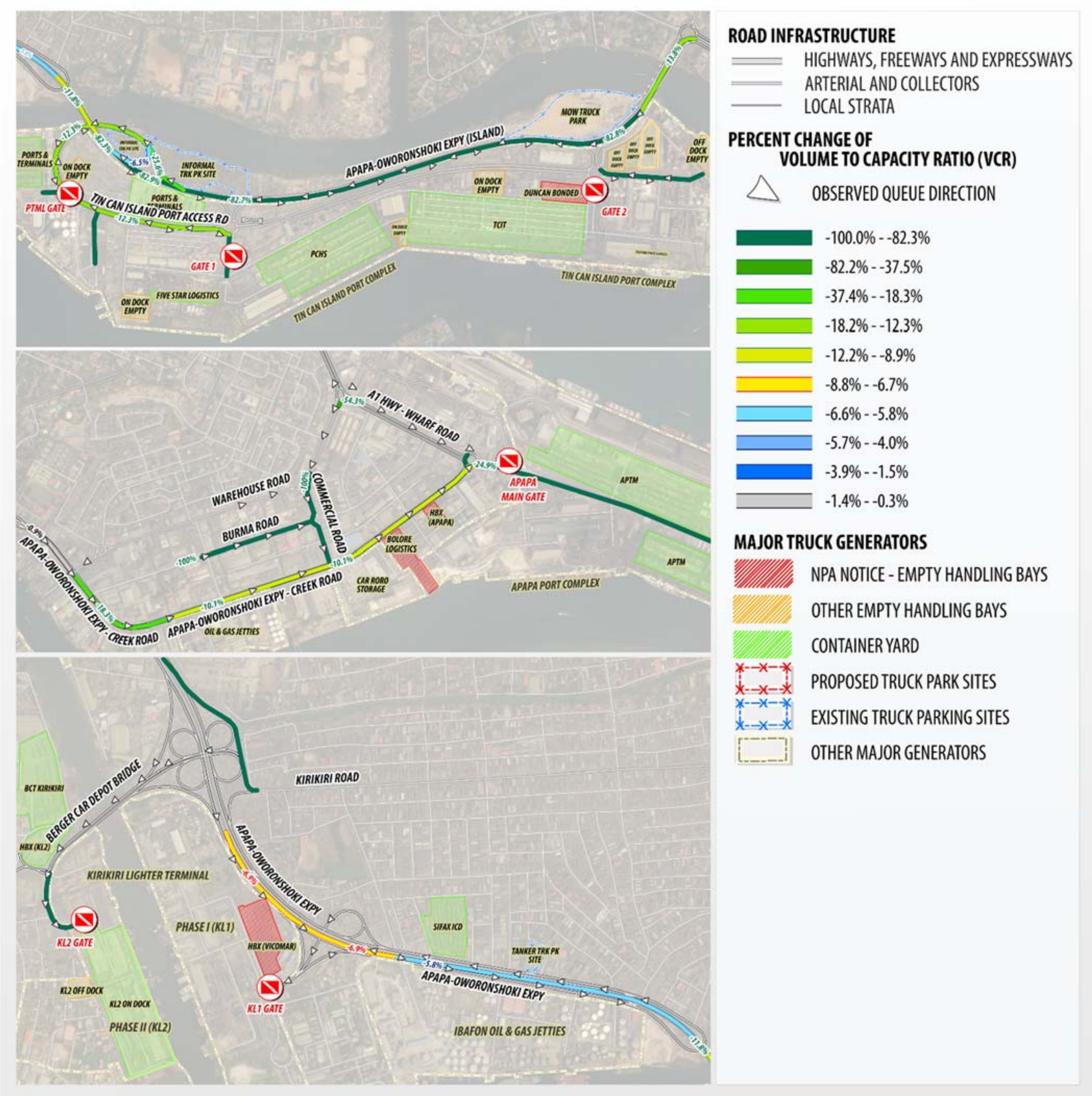


Figure 7-10. Capacity improvement in the port area network as a result of congestion reduction



Source: CPCS analysis

7.4.4 Benefit Estimates

Reduced congestion and increased throughput translate into economic benefits. The economic benefits are composed of avoided operational delays (value of time) and avoided indirect cost of congestion. We ascribed a unit benefit value of **$250 / TEU** (i.e. per truck turn) for container trucks and about **$150 / per turn** for non-container trucks, using very conservative estimates (20 – 30% benefit capture) of the "ideal" available benefits highlighted earlier. The unit benefits are applicable to those queues that actually perform turns (~ 1 in 5 trucks in the queue on a given day). Breakdowns for these assumption are shown below.

Figure 7-11. Potential time saving under ideal conditions for landside and dray operations

Total Potential Avoidable Delay - Container Trucks	120 hours (5 days)
Landside Operations	96 hours (4 days)
Dray and Transhipment	24 hours (1 day)
Total Potential Avoidable Delay – Non-Container Trucks	72 hours (3 days)
Landside Operations	48 hours (2 days)
Dray and Transhipment	24 hours (1 day)
Indirect Cost of Delay for Truck - Container	$119.86 / TEU
Interest Rate	25.0% per year
Interest Rate	0.003% per hour
Value of Average Basket Import TEU	$35,000 USD/TEU
Indirect Hourly Cost of Delay	$1.00 per TEU per hour
Indirect Cost of Delay for Truck - Other	$72 / truck
Interest Rate	25.0% per year
Interest Rate	0.003% per hour
Indirect Hourly Cost of Delay	$1.00 per truck per hour

Source: CPCS analysis of NEXTT (2015) data

Assumptions / benefit estimates for avoided emissions as a result of efficient dray operations (reduced idling, fuel use) are shown below.

Figure 7-12. Avoided emissions as a result of efficient dray operations

Avoided Idling emissions	$2.23	Per Trip
HDDV Vehicle Idling Diesel Usage	2.271	liter/hour
Mobile CO2 Emissions Factor	2.663	kg/liter
	2.697	kg/liter
Idling CO2 Emissions Factor	4.640	kg/hr
Transport CO2 production factor	0.296	kg/ton-mile
	0.185	kg/ton-km
Value of avoided CO2 emissions	0.010	USD/ton
Assumed reduced idling time	48.000	hours

Source: CPCS analysis of Natural Resources Canada (NRCAN), US Environmental Protection Agency (US EPA), Port of Long Beach Emissions Model

Figure 7-13 summarizes the cumulative benefits of operational improvement and congestion reduction between 2018-2037, using the same scenarios developed earlier for truck appointment forecasts. We incorporate a sensitivity analysis into the benefit estimates across the three truck appointment growth scenarios.

Figure 7-13. Cumulative Economic Benefits under conservative assumptions

Truck Turn Growth Scenario	Low (2%)	Base (5%)	High (7%)
EIRR	62 %	68 %	71 %
Avoided GHG Emissions (ton CO2)	0.82 million	1.08 million	1.34 million

Source: CPCS analysis

7.5 Financial Analysis

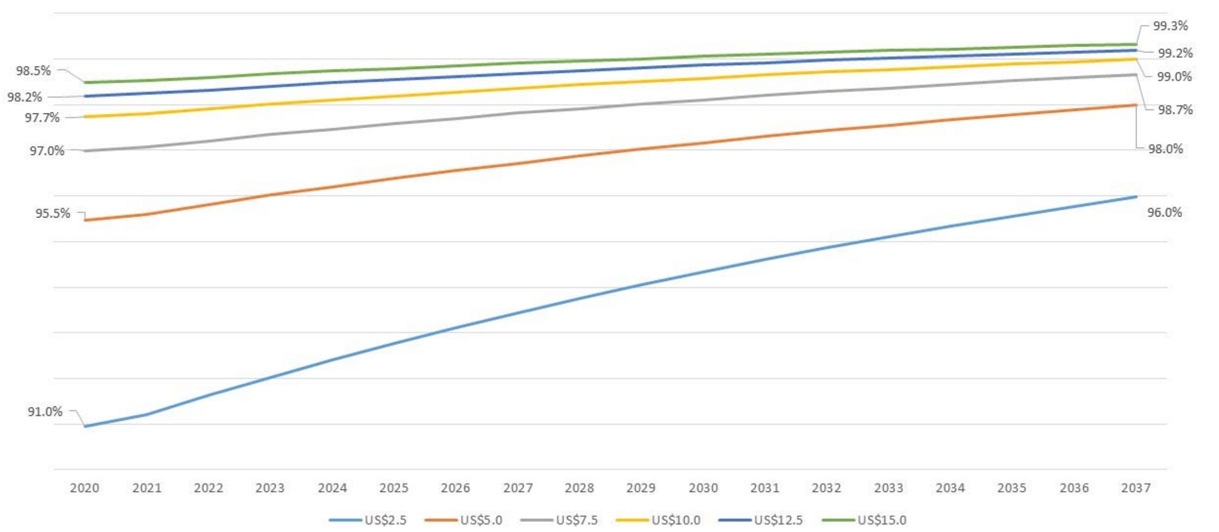
7.5.1 Operating Margin Analysis

To inform the level of financial participation from both the public and the private sectors to make the TPPAF project viable, an important first step is to analyze the **operating margin** of (1) the TAS system as a standalone project and (2) the TAS with the inclusion of the proposed buffering lots as part of the project. The higher the operating margin, the better the operating performance of the project. The figures on the following pages summarize the operating margin of (1) and (2) above. The results inform the following:

1. As noted, the likely affordable range for the TAS fee ranges between US$5.00 and US$10.00/TEU. The range in Figure 7-14 covers a fee that is between US$2.50/TEU and US$15.00/TEU. Based on the results, the operating performance of just the TAS is strong across all fees in the range at greater than 90%. This result is especially important for the lower ranges (e.g., US$2.50 to US$5.00/TEU) as some fee discounting may be required in the earlier stages to quell resistance and promote buy-in into the program

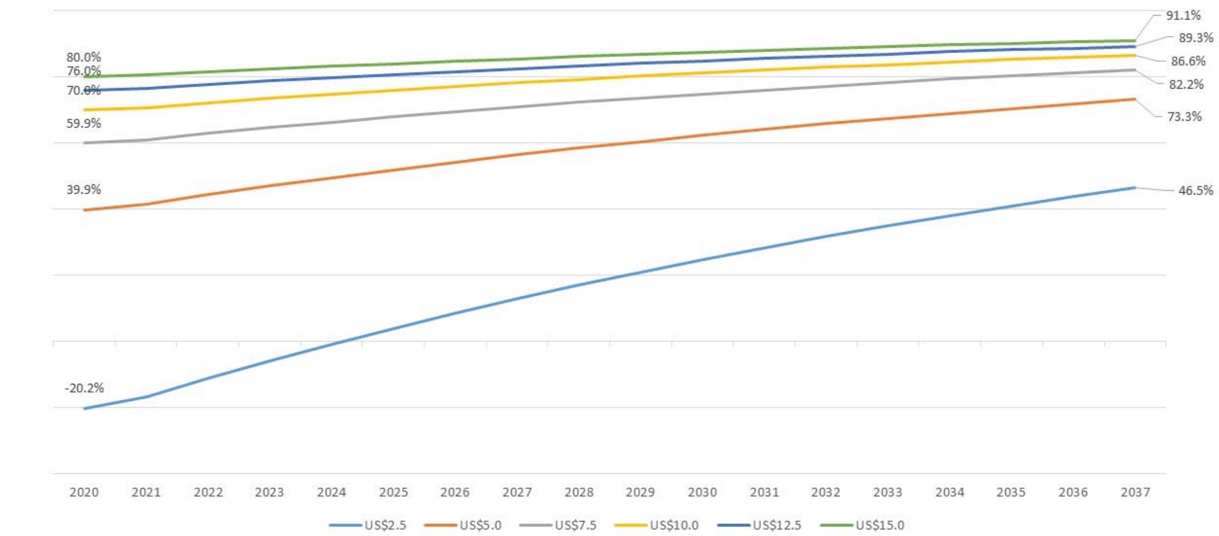
2. Figure 7-15 presents the operating margin of both the TAS and the buffering lot operations. In the case where parking operations are integrated into the project (along with the TAS), operating margins are positive for all fee ranges except for US$2.50/TEU. In the US$2.50/TEU case, the operating margin is negative at the start of operations but by year 2025, becomes positive. Generally then, a positive operating margin gives scope to (1) the TAS and buffering lot operator to pay for some or all of the capital outlays (e.g., land acquisition, terminal development etc.) and/or (2) for the operator to pay a concession fee to Government.

Figure 7-14: Operating Margin (TAS System Only)



Source: CPCS Estimate

Figure 7-15: Operating Margin (TAS System and Buffering Lot Facilities)



Source: CPCS Estimate

7.5.2 Unlevered Analysis

Prior to examining the various structures for PSP, it is useful to analyze the entire project as a whole without the use of leverage (debt). Specifically, it is useful to look at the project just as (1) a Truck Appointment System only and (2) as a Truck Appointment System with the proposed buffering lots as well. The unlevered financial analysis tests if cash flows (internally generated) are sufficient to provide a reasonable rate of return, prior to considering the following financial structuring options:

1. Government's upfront subsidy and recurring financial participation in the project;
2. Commercial debt; and

3. Duration of the PSP.

What constitutes a reasonable level of return depends on who is making the investment (in this case, Government or the private sector) and if the return thresholds meet objective investment criteria and standards. For the purposes of this analysis, the return threshold is set at 10% (in US dollar terms).

The goal of this analysis is ultimately to derive the project cash flows over the forecast period. The cash flows are calculated using a buildup approach. The steps taken to derive the cash flows are as follows:

1. Earnings before Interest, Taxes, Depreciation and Amortization (EBITDA) is calculated for each year of the forecast period,
2. Earnings before Interest and Taxes (EBIT) is calculated by deducting depreciation from each year's operating profit or loss,
3. Utilizing the EBIT figure, corporate taxes are calculated for each year in the forecast period. The total of corporate taxes are summed in order to reduce EBITDA commensurately for each period,
4. Changes in Working Capital are added back to EBITDA,
5. Capital Investment is deducted from EBITDA,
6. The Terminal value[87] (only applies for the final year of the forecast period) is added back to the respective EBITDA figure,
7. A yearly cash flow figure is derived based on the above steps.

The following tables summarizes our unlevered financial analysis for just the TAS system itself (i.e., if the TAS system itself was a project without the buffering lots) and the TAP system combined with each of the proposed buffering lot sites, individually. The tables are accompanied with commentary.

7.5.3 Unlevered Analysis –TAS Only

Table 7-5: Unlevered NPV (Discounted at 10%) For Truck Appointment System Only (US$ 000)

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	1,294	3,068	**-789**
5	11,005	14,503	6,931
7.5	20,413	25,632	14,339
10	29,778	36,738	21,680
12.5	39,143	47,843	29,021
15	48,509	58,948	36,362

Source: CPCS

[87] The Terminal Value represents all cash flows that occur so far into the future (i.e. following the project period) that it would not be practical to forecast them. For the purposes of this analysis, the Terminal Value represents the value of the project following the 20-year project period. We have assumed the terminal value to be the net-book value of assets at the end of the concession period

Table 7-6: Unlevered NPV (Discounted at 10%) For Truck Appointment System Only (Naira 000)

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	465,829	1,104,365	**-283,983**
5	3,961,809	5,220,945	2,495,030
7.5	7,348,507	9,227,663	5,162,190
10	10,720,043	13,225,584	7,804,953
12.5	14,091,579	17,223,505	10,447,717
15	17,463,114	21,221,426	13,090,480

Source: CPCS

7.5.4 Unlevered Analysis –TAS Only

Table 7-5 and Table 7-6 summarize the unlevered net present value (discounted at 10%) for the TAP system only (no buffering sites) at different rates and across our three traffic cases. What is immediately clear is that project revenues can cover both operational and capital costs related to the TAS while also providing a return that is above 10% for all cases within the fee range presented in the tables above, except when the fee is set to US$2.50/TEU under the low traffic case. Thus, the income generated from the TAS could also be used to reduce fee levels over time or reinvested into buffering lots as is analyzed below.

7.5.5 Unlevered Analysis – TAS and St. Mathew Daniel Buffering Site

Table 7-7: Unlevered NPV (Discounted at 10%) For Truck Appointment System and St. Mathew Daniel Buffering Site (US$ 000)

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	**-53,142**	**-50,699**	**-56,042**
5	**-41,844**	**-38,276**	**-46,095**
7.5	**-32,018**	**-26,772**	**-38,153**
10	**-22,517**	**-15,558**	**-30,615**
12.5	**-13,152**	**-4,452**	**-23,274**
15	**-3,787**	**6,653**	**-15,933**

Source: CPCS

Table 7-8: Unlevered NPV (Discounted at 10%) For Truck Appointment System and St. Mathew Daniel Buffering Site (Naira 000)

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	**-19,131,089**	**-18,251,607**	**-20,175,281**
5	**-15,063,780**	**-13,779,329**	**-16,594,266**
7.5	**-11,526,513**	**-9,637,809**	**-13,734,975**
10	**-8,106,273**	**-5,600,732**	**-11,021,363**
12.5	**-4,734,737**	**-1,602,811**	**-8,378,599**
15	**-1,363,201**	**2,395,111**	**-5,735,836**

Source: CPCS

As evidenced in the tables above, for the majority of proposed fees and traffic cases, the net present value of the project (TAS and the St. Mathew Daniel Buffering Site) is negative. Hence, Government support would likely be required (e.g., by providing the land and/or viability gap funding). The table below summarizes the fees required under each of the traffic scenarios to make the TAS and St. Mathew Daniel Buffering Site project combination breakeven under the different traffic scenarios (i.e., NPV = US$0).

Table 7-9: Breakeven TAS Fee (NPV = 0) For Truck Appointment System and St. Mathew Daniel Buffering Site (US$/TEU)

Base Traffic Case	High Traffic Case	Low Traffic Case
16.0	13.5	20.43

Source: CPCS

For interest, the below tables recast the unlevered NPV (discounted at 10%) excluding the upfront costs related to land acquisition. With land acquisition costs removed, the unlevered NPV valuation significantly improves with a US$10/TEU fee or higher achieving a positive NPV across all traffic cases.

Table 7-10: Unlevered NPV (Discounted at 10%) For Truck Appointment System and St. Mathew Daniel Buffering Site and Excluding Land Acquisition (US$ 000)

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	-22,400	-19,957	-25,300
5	-11,102	-7,534	-15,353
7.5	-1,276	3,971	-7,410
10	8,225	15,185	127
12.5	17,590	26,290	7,468
15	26,956	37,395	14,809

Source: CPCS

Table 7-11: Unlevered NPV (Discounted at 10%) For Truck Appointment System and St. Mathew Daniel Buffering Site and Excluding Land Acquisition(Naira 000)

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	-8,063,872	-7,184,389	-9,108,063
5	-3,996,562	-2,712,111	-5,527,049
7.5	-459,296	1,429,408	-2,667,758
10	2,960,945	5,466,486	45,855
12.5	6,332,480	9,464,407	2,688,618
15	9,704,016	13,462,328	5,331,382

Source: CPCS

7.5.6 Unlevered Analysis –TAS and Kirikiri Buffering Site

Table 7-12: Unlevered NPV (Discounted at 10%) For Truck Appointment System and Kirikiri Buffering Site (US$ 000)

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	-16,676	-14,860	-18,859
5	-6,745	-3,240	-10,836
7.5	2,773	7,993	-3,300
10	12,139	19,099	4,041
12.5	21,504	30,204	11,382
15	30,869	41,309	18,723

Source: CPCS

Table 7-13: Unlevered NPV (Discounted at 10%) For Truck Appointment System and Kirikiri Buffering Site (Naira 000)

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	-6,003,198	-5,349,678	-6,789,310
5	-2,428,083	-1,166,261	-3,901,085
7.5	998,402	2,877,558	-1,187,915
10	4,369,938	6,875,479	1,454,848
12.5	7,741,474	10,873,400	4,097,612
15	11,113,010	14,871,322	6,740,375

Source: CPCS

Per Table 7-12 and Table 7-13, fees that are in the range of US$7.5/TEU or higher start to support the TAP system and Kirikiri short term parking facility project (inclusive of land acquisition). The table below summarizes the fees required under each of the traffic scenarios to make the TAP and Kirikiri Buffering Site project combination breakeven under the different traffic scenarios (i.e., NPV = US$0).

Table 7-14: Breakeven TAP Fee (NPV = 0) For Truck Appointment Program and Kiri Kiri Buffering Site (US$/TEU)

Base Traffic Case	High Traffic Case	Low Traffic Case
6.76	5.71	8.62

Source: CPCS

7.5.7 Unlevered Analysis –TAS and Orile Buffering Site

Table 7-15: Unlevered NPV (Discounted at 10%) For Truck Appointment System and Orile Buffering Site (US$ 000)

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	-6,002	-4,215	-8,116
5	3,787	7,285	-288
7.5	13,239	18,459	7,166
10	22,605	29,565	14,507
12.5	31,970	40,670	21,848
15	41,336	51,775	29,189

Source: CPCS

Table 7-16: Unlevered NPV (Discounted at 10%) For Truck Appointment System and Orile Buffering Site (Naira 000)

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	-2,160,559	-1,517,335	-2,921,807
5	1,363,409	2,622,545	-103,592
7.5	4,766,203	6,645,359	2,579,886
10	8,137,739	10,643,280	5,222,650
12.5	11,509,275	14,641,202	7,865,413
15	14,880,811	18,639,123	10,508,176

Source: CPCS

Of the three proposed sites, the Orile site (from a financial point of view) provides the highest returns as evidenced in the tables above. At a fee range of higher than US$5/TEU, the related NPVs by traffic case are above zero. The table below summarizes the fees required under each of the traffic scenarios to make the TAS and Orile Buffering Site project combination breakeven under the different traffic scenarios (i.e., NPV = US$0).

Table 7-17: Breakeven TAP Fee (NPV = 0) For Truck Appointment Program and Orile Buffering Site (US$/TEU)

Base Traffic Case	High Traffic Case	Low Traffic Case
4.01	3.40	5.10

7.6 Introducing PSP in the Project Structure

The financial analysis shows that a TAS system provides healthy returns for fee levels as low as US$ 2.5 / TEU, however returns are more robust under all truck traffic scenarios tested at a higher fee range of US$ 5 / TEU. Implementing a TAS on its own can result in significant benefits, as evidenced in the Manila project. In comparison the Port of Manila project had fee levels ranging from US $5/TEU to US $20/TEU, depending on time of day. Thus implementing the scheduling system (TAS) is a viable option, with the opportunity to re-use the returns from such a project either for reinvestment into scaling up the TAS, or towards buffering lots.

Fee Range (US$/TEU)	Base Traffic Case	High Traffic Case	Low Traffic Case
2.5	1,294	3,068	**-789**
5	11,005	14,503	6,931

When coupled with a buffering site, the fee level required is between US$ 3.40 / TEU (for Orile) and US$ 20.43 for St Mathew Daniel, depending on the traffic scenario. For these options, the cost of land acquisition is borne by the public sector, whereas the capital and operating costs of the TAS and buffering site operations are the responsibility of the TAS.

	Base Traffic Case	High Traffic Case	Low Traffic Case
TAS + St Mathew Daniel	16.0	13.5	20.43
TAS + KiriKiri	6.76	5.71	8.62
TAS + Orile	4.01	3.40	5.10

The private sector participant would undertake the concession on an integrated deployment, management, and operation basis over a period of 8 - 10 years, with a 7-9 year operating period. As indicated by the traffic scenarios, the private entity would bear the revenue risk of the project.

These results inform the PSP implementation strategy as discussed below.

7.6.1 PSP Implementation Strategy

Based on the precedent observed in the Manila case, the specific modeling results for the TAS only option tested here, and the significant benefits of addressing extreme congestion at the Lagos area ports, implementing the TAS is a compelling option.

Setting the Stage

For the TAS to work however, some pre-requisites would first need to be addressed. Each truck wishing to conduct a dray move at the port would need to be registered in a common database. The database would be accessible by agencies such as LASG as well as the NPA to enable identity validation checks and to allow these trucks to access port facilities. Without this registration certificate, trucks would not be able to access the port or participate in the appointment system.

It is critical that LASG and NPA enforce the required registration and confirmation of appointments for port access, otherwise the TAS will lose its power for controlling truck flow entirely.

Another priority is to develop and enforce parking restrictions in the vicinity of the ports, and access roads. This is important to ensure compliance with the above requirement that only registered trucks with confirmed appointments should be able to access port facilities, and that when they do travel to the terminals, the port area access roads can indeed allow for a reasonable flow of traffic. LASTMA is the appropriate agency to oversee the enforcement of a parking policy within a security cordon established around the ports. Both the NPA and LASTMA would need to be involved to screen consignment notes or bills of lading, to ensure that trucks have legitimate business. Without these checks and enforcement, trucks will not have an incentive to participate in the TAS system, and are therefore not part of the captive revenue stream.

In the meanwhile, as stakeholders engage in developing these pre-requisites, the truck parking facility on Tin Can Island owned by FMPWH is 90% complete and should be operationalized to provide some staging space for trucks (~350 trucks). While the measures above are being put in place, some trucks can be accommodated in the TCI site. Additional coordination is required between the NPA and FMPWH to enable this.

Overall, NPA, LSG and FMPWH would need to agree on the holistic port access governance arrangement, enforcement policies and mechanisms, and the implementation agreements to deploy the new procedures. This charter and pursuant agreements would need to be in place to enable the PSP option, and to determine the business rules that govern how and when charges are levied for the use of the TAS.

Various stakeholders should be engaged and sensitized to proposed changes, and the new procedures and protocols. As described below, participation in a pilot demonstration would be critical for the buy-in and value proposition of those who may have reason to initially resist participation.

NPA can pave the way for an eventual PSP project by engaging with STOAN as a representative of terminal operators to put in place the framework for formulating an Authorized Economic Operator (AEO), a Special Purpose Vehicle that will ultimately oversee the procurement of the scheduling and buffering scheme. The terminal operators (concessionaires) would altogether comprise a 49% minority equity stake in the AEO. A transaction for the 51% majority stake would be conducted to identify the private sector anchor for the AEO. To align interests and incentives, a foreign entity with expertise in Truck Appointment Systems and port operations would form a joint venture with a local Nigerian firm to ensure that the local context is respected, international expertise is brought to the table, and local capacity continues to build.

Piloting a Truck Appointment System with Buffering

The combination of truck registration, transaction documentation checks, and enforcement of no parking can by itself remove congestion from near the port gates, however this will only move truck queues a bit further out into the LMA, as the fundamental ambiguity in when trucks need to arrive at the port has not been resolved. The Truck Appointment System is therefore critical to provide this visibility.

As a first step in this phase, the AEO can retain a transaction advisor to develop the business rules among terminal operators, trucks / carriers, shippers and government agencies. The clarity of business rules must indeed precede the operating procedures that will be put in place.

The business rules provide a set of performance objectives, which the AEO can then use to conduct a tender process for the selection of the international private partner. The private partner would either integrate is own TAS, or procure one on a pilot basis.

The TAS could be operated in conjunction with the aforementioned truck holding lot to provide a buffering aspect of the pilot. FMPWH participation in this overall project is therefore instrumental. Data should be collected to assess the impact of the pilot TAS and buffering lot on truck dwell time, container throughput, and overall process efficiency.

Once registered trucks have suitable assurance that they can clear the security in a timely manner with the necessary documentation, and their arrival at the ports will have a reduced dwell time due to confirmed appointments, they will have a stronger incentive to register and participate in the system. Indeed in the absence of their fulfilling these requirements they will not be able to engage in dray moves. The pilot will help establish the precedent for refining the approach, and eventually scaling up to a broader system build out.

At the same time, a number of complimentary strategies such as enforcement of the empties handling policy, truck route and hours of travel restrictions, etc should also be implemented to enhance the likelihood of success of the TAS.

Building out the System

Revenues from the TAS pilot can be re-invested into both scaling up the TAS to additional terminals, as well as developing either the St Mathew Daniel, KiriKiri, or Orile sites as additional buffering facilities. Market Sounding

We conducted market sounding discussions with key stakeholders (Appendix A) involved in the LMA supply chain including terminal operators, trucker representatives, the NPA, and potential investors. A stakeholder workshop was also conducted in Lagos on July 12, 2018 to facilitate a discussion around the scheduling and buffering project concept, and the identification of risks.

Stakeholders affirmed two main ideas with respect to the project concept:

→ **Improving operational coordination**: There was overwhelming support for the objective that the queue removal in the Lagos ports envelope and better coordination of truck movements (including the management of empties) must be addressed. In the absence of such coordination, the available economic benefits from dray operation improvements will be left uncaptured. The private sector, i.e. terminal operators and private investors confirmed their interest in integrating and operating ICT-enabled Truck Appointment Systems (scheduling) to support this objective.

- **Allocating risks appropriately**: The private sector would focus their efforts on the scheduling component and corresponding operational protocols, business rules, and management mechanism as these are the sector's main areas of expertise (consistent with project structure Option 3). The buffering element (short-term holding lots) is best unbundled and allocated to the public sector as it might be in a better position to acquire land, provision the buffering lots, maintain environmental and social impact standards, and provide the overall enabling environment. Conversely, allocating these responsibilities and risks to the private sector would drive up the cost of the solution considerably, as the private sector risk premium would be reflected in the charges for truck appointments.

7.7 Risk Analysis

The project is heavily dependent and linked with the following factors:

- Successful enforcement of appointment requirement to access port facilities and transact business
- Successful enforcement of "empties" return policy to off-dock holding bays
- Separation / decoupling of scheduling, buffering (short-term holding lots), and long-term parking elements of the project for commercial viability and sustainability

The figure below highlights the key risks on the scheduling and buffering project and the potential risk allocation assuming some form of BOT type of arrangement for illustration.

Figure 7-16. TPPAF (Scheduling and Buffering) Project Risk Matrix

No	Risk Heading	Definition	Public Sector	Private Sector	Shared	Ability to Transfer Risk
1	**Design Risk**					
1.1	Failure to adequately specify the sector's requirements	Sector's requirements not accurately translated into Tender Documents	*			No
1.2	Continuing development of design/design work not being completed on time	The detail of the design should be developed within an agreed framework and timetable. Failure to do so may lead to additional design and construction costs.		*		Yes, through Contract
1.3	Change in design requirements by the Government and (or) the scheduling / buffering system operator	The Government and(or) the scheduling / buffering system may require changes to the design, leading to additional design costs			*	
1.4	Failure to build to brief	Misinterpretation of design or failure to build to specification during construction could lead to additional design and construction costs		*		Yes, through the Contract, careful development of the project brief and ongoing liaison between the Government's agent, Operator's agent and the Contractor's designer will help remove the possibility of misinterpretation of the construction requirements
1.5	Governments' concession programme (Political expediency)	The speed of the Governments' programme leading to design inadequacies if Contractors are required to undertake the completion of the works within a timescale that is unreasonable or shortened	*			This can be eliminated through adequate allocation of time and avoidance of delay at the initial stages and consideration of the use of Early Contractor Involvement (ECI)

No	Risk Heading	Definition	Public Sector	Private Sector	Shared	Ability to Transfer Risk
1.6	Inaccurate truck traffic and appointment forecasts	Inaccurate traffic forecasts may result in an inaccurate design/resourcing/operating plan	*			No
1.7	Inadequate liaison with stakeholders	Inadequate liaison may lead to third party requirements or accommodation works being omitted from the employer's requirements			*	Yes, through the contract
1.8	Service objectives not met	Objectives set forth by the service may not be met at satisfactory levels	*			No, but can minimise through careful development of service proposals
1.9	Data availability	Information coming from the Government and their other key stakeholders might be slow		*		Make early contact with all parties; Be prepared to adjust presentation to address shortcomings
1.10	Tender Capacity	There may be lack of tender capacity, or collusion between tenders which may cause an annulment of the tender and time delays in the tender process	*			No
1.11	Construction Costs	Cost estimates to be based on preliminary design which would not be adequate		*		Conduct peer reviews or independent engineer reviews
1.12	Substandard design	The design may have shortfalls in terms of adequate engineering principles and its addressing of problem areas with cost effective engineering solutions		*		Conduct peer reviews or independent engineer reviews
2	**Construction and Development Risks**					

No	Risk Heading	Definition	Public Sector	Private Sector	Shared	Ability to Transfer Risk
2.1	Incorrect time estimate	The time taken to complete the construction phase may be different from the estimated one		*		Yes, ensure estimate is reasonable and control through the Contract
2.2	Delay in gaining access to the buffering site(s)	A delay in gaining access to the site may delay the entire project (land Acquisition planning & effective implementation)	*			No, but can be minimised through project management
2.3	Access to land not available for construction	Access to land for verification surveys or construction of the permanent works may not be available to the whole of the site by the Contract starting date.			*	No, but can be minimised through careful forward planning
2.4	Poor coordination with other works	Interference from other third party works may lead to a delay in starting some elements of the permanent works			*	No, but can be minimise through project management and careful liaison
2.5	"Compensation events"	An event of this kind may delay or impede the performance of the contract and cause additional expense			*	No, but can be minimise through Contract and project management
2.6	Force Majeure	In the event of Force Majeure, additional costs will be incurred	*			No
2.7	Contractor Default	In the case of contractor default, additional costs may be incurred in appointing a replacement, and may cause delay		*		Yes, through Contract compensation to the Employer can be defined
2.8	Poor project management	There may be a risk that poor project management will lead to additional costs			*	No but can minimise through careful selection of project management

No	Risk Heading	Definition	Public Sector	Private Sector	Shared	Ability to Transfer Risk
2.9	Contractor/sub-contractor industrial action	Industrial action may cause the project to be delayed as well as incurring additional management costs			*	No, but can minimise through careful election of reputable contractor and could seek to recover any costs incurred
2.10	Key subcontractor becomes bankrupt	Bankruptcy of a key contractor may lead to a delay until a replacement sub-contractor can be appointed		*		Costs associated with appointing a replacement will be borne by the principal EPC Contractor; Delay damages will be repaid to the Employer in the event of the works overrunning the allocated time
2.11	Abnormal weather conditions	Excessive periods of inclement weather are normally considered to be compensation events			*	The risk can be transferred with onerous Conditions of Contract but this may lead to higher than anticipated tender prices; Can seek Insurance against such conditions
2.12	Availability of terminal design meeting minimum specifications and other material supply difficulties	There may be difficulties in obtaining customized design or proprietary materials		*		Minimum Specifications to be proposed in generic terms so as to enable both customized design of terminals.
2.13	Material lead times	Estimated lead times on long-lead items may be underestimated		*		No, but may be minimised through careful planning
2.14	Interface with the Lagos State Bus Reform Programme	The move to five State bus concessions with modern buses may be delayed and affect the effectiveness of the Mega Terminals	*			No, but may be minimised through careful planning

No	Risk Heading	Definition	Public Sector	Private Sector	Shared	Ability to Transfer Risk
2.15	Substandard construction methods	The contractor may use substandard methods of construction which may compromise delivery and quality of project		*		No but may be minimised through careful formulation of bidding documents and monitoring
3	**Health and Safety Risk**					
3.1	Contractor does not adhere to current regulations	The Contractor may breach current Health and Safety legislation or accepted codes of practice		*		No, but could impose penalties and charges to the Contractor
3.2	Changes to regulations	Legislation or accepted codes of practice may change during contract period	*			No, but within control of Government
3.3	Responsibility for maintaining on-site security	Theft and/or damage to equipment and materials may lead to unforeseen costs in terms of replacing items, and delay		*		
3.4	Responsibility for maintaining site safety	The Construction, Design and Management Regulations and Occupational Safety Health and Safety at Work regulations must be complied with		*		
4	**Environmental**					
4.1	Mitigation does not match environmental objectives	Suggested mitigation measures to alleviate environmental impact of the proposals may not adequately protect the environment as intended and hence may need to be amended leading to time and cost implications			*	No, but can be minimised through careful planning of mitigation measures

No	Risk Heading	Definition	Public Sector	Private Sector	Shared	Ability to Transfer Risk
4.2	Contamination of water	Accidental contamination of the water may lead to delay in the works during construction or due to leakage of fuel during operations			*	The risk can be transferred with Conditions of Contract; Can seek Insurance against such conditions
5	**Public Inquiry**					
5.1	Number of objections greater than anticipated	Dealing with a greater than anticipated number of objections may lead to additional management costs and delay	*			No
5.2	Protester action	Protester action against the scheme may incur additional costs, such as security costs			*	Yes, can be transferred through the Contract
6	**Finance**					
6.1	Failure to obtain adequate funding	Failure to obtain adequate funding may lead to indefinite delay (no financial close)		*		Bidders to submit proof of financing as part of their bid packages.
6.2	Target cost exceeds budget (Budget to include optimism bias)	Tender prices may exceed the pre-tender estimate and allocated budget		*		
6.3	Change in volumes and controlled charges/fares	Traffic shortfalls and price control limit actual revenues.	*			Covered under the availability payments and performance regime in the contract
6.4	Currency / Foreign exchange	Unforeseen fluctuations in currency may change budget costs dramatically		*		This risk is typically priced in bidders' proposals
7	**Legislation**					
7.1	Legislative/regulatory change	A change in non-specific legislation/regulations taking effect during the construction phase,	*			No, but control rests with Government

No	Risk Heading	Definition	Public Sector	Private Sector	Shared	Ability to Transfer Risk
		leading to a change in the requirements and variations in cost				
7.2	Changes in taxation	Changes in taxation may affect the cost of the project			*	No, but control rests with Government
7.3	Changes in the rate of Value Added Tax (VAT) or VAT legislation	Changes in the rate of VAT or VAT legislation may increase the cost of the project	*			No, but control rests with Government
8	**Performance Risks**					
8.1	Latent defects in new build	Latent defects to the new build, which require repair, may become apparent		*		Yes, can be transferred through the Contract
8.2	Change in specification initiated by both Government and Operator	There is a chance that, during the construction phase of the project, the Government and the Operator will require changes to the specification			*	No, but can minimise through careful project management and internal coordination
8.3	Lack of Enforcement of no truck access to port / terminals without appointments	Would mean that the TPPAF concept not attractive to and not used by trucks. With significant Revenue and congestion impacts.	*			Need to be planned in parallel for effective TPPAF start up.
8.4	Maintenance Risk	The risk of not maintaining the assets to the appropriate standards and specifications for the life of the project. Increased maintenance costs due to increased volumes. Incorrect estimates and cost overruns.		*		Contract reporting & monitoring. Performance Bond may be called upon to rectify maintenance shortfalls particularly towards the end of the contract period.
8.5	Meeting hand back requirements	The risk of not maintaining the concession assets, operations, staffing etc. in line with the		*		Sound monitoring & control of contract performance by the authority.

No	Risk Heading	Definition	Public Sector	Private Sector	Shared	Ability to Transfer Risk
		transfer back requirements at the end of the contract				Performance Bond may be called upon to rectify maintenance shortfalls particularly towards the end of the contract period
9	**Termination Cost Risks**					
9.1	Termination due to default by Government	The risk that the Government defaults, leading to contract termination and compensation for the private sector	*			No
9.2	Default by external funding sources	The risk that the external funding defaults and the project is not completed		*		Yes, through Contract
9.3	Termination due to default by the bus terminal operator	The risk that the operator defaults and step in rights are exercised by the financiers, but they are unsuccessful, leading to contract termination		*		Government could recover costs for default but would incur additional costs associated with appointing another operator
10	**Technology and Obsolescence Risks**					
10.1	Technological change	Technical changes that require Government and Operator to revise their output specifications			*	No
11	**Land Risks**					
11.1	Cost of land	Land costs could be greater than expected	*			No
11.2	Protracted Land Acquisition process	Compulsory purchase/Negotiations/Compensation process delays project and prevents timely financial close	*			No

No	Risk Heading	Definition	Public Sector	Private Sector	Shared	Ability to Transfer Risk
12	**Statutory Undertaker Risk**					
12.1	Unforeseen STAT's apparatus	The possibility exists that statutory utilities apparatus may be found that will require diversionary works or changes to the design	*			Yes, can be transferred with onerous Conditions of Contract but this may lead to higher than anticipated tender prices
13	**Other project risks**					
13.1	Delayed planning approval	A delay in receiving planning permission may have broader cost implications for the project, as well as the loss of potential savings			*	No, but can be minimised through coordination with different agencies
13.2	Inadequate Resources	Human resources or allocated time may be inadequate for satisfactory project management		*		
13.3	Critical staff appointment / competencies / certification	Difficulty in obtaining the required number of critical staff for efficient operations, and/or inadequate certification obtained		*		
13.4	Insufficient project capacity	Possible fatalities or interruptions in operations, or damage to assets			*	No, but can be minimised through internal co-ordination
14	**Political Risk**					
14.1	Political risk	The risk of Government intervention, discrimination, seizure or expropriation of the project. Public sector budgeting.	*			The Contracting Authority typically bears responsibility for political events outside the Private Partner's control.
15	**Revenue Risk**					

No	Risk Heading	Definition	Public Sector	Private Sector	Shared	Ability to Transfer Risk
15.1	Truckers not using the appointment system	Truckers continue to queue outside terminals without scheduling appointments or checking in at buffering lots	*			Regulation and enforcement. Appointment fee set at cost recovery + hurdle rate levels to reduce burden on Total Logistics Costs

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8 Recommendations & Implementation Next Steps

Key Messages

Three high level recommendations emerge wherein the private sector should be entrusted with the development of a scheduling TAS system. Public agencies should address the buffering aspect of the solution. A complimentary and coordinated approach is needed to develop considerations for longer-term truck accommodation measures.

8.1 Main Recommendations

Our analysis has documented the severe conditions around truck dray operations and queues, extensive economic benefits for the LMA that could result from addressing those issues, technical and operational logic for scheduling and buffering as a solution, and the financial viability of project structures under a PSP approach. Our recommendations emerge from this holistic view.

Recommendation 1: Public sector agencies should coordinate to provide an enabling environment for a private sector-led deployment and operation of an ICT-enabled Truck Appointment System (scheduling).

Recommendation 2: Agencies should supplement the scheduling element by provisioning short-term holding lots (buffering), to be operated in conjunction with the private sector-led Truck Appointment System.

Recommendation 3: Agencies should also focus on separate but complimentary strategies to extract value from the deployment, including long-term parking solutions outside the LMA.

8.2 Benefits of an ICT Approach to Scheduling

ICT arrangements are not required for deploying a basic Truck Appointments System, but they are a significant enabler in accomplishing the objectives of the TPPAF. There are many primary functions and benefits that an ICT-enabled TPPAF can deliver for the four main types of actors defined earlier, which come with requirements for investing in not just technology but also capability and skills. Both beneficial functions, and required commitments are in Figure 8-1.

Figure 8-1. Benefits and commitments of moving to an ICT-enabled Scheduling and Buffering System

Available Beneficial Functions	Required Commitments and Efforts
Real-time (or near real-time) information on truck-related operations and interactions	Developing and continuously feeding electronic databases with truck records, transactions, and other attributes for making appointments
Single source of "truth" for a variety of decentralized decisions	Holding actors accountable for information submitted, and including a number of validation and verification steps
Automating and streamlining mechanical but error-prone tasks	Moving to digital data entry and records, minimizing human touch points on the event data, and additional training and skills on new systems for operators
Performance data collection over time, including for storing and analyzing "big" data on operations	Leveraging data as a benchmark for performance monitoring and improvement
Reporting for compliance, planning, and operations objectives	Key interfaces and visibility for jurisdictional authorities such as NPA, customs, other agencies
Additional security layers for sensitive data	Building in appropriate safeguards for private, or otherwise commercially sensitive information to ensure participation

Source: CPCS analysis

8.3 Phased Approach for Implementing Recommendations

The proposed scheduling system with or without buffering lots, is only likely to be successful if some other fundamental mechanisms and complementary strategies are in place and working. As such, our proposed **phased approach** for the project is as follows:

Phase 1: Setting the Stage

15. **Registration**: Begin requiring drivers and fleets to register their trucks in an electronic Lagos State Parking Authority (LSPA) database, and then enforce port-area and terminal access only for those with the recognized authority to operate. The Nigerian Ports Authority (NPA) must be able to access the database for port-area checks.

16. **Implementation Charter**: LASG and the Federal Government (represented by the Federal Ministry of Transport - FMOT, the Nigerian Ports Authority and the Federal Ministry of Power, Works and Housing – FMPWH) come to an agreement with the objective of decongesting the ports and improving traffic flow in/around the Lagos ports area. The charter would impose obligations on each party with LASG assuming responsibility for enforcing parking restrictions (#3 below), FMOT and NPA granting access to the port gate (#6 below) and FMPWH providing the Tin Can Island site as the buffering lot staging platform (#5 below).

17. **Port Traffic Management**: LASG to ensure that Lagos State Traffic Management Authority (LASTMA) develops, implements and enforces regulations restricting arbitrary parking in the port environment, creating an environment conducive to a scheduling system.

18. **Special Purpose Vehicle**: NPA to convene stakeholders and oversee an arrangement leading to the formation of a Special Purpose Vehicle (SPV), which would later be granted status as the Authorized Economic Operator (AEO) in a PPP for implementing and operating the Truck Appointment System and the buffering site. It is envisioned that a competitive process (transaction) would be undertaken (see Phase 2a below) to identify a private foreign entity who would enter into a Joint Venture with a local firm to form a majority group (51% equity stake) in the SPV. This approach would bring both the needed international expertise and also ensure capacity building for the local participants. NPA to hold discussions with terminal operators under the umbrella of the Seaport Terminal Operators Association of Nigeria (STOAN) to ensure fairness and transparency in dealings, with terminal operators on Tin Can Island and Lagos port complexes forming a minority group (49% equity stake) in the SPV. As terminal concessions expire and new concessionaires are identified, the equity stake can be transitioned to them to maintain the 49% among active concessionaires.

19. **Buffering / Staging**: FMWPH, via the Implementation Charter, commit to leasing its truck holding site (currently at 90% completion) to the AEO / SPV to manage as a buffering lot staging area for trucks destined to either of the Lagos area ports. The objective of this optional component of the approach is to strengthen the TAS as a solution and extract value from it.

20. **Port Access Governance**: NPA to provide firm commitment in Implementation Charter on port access, and their interest in implementing a scheduling system. Such systems always face some level of opposition from vested interests, and commitments from key stakeholders are a must. This commitment must include unequivocal declaration to allow gate access to only vehicles with valid registration and documentation. The updated provisions to also include a separate line item for the inclusion of the service fee for the use of the TAS, as one of the business rules for the AEO.

21. **Awareness**: Sensitize key stakeholders (particularly road transport unions) about the benefits of the truck scheduling scheme, emphasizing successes in other jurisdiction such as Manila and other congestion management efforts at other African and global ports.

Phase 2a: Operationalize Pilot Phase of Scheduling System

The first step of this phase would be to implement a transaction to identify and select a private group acting as an Authorized Economic Operator to manage the Tin Can Island staging area. This private group would hold a controlling stake (51%) in the SPV assigned the lease to operate and manage the Tin Can Island truck staging area. The SPV would include terminal operators as minority members (holding 49% stake) of this SPV. The Authorized Economic Operator would be responsible for stewarding linkages between Terminal Operating Systems and port-truck interface / landside operations. Specific steps would involve:

13. **Business Rules**: Engage a Transaction Advisor to develop an Outline Business Case (OBC) identifying the business rules that will govern transactions between the terminals, trucks / carriers, and the NPA. Harmonize the various fees, charges, and requirements holistically.

14. **Truck Appointment System**: Implement a competitive tender process to identify a private group that will assume a majority stake in the Authorized Economic Operator and be responsible for procuring / integrating a common Truck Appointment System across participating terminals. The entity is likely to be foreign, given the specialized technical and operational experience required, but could enter into a Joint Venture with a Nigerian firm to ensure that the local context is respected, international technological expertise is brought in, and local capacity building is fostered over time. The initial focus for TAS implementation could be on TCI terminals.

15. **Tin Can Island Buffering Lot**: Leverage the almost-operational truck holding lot on Tin Can Island as the first buffering lot to test the scheduling and buffering concept, and refine operating rules. Very little ICT investment is deemed necessary at this stage, with the minimum requirements being a computer system to validate truck identities, transaction statuses, and registrations. Radio communications with the terminal operators will also streamline information flow.

16. **Assessment**: Evaluate the changes / impacts to throughput from the use of the scheduling system and the pilot buffering lot.

In parallel to Phase 2a related directly to the project, other reinforcing measures must be put in place to maximize the likelihood of success.

Phase 2b: Reinforcing Measures

Without supporting measures, there is a likelihood that a scheduling system will not bear the anticipated fruits. By far the most important measure is the enforcement of port-area access and parking restrictions, which would also be a strong indicator of the authorities' commitment to deal with the congestion issue. As such, key measures would be as follows:

17. **Port Access**: Enforce the requirement for valid truck registration (license to operate), and consignment notes / bills of lading for access beyond a security cordon in the vicinity of the ports, in line with the new LASTMA legislation and regulations for implementation noted above. There are no additional fees or charges beyond what trucks are already responsible for today.

18. **Parking**: Enforce restrictions of truck parking on port-area access roads beyond that security cordon.

Phase 3: System Build-Out

Once the system is working at TCI terminals, and the supporting measures are well in place, the financial balance of the project should be quite positive. If the staging area has been successful, the TPPAF area of operation can be extended to the Lagos port complex terminals, this should allow for a significant fee, which could be reinvested to build up additional buffering zones and other supporting infrastructure. As such, key steps would be:

7. **Scale Expansion**: Expand scheduling to all terminals, renegotiating a concession fee to be used for initiatives related to port congestion management initiatives.

8. **Buffering Capacity Expansion**: Pursue site acquisition for St. Mathew Daniel and Kirikiri sites as optional buffering lots, using some of these funds

9. **Long-term Parking**: Develop long-term parking zones further away from the port outside the LMA and near major freight corridors, as a feeder to the port area facilities and buffering lots.

In particular, long-term parking zones with suitable pricing will become interesting to truckers if they have some level of confidence that *when granted an appointment* they can move from a long-term parking lot to the port access are, and a buffering zone if needed and wait for their scheduled appointment with limited to no risk of missing it. The choice of staging in long-term parking and then in buffering zones near the port will be reinforced significantly by a strict enforcement of the use of the Truck Appointment System and parking rules near the port, and the requirement to have the necessary registration, consignment notes, and confirmed appointments.

Complimentary Strategies

Complimentary strategies include investments in infrastructure, services or amenities that indirectly decrease congestion, decrease dwell times and increase truck driver performance at the port can also be phased in over time. These can also be tied to value added services for truck drivers who have appointments at the TPPAF.

→ **Empty Container Policy**: NPA should assess the impact of the new empty container handling policy by collecting data on number of trucks with empties attempting to access ports, recording delivery notes for the holding bays to which those containers have been assigned, and documenting the dwell time and turnover rate of those empty containers in holding bays.

→ **Improved Processes**: Harmonize and streamline the process for customs, inspections, and administrative checks for releasing containers and digitize transactions to provide a single source of truth for agencies, terminals and carriers. Leverage the efforts of the Nigerian single window initiative to expedite the development of the unifying database.

→ **Routing**: Harmonize and enforce truck routing and travel time restrictions within the LMA to ensure that trucks are neither affected by peak congestion, nor exacerbating it. Publicize information and ensure adequate signage for routing and hours to assist truck driver navigation.

→ **Axle-Weights and Safety Inspections**: Enforce truck loading axle-weight restrictions to minimize road wear and tear and reduce the likelihood of truck breakdowns. Inspect trucks for emissions profile and safety as part of checks.

→ **Real-time Truck and Traffic Visibility**: Appointment systems can deliver real-time information updates on congestion in the vicinity, transit time to the TPPAF from main access roads, transit time between the truck park and port access control, etc. real time information to drivers in transit and at the port

→ **Infrastructure Design and Maintenance**: Associated investments in access roads will significantly improve overall travel time reliability as trucks enter the "last mile" of port access. Improvements in signage, lighting, and design considerations and route restrictions for improved safety will help feed truck traffic into and out of the port area

→ **Long-term Parking** options such as "truck villages" outside the LMA with food service, toilets, sanitation facilities, convenience store, and refueling options

Appendix A: List of Stakeholders consulted

- LAMATA
- NPA
- Que-Less Systems
- 1-Stop Port Solutions
- Grimaldi Agency (NG) Ltd.
- APM Terminals
- Hull Blyth
- Bollorè Africa Logistics Nigeria Ltd
- Ports & Terminals Multiservice Ltd.
- Associated Port & Marine Ltd
- Neon Andani Port Consortiums
- Trevari-Cartlark Consortiums
- Creseada International Limited
- Comet Shipping Agency
- DTK Oceanic Ltd
- CMA-CGM
- Skye Shelter Fund
- NES Shipping
- Savol WestAfrica
- Seaport Terminal Operators Association of Nigeria (STOAN)/ENL Consortium
- TICT
- NAFITH

Appendix B: List of Secondary Data/reports reviewed

→ Frederic Oladeinde. Presentation on the Lagos Strategic Transport Master Plan. Lagos Metropolitan Area Transport Authority (LAMATA). 2017

→ Nigeria Expanded Trade and Transport Program (NEXTT) Lagos-Kano-Jibiya (Lakaji) Corridor Performance: Baseline Assessment Report On The Time And Cost To Transport Goods, 2015

→ ALG. Europraxis., 2014. Consultancy Services for the Extension of the STMP and STDM to Cover Mega City Region.

→ Cambridge Systematics Inc., 2016. Lagos Region Freight Demand Study: Final Study Report. Prepared for the Lagos Metropolitan Area Transport Authority (LAMATA).

→ Federal Ministry of Transportation (NGA), Axle Load Study and Review and Update of Design Standards for Federal Roads, Nigeria. November, 2008.

→ CPCS, 2014. Freight Forecasts for the Nigerian Port Authority (NPA).

→ Google Earth, Time Series Satellite Photos of Lagos Metropolitan Area, 2016 to January 2018

S.No.	Documents specific for Legal Review	Source
1.	Lagos State Transport Sector Reform Law of 2018	Online + LASWA
2.	Lagos State Urban and Regional Planning and Development Law 2010	Online
3.	Lagos State Development Plan 2012- 2025	Online
4.	Lagos State Public Private Partnership Law 2011	Online
5.	PPP Manual for Lagos State	Online
6.	Lagos State Public Procurement Law 2011	Online
7.	Lagos State Environmental Protection Agency Law 1996	Online
8.	Land Use Act 1978	Online
9.	Lagos State Safety Commission Law	Online
10.	Lagos State Arbitration Law 2009	Online
11.	Lagos Court of Arbitration Law 2009	Online
12.	Arbitration & Conciliation Act	Online

Appendix C: Questionnaire Template used for the survey

	Truck Survey	
1	Name of location/road	
2	Type of Truck (Check 1 box)	
	a. Container	
	b. Liquid Bulk (tanker)	
	c. Dry bulk (other)	
3	Status of Truck	
	a. Truck with empty container	
	b. Truck with loaded container	
	c. Truck with Chassis - no load to pick up	
	d. Truck with Chassis - Load to pick up	
4	What is the City of Origin (if loaded) or where did the truck off load the cargo	
5	Number of days in queue	
6	Truck registration number	

Appendix D: Key State/Federal approvals required for the project

	Nature of Approval	Agency/ Institution(s)	TPPAF
1.	Approval of PPP transactions	→ Lagos State Executive Council (Exco) and the Governor of Lagos State are the authorities for the final approval of PPP transactions.	✓
2.	User Fee	→ PPP Office with the approval of the Lagos State House of Assembly approve the user fees or toll to be charged by any concessionaire or private operator. → The Law did not provide for the approval of Lagos State Ministry of Finance (MoF) or Attorney-General of Lagos State. However, MoF will play a key role in assessing the budgetary implications of PPP projects.[88]	✓
3.	Permit to operate a private bus terminal and truck park	→ Lagos State Parking Authority	✓
4.	Planning Permit	→ Lagos State Ministry of Physical Planning and Urban Development	✓
5.	Environmental Impact Assessment (EIA) Report	→ Lagos State Environmental Protection Agency (LASEPA) → National Environmental Standards and Regulations Enforcement Agency (NESREA)	✓
6.	Safety Compliance Certificates	→ Lagos State Safety Commission (LSSC)	✓

[88] The MoF ensures that the forecasted costs for the LASG including any subsidies that may be required to make a project viable are affordable over the full life of the contract. Together with the relevant MDA, it also reviews the costs and contingent liabilities as the project design and risk valuations are refined during the project preparation and procurement phases

Appendix E: Nigerian PPP procurement score

NIGERIA

SUB-SAHARAN AFRICA

GNI PER CAPITA (IN USD) $2,450

Preparation of PPPs

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Central budgetary authority's approval	Yes	Only before tendering
Fiscal treatment of PPPs	No	
PPPs' prioritization consistent with public investment prioritization	Yes	Detailed procedure not regulated
Economic analysis assessment	Yes	No specific methodology developed
Fiscal affordability assessment	Yes	No specific methodology developed
Risk Identification	Yes	No specific methodology developed
Comparative assessment (value for money analysis)	Yes	No specific methodology developed
Financial viability or bankability assessment	Yes	No specific methodology developed
Market sounding and/or assessment	Yes	No specific methodology developed
Environmental impact analysis	Yes	No specific methodology developed
Assessments included in the RFP and/or tender documents	No	
Draft PPP contract included in the RFP	Yes	Tender documents not available online
Standardized PPP model contracts and/or transaction documents	No	

Procurement of PPPs

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Evaluation committee members required to meet specific qualifications	Yes	Detailed membership and/or qualifications not regulated
Public procurement notice of the PPP issued by procuring authority	Yes	Available online
Foreign companies permitted to participate in PPP bidding	Yes	
Minimum period of time to submit the bids	Yes	42 calendar days
Availability of various procurement procedures for PPPs		Open procedure (single-stage tendering). Restricted procedure (competitive procedure with prequalification stage)
Direct negotiation not discretionary	No	
Tender documents detail the procurement procedure	Yes	
Tender documents specify prequalification/shortlisting criteria (if apl.)	Yes	
Clarification questions for procurement notice and/or the RFP	Yes	Answers publicly disclosed
Pre-bidding conference	Yes	Results publicly disclosed
Financial model submitted with proposal	Yes	
Proposals solely evaluated in accordance with published criteria	Yes	
Treatment when only one proposal is received	Yes	Detailed procedure established
Publication of award notice	Yes	Available online
Notification of the result of the PPP procurement process	Yes	Grounds for selection not included
Standstill period	No	
Negotiations with the selected bidder restricted	Yes	
Publication of contract	No	

PPP Contract Management

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System to manage the implementation of the PPP contract	Yes	Establishment of a PPP contract management team. Detailed membership and/or qualifications of the PPP contract management team regulated
System for tracking progress and completion of construction works	Yes	
Monitoring and evaluation system of the PPP contract implementation	Yes	Private partner provides periodic information
Foreign companies permitted to repatriate income	Yes	
Change in the structure (stakeholder composition) of the private partner and/or assignment of the PPP contract regulated	No	
Modification/renegotiation of the PPP contract (once the contract is signed) regulated	Yes	Approval by an additional government authority required. Regulations about: changes in duration; changes in the price or tariff
Circumstances that may occur during the life of the PPP contract regulated	Yes	Force majeure. Material adverse government action. Change in the law. Subcontracting
Dispute resolution mechanisms	Yes	Domestic arbitration. International arbitration. Investor-State Dispute Settlement (ISDS)
Lenders' step-in rights	Yes	To be regulated as part of a direct agreement or in the PPP contract
Grounds for termination of a PPP contract	No	

Unsolicited Proposals

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Regulation of USPs		Expressly regulated
Assessment to evaluate unsolicited proposals	Yes	
Vetting procedure and/or pre-feasibility analysis of USPs	No	
Evaluation of consistency of USPs with other government priorities	Yes	Detailed procedure established
Competitive PPP procurement procedure for USPs	Yes	
Minimum period of time to submit the bids	Yes	30 calendar days

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Source: Report on Procuring Infrastructure PPPs, The World Bank, 2018

Appendix F: Observed Capacity Reductions on Apapa and TCI access roads

Associated Area	Street Name	Direction	Location	Queue Access	Typical Congestion or Truck Queue	Road Classification	Number of Lanes	Road Condition	HSV (LOS C)	Number of free lanes	new HSV (LOS C)	HSV (LOS C) Percent Change
Apapa	**Aerodrome Rd**	**Northbound**	Commercial Rd to Apapa Rd	ENTERING APAPA	QUEUE IN ONE STALL	Arterial Major	4	Tarmac is fair	2894	1	543	-81%
Apapa	**Apapa Rd**	**Southbound**	Aerodrome Rd to Apapa Main Gate	ENTERING APAPA	QUEUE IN ONE STALL	Arterial Major	4	Tarmac is fair	2894	1	543	-81%
Apapa	**Burma Rd**	**Eastbound**	To Commercial Rd	ENTERING APAPA	QUEUE IN ONE STALL	Collector Minor	2	Tarmac is good	940	1	470	-50%
Apapa	**Commercial Rd**	**Southbound**	Burma Rd to Creek Rd	ENTERING APAPA	QUEUE IN ONE STALL	Arterial Minor	2	Tarmac is fair	1070	1	401	-63%
Apapa	**Commercial Rd**	**Southbound**	Warehouse Rd to Burma Rd	ENTERING APAPA	QUEUE IN ONE STALL	Arterial Minor	2	Tarmac is fair	1070	1	401	-63%
Apapa	**Creek Rd**	**Eastbound**	Commercial Rd to Apapa Main Gate	ENTERING APAPA	QUEUE IN THREE STALLS	Urban Highway	6	Tarmac is fair	7440	1	930	-88%
Apapa	**Creek Rd**	**Eastbound**	TCI Bridge (Liverpool) to Commercial Rd	ENTERING TANK FARM	QUEUE IN THREE STALLS	Urban Highway	6	Tarmac is poor, water hazards & pot holes	7440	1	496	-93%
Apapa	**Warehouse Rd**	**Eastbound**	To Commercial Rd	ENTERING APAPA	QUEUE IN ONE STALL	Arterial Minor	2	Tarmac is fair	1070	1	803	-25%
Apapa	**Warehouse Rd**	**Westbound**	To Creek Rd	ENTERING TANK FARM	QUEUE IN ONE STALL	Collector Minor	2	Tarmac is fair	1070	1	401	-63%
Apapa	**A1**	**Southbound**	To Aerodrome Rd	ENTERING APAPA	QUEUE IN ONE STALL	Urban Highway	4	Tarmac is poor, water hazards & pot holes	4960	1	496	-90%
TCI	**Apapa-Owonronshoki Expy (Island)**	**Westbound**	On Island	ENTERING/LEAVING TIN CAN ISLAND	QUEUE IN ONE STALL	Expressway	4	Tarmac is poor, water hazards & pot holes	5090	1	509	-90%
TCI	**Apapa-Owonronshoki Expy (Island)**	**Eastbound**	On Island	ENTERING/LEAVING TIN CAN ISLAND	QUEUE IN TWO STALLS	Expy	4	Tarmac is poor, water hazards & pot holes	5090	1	509	-90%

Associated Area	Street Name	Direction	Location	Queue Access	Typical Congestion or Truck Queue	Road Classification	Number of Lanes	Road Condition	HSV (LOS C)	Number of free lanes	new HSV (LOS C)	HSV (LOS C) Percent Change
TCI	**Apapa-Oworonshoki Expy**	**Eastbound**	West of Island	ENTERING IBAFON TANK FARM / TCI	QUEUE IN THREE STALLS	Expy	6	Tarmac is poor, water hazards & pot holes	8240	1	549	-93%
TCI	**Apapa-Oworonshoki Expy**	**Westbound**	West of Island	LEAVING IBAFON TANK FARM / TCI	QUEUE IN TWO STALLS	Expy	6	Tarmac is poor, water hazards & pot holes	8240	1	549	-93%
TCI	**Tin Can Island Port Acces Rd**	**Eastbound**	Island On/Off Ramp	ENTERING TIN CAN ISLAND GATE 1 / TANK FARM	QUEUE IN ONE STALL	Arterial Major	4	Tarmac is fair	2894	1	543	-81%
TCI	**Tin Can Island Port Acces Rd**	**Eastbound**	Island On/Off Ramp	ENTERING TIN CAN ISLAND GATE 1 / TANK FARM	QUEUE IN ONE STALL	On-Ramp	2	Tarmac is fair	535	1	201	-63%
TCI	**Tin Can Island Port Acces Rd**	**Westbound**	Island On/Off Ramp	EXITING TIN CAN ISLAND	QUEUE IN ONE STALL	Arterial Major	4	Tarmac is fair	2894	1	543	-81%
TCI	**Tin Can Island Port Rd**	**Eastbound**	TCI Port Rd (To Flour Sugar Mills)	ENTERING MILLS	QUEUE IN TWO STALLS	Arterial Minor	2	Tarmac is poor, water hazards & pot holes	1070	1	214	-80%
TCI	**Tin Can Island Port Rd**	**Westbound**	TCI Port Rd (To Flour Sugar Mills)	ENTERING MILLS	QUEUE IN TWO STALLS	Arterial Minor	2	Tarmac is poor, water hazards & pot holes	1070	1	214	-80%

Appendix G. Salient Sections of Lagos State Traffic Law for Dray Trucks

Source: Lagos State Government, 2012. Lagos State Road Traffic Law 2012 Guidebook. No. 4 of 2012.

Traffic Law Provisions. Numbers indicate section and sub-section where applicable
Time Restrictions, and associated fines
2 (1) Save as may be prescribed by the Commissioner by regulation, no trailer other than petrol tankers and long vehicles used in conveying passengers, shall enter into or travel within the metropolis of Lagos between the hours of 6.00am - 9.00pm.
2 (2) Any driver who is found contravening the provisions of this Section shall have his vehicle impounded by a duly authorised officer of the Authority and shall upon conviction be liable to a fine of ₦50,000 (Fifty Thousand Naira) or a term of imprisonment for 6 months or both.
Safeguards and restrictions for maintaining critical transportation assets
6 (1) The Ministry shall cause to be placed in a conspicuous place at both ends or near the bridge a notice to the effect that – (a) The bridge is not designed to carry more than a certain weight; (b) A vehicle exceeding a certain breadth or height cannot with safety be driven on or over such bridge;
(c) Vehicles may not exceed a specified speed limit when crossing the bridge and thereafter any person who contravenes or fails to comply with the terms of such notice shall be guilty of an offence.
6 (2) When any bridge is damaged –
(a) By reason of any vehicle passing over it in contravention of the provisions of this section; or
(b) By reason of any vehicle when passing over the bridge coming into contact with any portion thereof other than the surface of the roadway, the owner of the vehicle and the person driving or propelling the same shall,

Traffic Law Provisions. Numbers indicate section and sub-section where applicable
without prejudice to any other penalty stipulated by this Law for that offence, be jointly and severally liable to the Government for any damage done thereto.
o
o (3) A certificate under the hand of an officer of the Ministry for the cost of repairing such damage shall, be prima facie evidence of such cost.
o
o (4) For the purposes of this Section, the weight of a vehicle which is towing any other vehicle shall be deemed to be the gross weight of that vehicle and of the vehicle or vehicles being towed by it.
- **Pg 8.;**
- **Truck drivers must stay near their vehicles or risk impounding:**
o 8. (1) Where a motor vehicle is stationary or abandoned on a Highway or abandoned street or near private premises, any Police Officer, member of the Task vehicles from Force or officer of the Authority may cause the vehicle to be removed Highway and to a vehicle park if – (a) The officer has reasonable grounds for believing that the location of the vehicle is in contravention of the provisions of any enactment or Regulation relating to the parking of vehicles; and
o
o (b) He has reasonable grounds for believing either –
o
o (i) That the vehicle is not in a condition in which it can be moved under its own power; or
o
o (ii) That no person authorized to drive the vehicle is in the immediate vicinity of the vehicle.
o
o
o (2) The owner or occupier of the premises adjoining the Highway or private premises where the vehicle is stationary or abandoned shall lodge a report of such vehicle to the nearest office of the Authority or to the nearest police station.
o
o (3) Where the owner or occupier of premises adjoining the High way or private premises fails to make a report of a stationary or an abandoned vehicle to the office of the Authority or the nearest Police Station within48 hours, the owner or occupier of such premises shall be guilty of an offence and on conviction be liable to a fine of twenty-five thousand naira (₦25,000.00).

Traffic Law Provisions. Numbers indicate section and sub-section where applicable
o
o (4) Where the vehicle was found not to have been abandoned but left on the highway for an unreasonably long time, the owner shall bear the cost of towing the vehicle to a vehicle park as prescribed in Schedule I to this Law and the owner of the vehicle shall be guilty of an offence and on conviction shall be liable to a fine of fifty thousand naira (₦50,000.00) or to a term of imprisonment for three (3) months or both.
o
o (5) Where the owner of an abandoned or removed vehicle fails to claim the vehicle for a period of one (1) month, the Ministry shall publish a notice of its intention to dispose the abandoned or removed vehicle at the end of one (1) calendar month from the date of such publication in the State Official Gazette and one national newspaper.
- **Pg 38;**
- **Truck (dimensions)**
o Mostly doing with height and overhang from axles
o 11ft height, 8ft width and 3inch overhang past axles for freight
o 12ft6inches height for seed cotton or cotton lint
- **Pg 39;**
- **Can only carry maximum weight stated on vehicle license**
o freight or load of a greater weight than that which the vehicle is constructed to carry, as registered and stated on the licence, shall not be placed on any commercial vehicle or trailer and the owner shall cause the net weight of the vehicle, the weight of such freight or load and, where required by the licensing authority, the axle weights to be painted on some conspicuous part of the off side of the vehicle in letters and figures not less than one inch in height, and of such shape and colour as to be legible and clearly distinguishable from the colour of the ground where on the letters and figures are painted or marked and he shall cause the paint or marking to be from time to time repaired or renewed as often as may be necessary to keep the said letters and figures legible and clearly distinguishable;
- **Pg 41;**
- **Trailers on highways in Lagos Metropolitan Area must follow special safety requirements regarding the coupling of the trailer, weight limited to 4tonnes per axle and two brake systems**
o 4. A trailer shall not be used on any highway unless the following special conditions are observed-
o

Traffic Law Provisions. Numbers indicate section and sub-section where applicable
o (a) the couplings provided for attaching the trailer to a motor vehicle shall be efficient for the purpose;
o
o (b) every three or four-wheeled trailer exceeding five hundred weight net weight or two-wheeled trailer exceeding ten hundred weight net weight shall have a brake in good working order which when applied shall cause two of the wheels of the trailer on the same axle to be so held that the wheels shall be effectually prevented from revolving, or shall have the same effecting stopping the trailer as if such wheels were so held, and, subject to the provisions of paragraph (c) of this regulation, shall carry a person who shall be competent and shall be seated in a convenient position to apply the brakes of the trailer efficiently;
o
o (c) if the brakes upon the motor vehicle are so constructed that none can be used without bringing into action simultaneously the brake attached to the trailer, or if the brake of the trailer can be applied from the motor vehicle by a person upon the motor vehicle independently of the brakes of the latter, it shall not be necessary to carry a brakesman on the trailer;
o
o (d) if more than one trailer is drawn by a motor vehicle the provisions of paragraphs (a), (b) and (c) of this regulation shall apply to the trailer next to the motor vehicle and in respect of all other trailers the following provisions shall apply-
o
o (i) the coupling provided for attaching the trailer to the trailer in front of it shall be efficient for the purpose;
o
o (ii) the trailer shall have a brake in good working order which when applied shall cause two of the wheels of the trailer on the same axle to be so held that the wheels shall be effectually prevented from revolving or shall have the same effect in stopping the trailer as if such wheels were so held;
o
o (iii) there shall be carried on each trailer a person competent to apply the brake efficiently; and
o
o **(iv) the braking system of each trailer shall be entirely independent of the motor vehicle drawing the trailer and of any other trailer;**
o

Traffic Law Provisions. Numbers indicate section and sub-section where applicable
o **(e) (i) the gross weight of a two or three-wheeled trailer shall not exceed four tons and if a four-wheeled trailer eight tons;**
o
o **(ii) not more than four tons shall be carried on any one axle of a trailer:**
o
o Provided that the Ministry may by consent in writing, and subject to any conditions that may be impose, exempt a particular trailer from these provisions;
o
o (f) the wheel base of any trailer having an axle weight of four tons or over shall not be less than ten feet between axle centres;
o
o (g) not more than one person other than the brakesman may be carried or be permitted to be carried in a trailer.
o
o 5. Every heavy motor vehicle in use on any highway shall be fitted with electric lamps specified in sub-regulations 3 (1) (a) (i) and (ii)
- **Pg 42;**
- **Every commercial vehicle and trailer requires an inspection for the licensed appointed service.**
o 10. (1) Every commercial vehicle and every trailer shall before being registered or licensed and every six months thereafter be examined by an examiner appointed by the Service.
o
o (2) Where at such examination a vehicle is found to be roadworthy the examiner shall issue a certificate to that effect which shall remain valid for six months. Such certificate shall be carried within the vehicle and produced when required by the licensing authority, an administrative officer or an authorized officer.
o
o (3) A duplicate certificate may be issued upon application to the examiner and upon the prescribed fee being paid.
o
o (4) Where the vehicle has been examined and is found not to be roadworthy in any respect the owner of the vehicle shall be served with a notice by the examiner setting out the defects to be remedied and shall not after a receipt of such notice permit the vehicle to be used or submit the

Traffic Law Provisions. Numbers indicate section and sub-section where applicable
vehicle for licensing to any licensing authority until such time as the defects have been remedied to the satisfaction of the examiner.
o
o (5) There shall be payable by the owner for every such examination the prescribed fee.
- **Pg 49;**
- **Commercial and heavy vehicles require a commercial vehicle operator license obtained from the Ministry of Transport**
o 41. (1) No person shall operate or cause to be operated a commercial vehicle without having obtained a commercial vehicle operator licence from the Ministry.
o
o (2) The Ministry may not issue a commercial vehicle operator licence in respect of a vehicle unless such vehicle has been inspected and certified by the Vehicle Inspection Service.
o
o (3) The Ministry shall refuse a licence to, or if already issued, suspend the licence, of any vehicle found to be unfit for operation as a commercial vehicle after due inspection.
o
o (4) Every licence issued under this Part shall bear a distinct number which shall be painted conspicuously on the front and rear part of the vehicle or in any other manner as may be prescribed by the Ministry.
o
o (5) A licence issued under this Part shall be valid for one year from the date of issuance.
- **Pg 49;**
- **Commercial vehicle drivers may not drive in excess of 5.5hrs without 40mins rest period in aggregate (or 20min periods within 5.5hrs).**
- **Maximum daily length not exceeding 10.5hrs**
o (1) In the case of a commercial vehicle no person may drive or cause or permit any person employed by him to drive-
o
o (a) subject to the provisions of paragraph (2), for any continuous period of more than five and one-half hours; or

Traffic Law Provisions. Numbers indicate section and sub-section where applicable
o
o (b) subject to the provisions of paragraph (3), for periods amounting in the aggregate to more than ten and onehalf hours in any period of twenty-four hours commencing two hours after midnight; or
o
o (c) so that the driver has not at least eight consecutive hours for rest in any period of twenty-four hours calculated from the commencement of any period of driving.
o
o (2) Where in any such period of twenty-four hours one period of duty only is worked not exceeding eight hours in length then such period may, subject to the provisions of sub-paragraph (c) of paragraph (1) be worked instead of the period specified in sub-paragraph (a) of paragraph (1):
o
o Provided that the driver is allowed intervals of rest and time for refreshment of not less than forty minutes in the aggregate and one of such intervals is of not less than twenty minutes to be taken not earlier than two hours after the beginning nor later than five hours after the beginning of the eight-hour period of duty.