# Quantifying the relative contributions of customs, trade and ports to cargo time delays

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## Abstract

Sub-Saharan African delays for cargo are much longer than global benchmarks, reducing the competitiveness of the affected economies. This paper quantifies the contributions of customs, traders, and the port terminal operator to cargo time delays through the parallel customs and ports processes, by categorising cargo based on customs regime and declaration plans. We find that customs processes are the primary contributor for import cargo delays, while terminal operator processes are the primary contributor for transit cargo delays. Traders, however, also contribute significantly to time delays based on their response times. This is aggravated by the fact that traders from neighbouring countries are not allowed direct access to the port's electronic invoicing system. We recommend the implementation of electronic single window systems accessible by importers from all countries served by the port and the use of intelligent customs risk engines to reduce the need for physical inspections.


## 1. Introduction

Imports and exports have steadily increased in recent times as a fraction of the global economy (The World Bank, 2018). As 80 per cent of this trade is by sea (The United Nations Conference on Trade and Development [UNCTAD], 2018), ports therefore form a vital link between the economies of trading partners residing in different parts of the globe. While customs and ports processes are well streamlined in most developed economies, this is not yet the case in most developing countries (Arvis et al., 2013). In the case of Sub-Saharan Africa (SSA) port delays for cargo are still around 20 days, compared to global benchmarks of three to four days (Raballand, 2018). These delays add cost to the supply chain; as a result, transport as a fraction of the total cost of landed goods is about twice in SSA compared to the rest of the world (Portugal-Perez, 2008). This places countries within SSA in a disadvantageous position compared to competitors from continents like South America and Australia that also largely export raw materials and import manufactured goods.

Despite the severe impact of port inefficiencies on regional economies in SSA, surprisingly little research has been published about the composition of these delays, or subsequently, possible solutions to observed inefficiencies. While much effort and investment has gone into port improvements in Africa, the identification and elimination of remaining problems are not trivial, due to the large number of independent participants involved in ports operations, and the interdependence of the operations of these players. Recent studies (Hoffman, 2019) identified the terminal operator and customs authority as the primary players influencing port time delays; other role-players include cargo importers and exporters, freight forwarders and clearing agents and road and rail transport operators. To improve the speed of cargo movements through ports in SSA to be comparable to global benchmarks, it is essential to firstly identify the root causes and to secondly redesign existing operational practices and supporting systems to eliminate these causes.

This paper investigates the primary reasons for long delays experienced by cargo processed through a major east African port. This port forms part of a corridor, which serves not only the port country but also several landlocked countries in Eastern and Southern Africa. The challenges experienced at this port are therefore representative of typical challenges of trade corridors in SSA. The first objective of our study was to quantify the relative contributions of customs and terminal operations towards time delays for different cargo categories. In the process cargo is categorised based on customs clearance plans and customs regimes, as these proved to be primary determinants for the relative contributions of customs and the terminal operator towards measured delays (Hoffman, 2019). We furthermore identified the reasons why long delays tend to occur and made recommendations towards the elimination of these root causes. As import cargo is subject to longer delays compared to export cargo, we primarily focused on imports.

The rest of the paper is organised as follows: Section 2 provides a literature overview and Section 3 provides an outline of the methodology and approach to address the research problem. Section 4 describes the data collected to study port time delays, Section 5 reports on the observed results while Section 6 concludes, makes recommendations and provides topics for future research.

# 2. Literature review

Much work has been performed on multinational trade and transport corridors in general and on African corridors in particular (Bowland & Otto, 2012; Byiers, 2014). The impact of trade corridors on economic activities has also been widely studied (Jordaan, 2014; Hoffman et al., 2017). The specific trade corridor activity that has received the most attention in these studies is customs operations (Laporte, 2011; Davaa, 2015; Finger, 2010; Komarov, 2016; Hoffman, 2018). The most important recommendation resulting from these studies is that customs authorities should use risk management techniques by mining historical databases reflecting the relationships between customs risk and various contributing factors like country of origin and cargo type.

Ports operations have also been widely studied, with a focus on the costs and benefits of speeding up reporting formalities (Vaghi, 2016), the benchmarking of ports operations (Jeevan, 2017), port service congestion (Talley & Ng, 2016), applying queuing methodology to analyse congestion (Saeed & Larsen, 2016) and the economic losses resulting from port disruptions (Zhang, 2016). Other studies addressed drivers of port efficiency (Serebrisky et al., 2016) and simulation models for complex port operations (Kotachia, Rabadi & Obeid, 2013).

We could not, however, find published research that addresses the topic of this paper, namely the quantification of the relative contributions of customs and ports operations to the overall time delays experienced by cargo from the point of arrival of the ship until cargo leaves the port by road or rail. The absence of such studies provides additional motivation for the work reported in this paper.

# 3. Methodology and approach

## 3.1. Port layout, capacity and condition

The port under study is a large seaport along the east Africa seaboard and like many African ports is located directly in the city centre. It is strategically located to serve both domestic cargo and transit traffic from hinterland countries and is an important hub for the international trade of the neighbouring landlocked countries. However, the port is surrounded by the city to the north, west and south, so there is limited space to expand the port precinct to increase its capacity. Its location within the city also leads to congestion as the port traffic sometimes leads to queues that back up into the city.

The port is accessible from the Indian Ocean through an entrance channel. Its current depth allows vessels access with up to 234 m length overall. Berthing of large vessels is subject to operational (daylight and high tide) constraints. The port is linked to both road and rail but faces issues with landside access. The capacity of road access points does not meet current traffic requirements and the problem is compounded by lack of parking areas and insufficient gate management or trucking appointment systems operated by the Ports Authority.

The port has a capacity of 10 Mtpa (million tonnes per year), including 3.1 Mtpa of bulk cargo, 1 Mtpa (about 620,000 twenty-foot equivalent container units, or TEUs) of containerised cargo, and 6 Mtpa of liquid bulk (Port Statistics obtained from annual reports).

To ease congestion at the marine terminals, the Ports Authority allows for the transfer of domestic import containers to bonded Inland Container Depots (ICDs) located outside the port that are operated by private enterprises. The Port and Customs Authority currently do not allow transit imports to proceed to outside ICDs, so all transit imports are cleared and processed in the port prior to departure.

## 3.2. Port traffic

The port offers a wide range of shipping services to key destinations around the world. The import country's major markets comprise China, India, South East Asia, Europe, the Americas and the rest of Africa. Six fully cellular container services call at this port, which integrate this regional port with global hub ports.

In recent years, just under 5,000 vessels entered the port per year or about 400 vessels per month. One-fifth were deep-sea vessels and four-fifths coastal vessels. There has been steady growth in traffic, at a CAGR (compound annual growth rate) of 7.5 per cent. This growth has been led by a surge in imports at a CAGR of 7.8 per cent. Export growth has mirrored the growth in imports but from a much lower base, at a CAGR of 7.1 per cent. The highest growth in imports has been recorded in containerised cargo (10%), followed by dry bulk (8.4%) and liquid bulk (7.8%). In exports, growth was the highest for containerised cargo (9.3%). The growth in containers, measured in terms of TEUs (twenty-foot equivalent units) has been 10.3 per cent, with container traffic stabilising at between 40–45 per cent of total traffic. This growth in container traffic justifies our approach to focus primarily on the measurement of time delays for containerised cargo.

## 3.3. Port vessel processing time

The time a consignment spends at a port is broadly divided between time-on-ship (marine side, or ship dispatch) and time-in-port (landside, cargo handling). Table 1 provides results for the time from arrival of a vessel at berth till departure from berth. As these figures were obtained from the Ports Authority and Port Operator annual reports as well as a report from Hamburg Consultants (HPC Hamburg Port Consulting GmbH, 2017), we can only display those statistics that were available from these sources. The time at berth includes the cargo discharge and loading period, that is, it is shared between the time required for imports and time for exports. The time at berth takes close to two days.

*Table 1: Arrive at berth to depart from berth time (hours)*

| Terminal | Source | Number of Observations | Average | Median | Upper Quartile | Lower Quartile |
|---|---|---|---|---|---|---|
| Ports Authority | Annual Report 2015 | 154,060 | 57.1 | | | |
| | Annual Report 2016 | 139,037 | 39.5 | | | |
| | Annual Report Jun/Jul 2016 | 18 | 47.6 | 44.5 | 53 | 24.8 |
| | HPC Oct/Nov 2016 | 22 | 32.6 | 26.0 | 51.3 | 17.0 |
| Intermodal Container Terminal | Annual Report 2015 | 495,689 | 53.1 | | | |
| | Annual Report 2016 | 485,189 | 47.5 | | | |
| | Annual Report Jun/Jul 2016 | 34 | 45.9 | 42.0 | 58.0 | 32.0 |
| | HPC Oct/Nov 2016 | 23 | 52.9 | 49.0 | 71.0 | 26.5 |

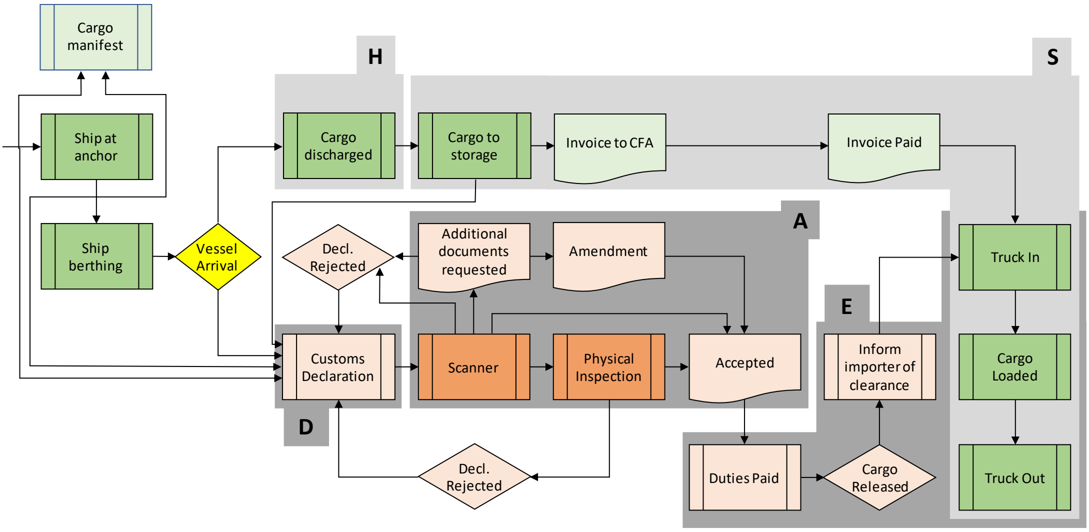
*Source*: HPC Hamburg Port Consulting GmbH 2017, Consulting services for productivity improvement study, PRQ20141894, Ports Authority, Intermodal Container Terminal & HPC Report, 30 September 2017.

Added to the previous measure (anchor-to-berth), the total effect of ship turnaround on cargo delay is around four to five days. This does not compare well with the international benchmark of 1.06 days and the Durban figure of 2.1 days (HPC Hamburg Port Consulting GmbH, 2017). Due to lack of information about the reasons for individual vessel delays it is not clear if performance improvements mainly depend on improvements to the port (for example, deepening the entrance to prevent tide delays), adding more berths or improving the efficiency of cargo handling capabilities inside the port. As the focus of our study is on cargo delays rather than vessel delays, we did not further investigate the underlying reasons for vessel delays.

## 3.4. Port and Customs process flows

Figure 1 provides a schematic depiction of typical ports processes for the importation of cargo. Careful consideration of these processes is important as there are several processes taking place in parallel while cargo is being processed through the port. The purpose of this study is to quantify the contribution towards overall time delay for each parallel process, and to repeat this for different scenarios (as determined by Clearance Plan and Customs Regime), so that the contribution of each role player to time delays for each scenario can be quantified.

*Figure 1: Port landside processes*




Legend: yellow: shipping line processes; dark green: port terminals physical processes; light green: port terminal documentation processes; dark orange: customs physical processes; light orange: customs documentation processes; dark grey: processes controlled by customs; light grey: landside processes controlled by port.

H: handling; S: storage; D: declaration; A: acceptance; E: exit.

## 3.5. Data available from operations

In a well-managed operation, the completion of each important activity in the port is recorded and stored on the IT system as it represents the change in status of documentation and cargo. Such changes in status should trigger further activities until the cargo and documentation processes have been concluded and the released cargo leaves the port. It furthermore allows measurement of the duration of each activity or process step.

The port processes are indeed recorded, but not all this data is combined in the same system. For example, the cranes that are used to pick and place containers are equipped with on-board computers that record these events, but this information is not uploaded to a central system and can therefore not be related to other transactional data. One area of recommendation in the HPC study (HPC Hamburg Port Consulting GmbH, 2017) was that the Ports Authority implement a proper Terminal Operating System (TOS) so that all terminal resources involved in the transport process of the cargo can be planned and tracked according to the progress of operation. That report furthermore stressed that the TOS should be fully integrated with other surrounding systems, including customs, government agencies and the Ports Authority financial systems.

For this study we therefore had to reconstruct the port situation in isolation, using data available from the Customs Authority and a port terminal, without being able to verify any of this information against information about concurrent process steps reflected in the systems of other participants in the overall process. It was therefore not possible to identify accurately the reason for process delays in individual cases, as any of several parallel processes could in principle cause a delay to the overall process at any stage. We could, however, generate accurate statistics for different time delays for both customs and ports processes and for each relevant cargo category.

The contributions of customs and the terminal operator to port delays are not easy to separate, as the activities that they are responsible for are interactive and run in parallel. Both sequences of activities have the potential to cause delays, and as a result it is not a simple matter to apportion blame for unnecessary or avoidable delays. The approach that we followed involved the collection of data from both customs and ports operations over the same period and for the same cargo consignments. We used identifiers of cargo, including manifest numbers and shipping container numbers, as well as date and time, to associate information collected by customs for a cargo consignment with information collected by the terminal operator for the same cargo consignment. This allowed us to calculate time delays for the two streams of parallel processes, as conducted by the customs authority and the terminal operator, and to determine in each case which process stream was the primary determinant of delays for that consignment.

## 3.6. Relevant cargo categories to measure contributions of customs and ports to time delays

It was apparent from the available data that big differences exist regarding the treatment by customs and ports of cargo consignments falling into different categories. The focus of this investigation is on inbound cargo, as inbound cargo in general experiences longer delays compared to outbound cargo. Inbound cargo is divided mainly into two customs regimes, namely import (code IM4) and transit (code IM8); other customs regimes represent a very small fraction of total cargo. Customs furthermore distinguishes between several so-called clearance plans; the two most important ones are Pre-Arrival Declarations (PAD) and Post-Manifest Declarations (PMD). We therefore divided cargo consignments into four categories based on these two dimensions and reported results separately for each category. This allowed us to investigate the reasons for delays as applicable to each category.

When customs processes declarations, several outcomes can be reached for any specific cargo consignment: ‘Released with no stop or amendment’; ‘Inspected’; ‘Amended’; ‘Inspected and Amended’, and several others. The outcomes listed are the most important ones regarding possible time delays in the customs process. We calculated time delays for each of these customs outcomes.

The fact that both import and transit goods are processed by the same entities and through the same choke points has the result that the two categories cannot be analysed totally in isolation, for the following reasons:

- Transit containers may wait for Import containers to be scanned at the port x-ray scanner.
- Trucks collecting transit containers from the port may wait in queues for trucks collecting Import containers.
- Transit containers already discharged from ships may wait to be taken to the x-ray scanner because the fleet of port trucks is busy offloading Import containers, for example.

Against this background we analysed both Import and Transit traffic, so that the performance achieved with both cargo streams can be compared and to allow the possible impact of one area of performance on the other to be assessed.

## 3.7. Landside import processes and responsibilities

The landside cargo handling and clearance processes take place after ship arrival until the cargo exits the port (in the case of imports). Several players are responsible for how long this takes:

- The port terminal operator physically moves the cargo off the vessel and through the port to a place of temporary storage.
- Customs (and some other regulatory agencies) verify the status of the goods and collect duties.
- The consignor/shipper, shipping line and freight forwarder are variously responsible to make applications and present documents, respond to issues raised, and to pay the port and Customs.
- Road and rail transport operators must physically remove cargo from the port after both customs and the terminal operator has released the cargo.

Apart from establishing how much time is consumed by the passage of cargo through the port, a key question is how to separate out the contribution of each of these parties to the total time goods take in-port.

Control of the cargo transfers from the shipping line during the voyage (forming part of the vessel sailing time), to the port terminal as well as to customs at the receiving port since it is also a customs port of entry. At the port, there is both a physical flow of cargo as well as a supporting flow of documents. What is clear from Figure 1 is that there is much interdependence between port and customs processes. For example, the delays measured from the point of discharge of cargo until cargo is collected will usually include the completion of the customs clearing process, which may involve physical inspections. If long delays occur during this period it may be caused either by customs clearance processes, or by the port not issuing the invoice to the clearing agent for ports services, or the cargo owner not paying the invoice, or a truck not arriving in time after being notified to collect.

From Figure 1 the total time in port is equal to the port's own processes (handling/H and storage/S) and to the customs processes in the port (Declaration/D, Acceptance/A and Exit/E). Customs processes that fall outside the landside period have a zero duration in the port. Delays in D and E are not primarily caused by customs; therefore A (Customs Acceptance) is on the critical path in the port. In other words, A as a share of total delay shows how much of the port time is essentially customs related.

## 3.8. Landside processes for exports

The primary focus of the investigation is on inbound cargo, as imports in general experience longer delays compared to exports. For exports, the same set of processes are involved as described for imports previously, but in a somewhat different order. For port cargo handling, the main difference is that for imports the cargo is first offloaded from the ship before trucks are notified to collect; for exports trucks deliver cargo in their own time before a ship is loaded. For customs processes, the import declaration is replaced by an export declaration.

In the case of imports, delays and unnecessary congestion may occur if trucks arrive before cargo has been offloaded from the ship and released. In the case of exports, delays may occur if a ship is ready for departure but critical cargo has not yet been delivered to the port. In such cases ships will often depart without this cargo, due to the high penalties involved when a ship does not keep to its berthing schedule at subsequent ports.

Another important difference between imports and exports is the probability of a physical inspection of cargo. As exports in this case are mainly raw materials, they seldom require physical inspections. Imports are mainly containerised goods subjected to inspection rates of between 70 per cent and

95 per cent. As a result, long delays and ports congestion are mainly related to imports. However, since exports must be processed by the same entities (port and customs) the delays spill over to exports as well, even though export activities may not be the root cause.

Of the available data sources, only the HPC report provides a comparison of equivalent important export processes. Table 2 provides the results for cargo dwell time (that is, storage, or discharge to truck-out for imports vs truck-in to loading for exports) for both imports and exports. These are averages as no median was available from this report. The results are from a short sample period in October/November 2016. In both cases (Ports Authority and Intermodal Container Terminal), export dwell time appears substantially shorter than import dwell time (a third shorter for the Ports Authority and about 50 per cent shorter for Intermodal Container Terminal). This justifies our decision to focus the detailed analysis on import cargo.

*Table 2: Transit storage time (days, Oct/Nov 2016)*

| Terminal | Direction | Observations | Average |
|---|---|---|---|
| Ports Authority | Import | ±25,000 | 7.5 |
| | Export | | 4.7 |
| Intermodal Container Terminal | Import | ±80,000 | 10.6 |
| | Export | | 5.5 |

*Source*: HPC Hamburg Port Consulting GmbH 2017, Consulting services for productivity improvement study, PRQ20141894, Ports Authority, Intermodal Container Terminal & HPC Report, 30 September 2017, Table 90, Table 91.

# 4. Data collection

Raw transaction data was obtained from both Customs and from the International Container Terminal Services, mostly for the calendar year of 2017. As the focus of this investigation is on the relative importance of the ports and customs processes as far as time delays are concerned, and as not all customs authority transactions apply to cargo handled by the Intermodal Container Terminal, only those transactions that were present in both the Customs Authority and the Intermodal Container Terminal datasets were used for the time delay analysis. The unique identifiers that were used to link Customs Authority and Intermodal Container Terminal transactions are Bill of Lading number and container number.

Against the above background, we divided the available data from the Customs Authority and Intermodal Container Terminal that were common to both data sets into categories as described in Table 3. Table 3 also indicates the number of transactions that was available in each category. The reason why the numbers for the individual clearance plans and Regimes do not add up perfectly to the total number of transactions is the fact that the relevant data fields in the Customs Authority tables indicating Clearance Plan or Regime are not always populated, making it impossible to allocate all transactions to specific categories. There are also several Clearance Plan and Regime categories that contain only a small number of transactions. To limit the complexity of the results tables, we show only the results for categories that contain a significant number of transactions.

Similarly, all the possible customs outcome categories are not displayed, but only the few where performance significantly deviates from population statistics (that is, for declarations that were inspected and/or amended, as this usually implies additional customs activities that consume a significant amount of time).

Within the available common dataset, approximately 75 per cent of declarations fall in the PAD category and about 25 per cent in PMD. Similarly, about 75 per cent are Import and 25 per cent are Transit goods. Of all inbound cargo, about 50 per cent is inspected, but this figure is much lower for Transit goods (only six declarations from about 18,000 transit declarations were inspected as opposed to almost 75 per cent of Import cargo). About 20 per cent of Import declarations are amended, with only about 1.5 per cent of Transit declarations amended.

*Table 3: Number of transactions in each category that were investigated*

| Categories | All | Clearance Plans | | Regimes | | Clearance Plans + Regime |
|---|---|---|---|---|---|---|
| | | PAD | PMD | Import | Transit | PAD + Transit |
| Total | 77,372 | 48,213 | 16,720 | 49,688 | 17,998 | 8,276 |
| Inspected | 37,603 | 32,289 | 4,930 | 37,376 | 6 | 3 |
| Amended | 16,844 | 14,914 | 1,872 | 15,321 | 1,276 | 740 |
| Inspected & Amended | 12,989 | | | | | |

# 5. Results for contributions of Port and Customs to time delays

## 5.1. Analysis of combined dataset

Table 4 displays the median and average of time delays measured across all regimes and clearance plans. The median value for the entire ports process (from arrival of vessel to payment of port invoice) is four days (8.5 days on average), while the median of the entire customs process (from submission of declaration to release of cargo) is 10 days (13.7 days average). For declarations that are amended, inspected and/or rejected, the customs clearance median time increases to between 14 to 19 days (17 and 21 days on average). It must, however, be considered that the declaration to customs may be made while the vessel is still at sea – for this reason we must also consider whether the ports or the customs process is first concluded for each consignment.

The customs process can be further broken down into different process steps:

- submission received to verified by customs official
- from verified till completion of the assessment process
- from assessment to inspected and/or paid
- from paid to released.

As can be seen below, all the customs process steps contribute significantly to the total duration. Measurement of the contribution of each process step is complicated by the fact that for a single declaration there may be several customs responses indicating an assessment and payment, for example. These processes are often repeated for declarations that are not immediately released. This causes possible overlap between our measurements for different processes, resulting in the sum of identified process steps taking longer than the overall process. The length of individual process steps should therefore only be used to obtain an indication of their relative contribution to total time.

Measuring the duration of the combined customs and ports process is not that simple either, as cargo not destined for re-export (that is, cargo falling in 'Regime: Import') usually moves from the port to an ICD before being cleared. For that reason, the delay from customs clearance to truck leaving the port is on average negative, as the customs process is not yet completed by the time that cargo leaves the port but is only concluded while the container is at an ICD.

*Table 4: Time in port, by process step (all regimes and clearance plans, days)*

| **Process Step** | **Total** | **Customs Outcome** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Start** | **Finish** | | | **Amended** | | **Inspected** | | **Rejected** | |
| **Port Processes:** | | **Median** | **Ave** | **Median** | **Ave** | **Median** | **Ave** | **Median** | **Ave** |
| Actual Arrival of Vessel | Payment of Port Invoice | 4.06 | 8.53 | 2.87 | 5.86 | 2.41 | 4.42 | 2.46 | 7.37 |
| Actual Arrival of Vessel | Cargo Discharged | 2.84 | 3.30 | 3.10 | 3.51 | 2.84 | 3.30 | 2.79 | 3.48 |
| Cargo Discharged | Port Invoice Delivered | 0.22 | 3.74 | -1.22 | 1.10 | -1.42 | 0.08 | -1.57 | 2.25 |
| Port Invoice Delivered | Payment of Port Invoice | 1.00 | 1.49 | 0.99 | 1.25 | 0.99 | 1.04 | 1.24 | 1.64 |
| **Customs Processes:** | | **Median** | **Ave** | **Median** | **Ave** | **Median** | **Ave** | **Median** | **Ave** |
| Declaration Received | Cargo Released | 10.01 | 13.66 | 17.04 | 20.01 | 14.19 | 17.58 | 19.01 | 20.47 |
| Declaration Received | Declaration Verified | 0.85 | 5.18 | 9.95 | 13.99 | 1.82 | 6.63 | 12.97 | 17.98 |
| Declaration Verified | Declaration Assessed | 1.11 | 5.47 | 8.96 | 12.58 | 2.85 | 7.44 | 12.47 | 17.34 |
| Declaration Assessed | Cargo Inspected | 11.96 | 14.89 | 13.91 | 16.85 | 11.96 | 14.89 | 9.23 | 13.19 |
| Declaration Assessed | Duties Paid | 6.57 | 10.25 | 10.88 | 14.67 | 9.99 | 13.28 | 7.73 | 13.72 |
| Duties Paid | Cargo Released | 2.98 | 6.06 | 6.93 | 9.46 | 6.25 | 8.67 | 3.92 | 7.33 |

| Process Step | Total | Customs Outcome | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Start** | **Finish** | | | **Amended** | | **Inspected** | | **Rejected** | |
| **Combined Processes:** | | **Median** | **Ave** | **Median** | **Ave** | **Median** | **Ave** | **Median** | **Ave** |
| Declaration Received | Actual Arrival of Vessel | -1.45 | -0.99 | 4.48 | 5.32 | 2.64 | 2.91 | 0.87 | 1.02 |
| Cargo Discharged | Cargo Released | 6.46 | 10.56 | 7.31 | 11.16 | 7.32 | 11.37 | 12.81 | 15.96 |
| Cargo Discharged | Cargo Inspected | 7.20 | 11.17 | 7.21 | 10.93 | 7.20 | 11.17 | 12.79 | 15.83 |
| Payment of Port Invoice | Cargo Released | 4.11 | 5.93 | 7.03 | 8.81 | 7.47 | 10.25 | 10.23 | 12.06 |
| Cargo Released | Truck/Train In | -2.19 | -3.55 | -4.16 | -6.47 | -4.55 | -7.89 | -7.4 | -9.78 |
| Payment of Port Invoice | Truck/Train In | 1.92 | 2.38 | 2.87 | 2.34 | 2.92 | 2.36 | 2.83 | 2.28 |
| Truck/Train In | Truck/Train Out | 0.09 | 0.18 | 0.08 | 0.15 | 0.08 | 0.15 | 0.09 | 0.16 |
| Truck/Train Out | Border Exit | 9.22 | 19.05 | 10.13 | 16.03 | 6.84 | 7.66 | 13.38 | 15.55 |
| Actual Arrival of Vessel | Truck/Train Out | 6.07 | 11.09 | 5.82 | 8.35 | 5.41 | 6.93 | 5.38 | 9.81 |
| Cargo Released | Border Exit | 7.12 | 15.68 | 6.05 | 9.71 | 2.37 | -0.08 | 6.07 | 5.93 |
| Actual Arrival of Vessel | Border Exit | 15.29 | 30.14 | 15.95 | 24.38 | 12.25 | 14.59 | 18.76 | 25.36 |

## 5.2. Analysis by clearance plan

To allocate the time-in-port between the port terminal and customs, it is necessary to separate the analysis by regime and clearance plan. Table 5 shows the results when distinguishing clearance plan, while Figure 2 and Figure 3 display the histograms for Discharge to Invoice and Customs Submission to Release, respectively. The information that indicates which of customs and the terminal operator was the primary reason for delays is displayed in Figure 4. The benefit of observing the histogram is that it allows all behaviour to become visible, rather than considering only medians or averages.

The following comments are relevant:

- For PMD, the ports process takes much longer than for PAD, mostly because port invoices are delivered much later for PMD than for PAD, as displayed in Figure 2. This may be because the required information in the case of PMD is not available at an earlier stage to allow the port to finalise the invoice.
- For PAD, the customs process takes much longer than for PMD, as shown in Figure 3. All the individual customs process steps take much longer for PAD. This is of concern as PAD declarations are usually made by importers for whom time is of the essence and who need to reduce customs delay time. This finding is exacerbated by the fact that for PAD, the fraction of cargo consignments that is inspected is about two-thirds, while it is less than a third for PMD.
- Figure 4 shows that for PAD declarations the time from payment of port invoice to release by customs is usually positive with a median value of more than five days. As a result, the customs process is the primary contributing factor for PAD. For PMD declarations this time delay is negative most of the time, with a median value of -0.83, which confirms that the ports process is the primary contributing factor for PMD.
- The total time from arrival of the vessel until the cargo exits to a neighbouring country is somewhat shorter for PAD vs PMD both in terms of median (four days) and average (seven days). The realised time saving is, however, not nearly as much as the difference in declaration submission times between PAD and PMD (11 to 16 days as can be seen by comparing ‘Declaration Received’ to ‘Arrival of Vessel’ for PAD vs PMD). As a result, the combined ports and customs processes at least partly defeat the purpose of making the PAD option available to importers.

*Table 5: Time delay, by clearance plan (days)*

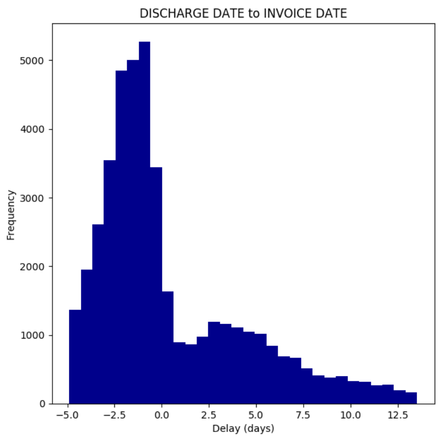
| | Start | Finish | PAD | | PMD | | PMD minus PAD | |
|---|---|---|---|---|---|---|---|---|
| | | | Med | Ave | Med | Ave | Med | Ave |
| **Port** | Actual Arrival of Vessel | Payment of Port Invoice | 2.93 | 5.92 | 7.54 | 11.44 | | |
| | Actual Arrival of Vessel | Cargo Discharged | 2.89 | 3.36 | 2.65 | 3.15 | | |
| | Cargo Discharged | Port Invoice Delivered | -0.95 | 1.31 | 3.74 | 6.15 | | |
| | Port Invoice Delivered | Payment of Port Invoice | 0.99 | 1.25 | 1.15 | 2.14 | | |
| **Customs** | Declaration Received | Cargo Released | 13.71 | 16.57 | 3.07 | 5.37 | | |
| | Declaration Received | Declaration Verified | 1.67 | 6.54 | 0.15 | 1.4 | | |
| | Declaration Verified | Declaration Assessed | 2.12 | 6.8 | 0.7 | 1.85 | | |
| | Declaration Assessed | Cargo Inspected | 13.42 | 16.21 | 4.06 | 6.89 | | |
| | Declaration Assessed | Duties Paid | 9.05 | 12.8 | 1.65 | 3.19 | | |
| | Duties Paid | Cargo Released | 5.3 | 7.62 | 0.16 | 1.66 | | |

| | Start | Finish | PAD | | PMD | | PMD minus PAD | |
|---|---|---|---|---|---|---|---|---|
| | | | Med | Ave | Med | Ave | Med | Ave |
| **Combined** | Declaration Received | Actual Arrival of Vessel | 2.39 | 4.67 | -8.47 | -10.82 | -10.86 | -15.49 |
| | Cargo Discharged | Cargo Released | 5.86 | 8.54 | 9.5 | 13.03 | | |
| | Cargo Discharged | Cargo Inspected | 6.27 | 9.06 | 13.63 | 20.08 | | |
| | Payment of Port Inv. | Cargo Released | 5.28 | 5.97 | -0.83 | 4.73 | | |
| | Cargo Released | Truck/Train In | -3.17 | -3.54 | 2.15 | -2.26 | | |
| | Payment of Port Inv. | Truck/Train In | 2.11 | 2.43 | 1.32 | 2.47 | | |
| | Truck/Train In | Truck/Train Out | 0.08 | 0.17 | 0.09 | 0.19 | | |
| | Truck/Train Out | Border Exit | 10.42 | 15.41 | 10.34 | 16.34 | | |
| | Actual Arrival of Vessel | Truck/Train Out | 5.12 | 8.52 | 8.95 | 14.1 | | |
| | Cargo Released | Border Exit | 7.33 | 12.04 | 12.58 | 14.27 | | |
| | Actual Arrival of Vessel | Border Exit | 15.54 | 23.93 | 19.29 | 30.44 | 3.75 | 6.51 |

Note: Table includes both domestic imports and transit movements. Negative values mean that the end of a step occurred before its start.

*Figure 2: Discharge to invoice time delay per declaration*

**PAD Declarations**




**PMD Declarations**

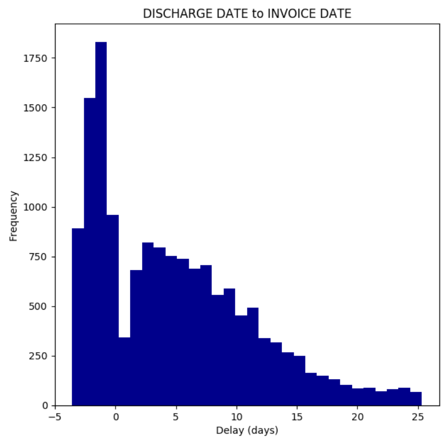
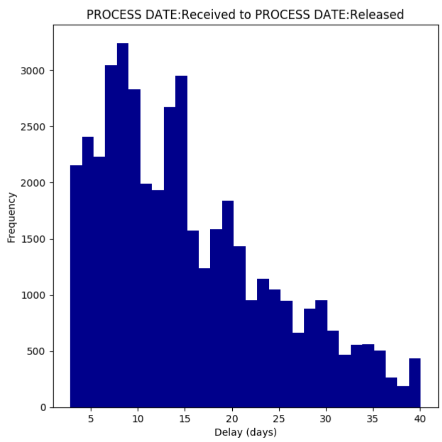



*Figure 3: Customs submission to released time delay per declaration*

**PAD Declarations**




**PMD Declarations**

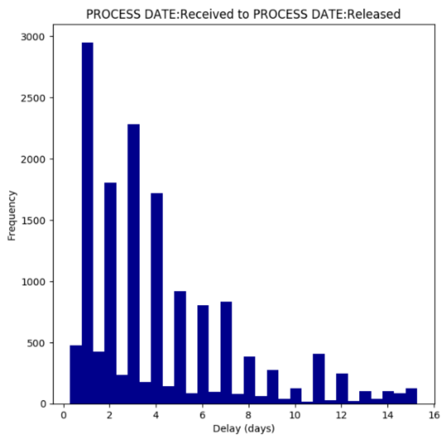
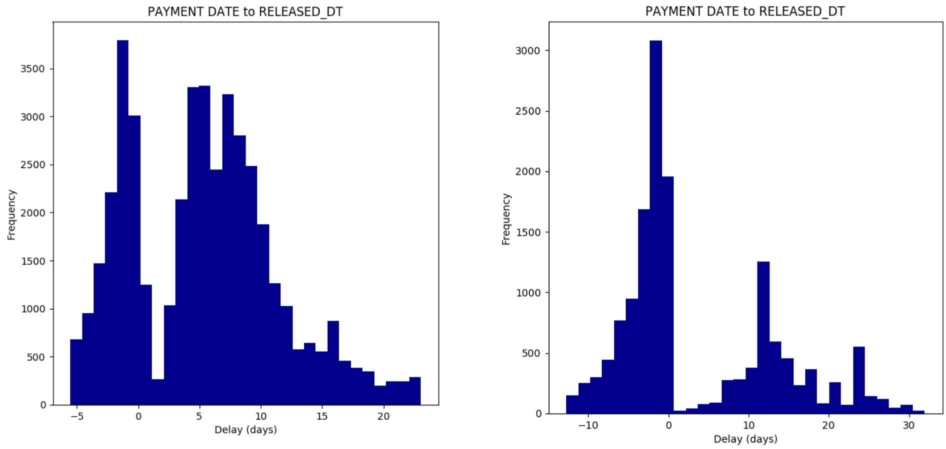


*Figure 4: Payment of port invoice to customs release time delay for import and transit goods*

**PAD Declarations** **PMD Declarations**




## 5.3 Analysis by regime

Table 6 displays time delay results for different regimes (containing transactions for all clearance plans unless otherwise stated). The following comments are relevant:

- On first observation, it may seem that ports processes dominate time delays for Transit goods. On average customs clear cargo about a day before the ports invoice has been paid for transit goods, mainly due to long delays between discharge of cargo and delivery of ports invoice. This can also be seen in Figure 5, which displays the histogram for port invoice payment date to customs release date. If the time delay from Payment of Port Invoice to Customs Release of consignments is positive, payment of invoice occurred before customs release, implying that the customs process was the primary reason for delays. A negative value means that payment occurred after release, implying the ports process was the primary reason for delays. Delays for import goods were mainly positive, meaning that the customs process was typically the reason for the delay. Delays for transit goods were all negative, meaning that in those cases, the port process was the primary reason for the delay.
- This is confirmed by analysing time delay from release of goods by ports or customs until entry of truck or train. If this time delay is positive, customs release of a consignment occurred before the truck entered. This is mostly the case for transit goods that must wait in the port until release before it can be transported to a neighbouring country. However, if this time value is negative, release of consignment occurred after the truck entered; this is mostly the case for import goods staying in the import country and that must be taken to an ICD before being cleared, resulting in the truck entering and leaving the port with the cargo while customs is still busy with the clearing process.
- Figure 6 shows that for transit cargo it takes typically five to seven days from customs clearance to truck/train port entry, while it takes only four to five days from payment of port invoice to truck/train port entry, confirming that the port is mostly the delaying factor. It is suspected that this lengthy time delay at least partly results from the fact that all containers must go to the x-ray scanner before they can leave the port.

- Customs processes dominate time delays for Import cargo, with time delays evenly spread across different customs processes, and with a high fraction of inspections. This is, however, not without good reason, as about a third of inspected consignments are amended.
- For Transit goods following the PAD clearance plan, the overall time delay, both in the port and until cargo exits the border, is not much less than for transit goods following the PMD clearance plan. This is mainly due to the lengthy time delay from discharge to delivery of the ports invoice, and possibly also due to containers waiting to be taken to the x-ray scanner.

*Table 6: Time delays, by regime (days)*

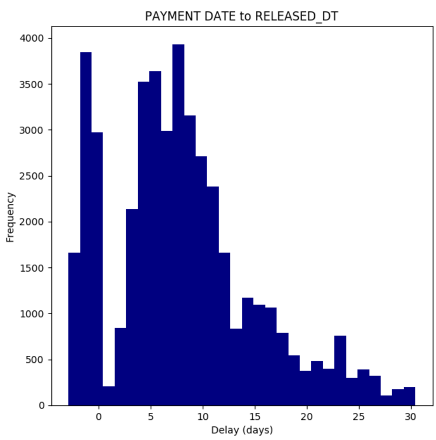
| | **Process Step** | | **Regime** | | | | **Clear. Plans + Regime** | |
|---|---|---|---|---|---|---|---|---|
| | **Start** | **Finish** | **Import** | | **Transit** | | **PAD + Transit** | |
| | | | **Med** | **Ave** | **Med** | **Ave** | **Med** | **Ave** |
| **Port** | Actual Arrival of Vessel | Payment of Port Inv. | 2.56 | 5.04 | 10.31 | 14.86 | 9.48 | 13.51 |
| | Actual Arrival of Vessel | Cargo Discharged | 2.85 | 3.30 | 2.84 | 3.33 | 3.13 | 3.50 |
| | Cargo Discharged | Port Invoice Delivered | -1.27 | 0.69 | 6.29 | 8.87 | 5.24 | 7.56 |
| | Port Invoice Delivered | Payment of Port Invoice | 0.98 | 1.05 | 1.18 | 2.66 | 1.11 | 2.45 |
| **Customs** | Declaration Received | Cargo Released | 13.90 | 16.96 | 3.10 | 4.99 | 5.06 | 6.64 |
| | Declaration Received | Declaration Verified | 1.87 | 6.98 | 0.17 | 1.06 | 0.18 | 1.13 |
| | Declaration Verified | Declaration Assessed | 2.29 | 7.17 | 0.68 | 1.65 | 0.71 | 1.83 |
| | Declaration Assessed | Cargo Inspected | 11.96 | 14.9 | 6.77 | 6.83 | 8.34 | 7.72 |
| | Declaration Assessed | Duties Paid | 9.29 | 12.94 | 2.1 | 4.17 | 4.20 | 6.03 |
| | Duties Paid | Cargo Released | 6.03 | 8.29 | 0.00 | 0.39 | 0.00 | 0.11 |

| | Process Step | | Regime | | | | Clear. Plans + Regime | |
|---|---|---|---|---|---|---|---|---|
| | Start | Finish | Import | | Transit | | PAD + Transit | |
| | | | Med | Ave | Med | Ave | Med | Ave |
| Combined | Declaration Received | Actual Arrival of Vessel | 1.46 | 1.19 | -3.60 | -5.54 | -1.58 | -2.59 |
| | Cargo Discharged | Cargo Released | 7.29 | 11.72 | 4.30 | 7.19 | **3.25** | **5.72** |
| | Cargo Discharged | Cargo Inspected | 7.18 | 11.15 | 14.46 | 14.95 | 16.68 | 16.78 |
| | Payment of Port Inv. | Cargo Released | 7.21 | 9.98 | -0.90 | -1.67 | -2.05 | -4.28 |
| | Cargo Released | Truck/Train In | -4.26 | -7.60 | 4.80 | 6.82 | 4.76 | 6.98 |
| | Payment of Port Invoice | Truck/Train In | 2.95 | 2.38 | 3.90 | 5.15 | 2.71 | 2.70 |
| | Truck/Train In | Truck/Train Out | 0.08 | 0.15 | 0.11 | 0.25 | 0.11 | 0.27 |
| | Actual Arrival of Vessel | Truck/Train Out | 5.59 | 7.57 | 14.32 | 20.26 | 12.30 | 16.48 |

*Source*: Customs Authority. Med, median. Ave, average. Inv., invoice.

*Figure 5: Payment of port invoice to customs release time delay for import and transit goods*

**Import**




**Transit**

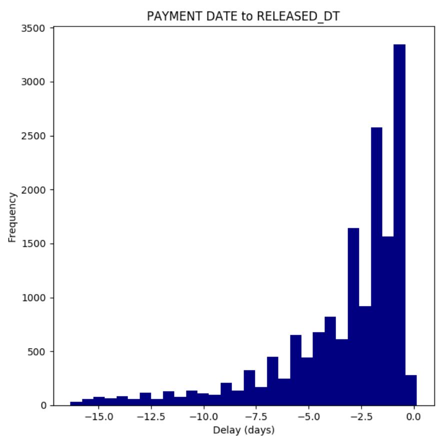
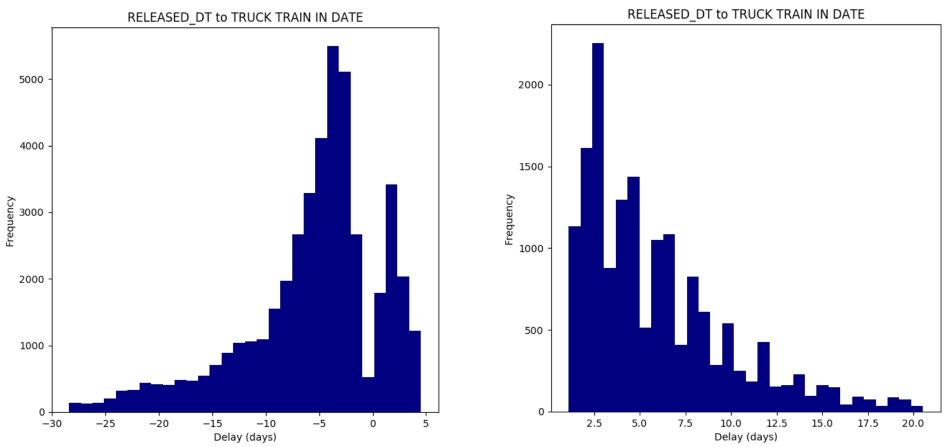


*Figure 6: Customs release to truck/train entry time delay for import and transit goods*

**Import** **Transit**

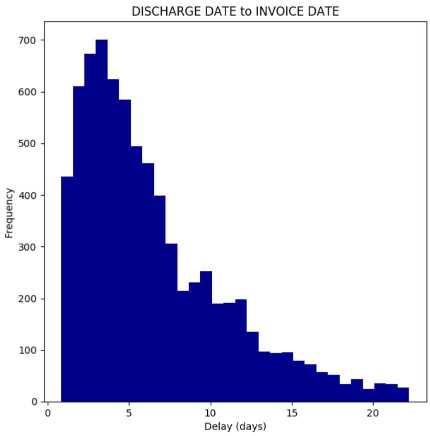



## 5.4. Analysis for transit PAD cargo

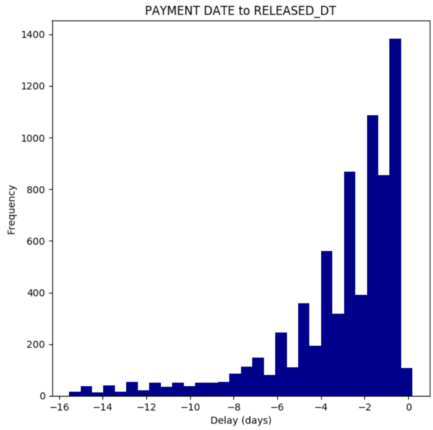
A combined category that is of specific importance is transit cargo with a PAD clearance plan. This is cargo imported through the port but destined for a landlocked neighbouring country and where the importer used a declaration plan with the aim to expedite the process as far as possible. The median and average time delay values appear in the last two columns of Table 6. Figure 7 displays the histograms of time delays from discharge to port invoice (average value of 7.6 days) and from payment of port invoice to customs clearance (average value of -4.3 days). For this cargo category the activities of the terminal operator are the primary delaying factor, as customs clearance is provided before the port invoice is paid and port clearance is subsequently provided. This is the case mostly due to the long delay from discharge of cargo until the port invoice is delivered to the importer (this process step consumes about 75 per cent of the landside port activities until cargo is released by both customs and port for collection).

*Figure 7: Discharge to invoice and payment of port invoice to customs release time delay for transit PAD goods*

**Discharge to invoice date**




**Payment of port invoice to customs release**




# 6. Measuring the contributions of traders to time delays

The above analysis assumes that the customs authority and ports terminal are fully responsible for the time delays associated with the processes that they impose on traders. In fact, the traders also contribute towards the effective time delays due to their response times, once requested by either customs or ports to either provide documentation or to collect cargo.

We therefore performed additional analyses by breaking down the customs (and ports) processes into those where customs (or ports) are responsible for completing the current activity and those where trade is responsible. For the customs chain of activities customs must receive, select, assign, accept, verify, assess, compare and release documents, while trade must submit additional documents upon request, amend documents and make payments. For the port chain of activities, the port is responsible to discharge cargo, issue an invoice and release cargo, while trade must pay the invoice and collect the cargo.

We firstly analysed only the customs chain of activities from submission of a declaration until it is released, and goods were removed from the port. Table 7 displays the relative contributions of customs and trade to this process for each customs regime. While customs consume most of the total time delay in each case, the contribution of trade is also very substantial, specifically for Import (IM4) and Transit (IM8) goods that represent the bulk of all cargo.

*Table 7: Relative contributions of customs and trade to customs process time delays*

| Regime | All | EX3 | IM4 | IM5 | IM6 | IM7 | IM8 |
|---|---|---|---|---|---|---|---|
| **Customs** | 0.56 | 0.93 | 0.55 | 0.81 | 0.65 | 0.66 | 0.58 |
| **Trade** | 0.44 | 0.07 | 0.45 | 0.19 | 0.35 | 0.34 | 0.42 |

Legend: EX3: re-exportation; IM4: entry for permanent imports; IM5: temporary import; IM6: re-importation; IM7: entry for warehousing; IM8: transit/transhipment.

We then proceeded to analyse the parallel customs and ports processes from where the vessel has arrived until goods leave the port, and divided it between customs, the port terminal and trade. This was somewhat more complex, as we first had to determine which of the customs and ports process caused the primary delay in each case. The primary delaying entity was allocated that part of the time delay that overlapped between the two parallel chains of events. By applying this logic, we derived the following set of rules for allocating time delays:

i. Contribution of Port Activities:

- If CUSTOMS RELEASE DATE< PORT INVOICE PAYMENT DATE: from VESSEL ARRIVAL DATE to PORT INVOICE DATE
- If CUSTOMS RELEASE DATE> PORT INVOICE PAYMENT DATE: from VESSEL ARRIVAL DATE to CARGO DISCHARGE DATE

ii. Contribution of Customs Activities:

- If CUSTOMS RELEASE DATE< PORT INVOICE PAYMENT DATE: zero
- If CUSTOMS RELEASE DATE> PORT INVOICE PAYMENT DATE: Total duration of all Customs Activities as from CARGO DISCHARGE DATE to CARGO EXIT DATE

iii. Contribution of Trade Activities:

- If CUSTOMS RELEASE DATE< PORT INVOICE PAYMENT DATE: from PORT INVOICE DATE to CARGO EXIT DATE
- If CUSTOMS RELEASE DATE> PORT INVOICE PAYMENT DATE: Total duration of all Trade Activities as from CARGO DISCHARGE DATE to CARGO EXIT DATE

Table 8 displays the relative contributions of customs, ports and trade to this combined process, based on the above set of rules. The contribution of trade to overall time delay is now even more apparent.

*Table 8: Relative contributions of customs, ports and trade to customs and port process time delays*

| Regime | All | EX3 | IM4 | IM5 | IM6 | IM7 | IM8 |
|---|---|---|---|---|---|---|---|
| **Customs** | 0.25 | 0.91 | 0.23 | 0.68 | 0.42 | 0.31 | 0.28 |
| **Port** | 0.23 | 0.02 | 0.23 | 0.11 | 0.22 | 0.27 | 0.23 |
| **Trade** | 0.52 | 0.07 | 0.54 | 0.21 | 0.36 | 0.42 | 0.48 |

Legend: EX3: re-exportation; IM4: entry for permanent imports; IM5: temporary import; IM6: re-importation; IM7: entry for warehousing; IM8: transit/transhipment.

The above results clearly indicate that traders are equally responsible, as are customs and ports, for the long delay times that are experienced. From interviews with traders, it was determined that there are, however, at least two mitigating factors in this respect:

- Customs does not always provide a complete list of required documents before a declaration is submitted for the first time, resulting in unnecessary repeated requests and submission of additional documentation before cargo is released
- The port does not allow foreign freight agents to electronically receive port invoices, resulting in delays while the local agent of a foreign agent relays such documentation to the entity responsible for payment.

## 7. Conclusions, recommendations and future research

The above analysis provides conclusive evidence for the following findings:

- For Import and PAD declarations, the customs process is the primary bottleneck as it causes delays much beyond the ports processes. The total customs process from submission of the declaration to clearance typically ranges from 14 to 17 days. The time to verify and assess declarations and to physically inspect cargo all consume significant portions of this delay.
- For Transit and PMD declarations, the ports process is the primary bottleneck as it causes average delays beyond the customs process. In the case of the Intermodal Container Terminal from which the ports data was obtained, the total ports process from arrival of the vessel until payment of the port invoice typically consumes between seven and 15 days. As no data are available for the rest of the port operated by the Ports Authority, no results can be provided for the rest of ports operations. The single biggest contributor to ports delays is the time taken from discharge to issuing an invoice to the importer. This appears to result from the fact that transit cargo is mostly handled by freight agents from neighbouring countries, and that data about the imported cargo is not immediately available to freight agents from outside the import country, as they are not allowed to use the eSWS (electronic single window system) but must work via local agents.

- While almost no transit cargo is inspected, the large fraction of import cargo that is inspected, combined with the fact that all containers, including all transit containers, must be x-ray scanned, contributes to congestion in and around the port and adds to time delays for both import and transit goods. As the times when containers go to and return from the scanner in the port were not available for this study, the contributions of these delays cannot be determined more accurately than the information provided above.

While many aspects of operations in and around the port can be marginally improved, the average long overall cargo dwell times in the port are mainly observed for the following reasons:

- The Customs Authority selects a large fraction of import cargo declarations, specifically Pre-Arrival Declarations, for the Red lane (rather than the Yellow or Green lanes) and thus subjects them to physical inspections. This largely defeats the efforts by commercial trade to expedite the process through pre-arrival declarations as well as the purpose of having a Green/Yellow/Red lane system.
- The Customs Authority requires all containers to be x-ray scanned, resulting in further delays even after cargo is released, due to lack of sufficient port land transport capacity and due to congestion inside the port, between the port and ICDs and long queues at the scanners.
- The same standard set of documents is not always requested by customs before cargo is released; this results in many additional requests for further documents, adding further time delays while traders are preparing such additional documents.
- Foreign freight agents do not have remote access to the port system and thus do not immediately receive invoices from the port once cargo has been discharged.

The first two problem areas can be largely eliminated by employing a data analytics – based customs risk management system, which uses historical data about actual customs infractions to produce a quantified risk figure for cargo before arrival. By using such a system that is trained over a period it should be possible to reduce the fraction of physical inspections from more than 70 per cent to around 1–2 per cent high risk cases, and the fraction of scanned containers from 100 per cent to below 25 per cent representing moderate risk cases (Laporte, 2011). This should reduce cargo dwell time from around 14 days to less than three days on average, in line with international standards and to the benefit of the entire regional economy.

Based on the above, the following recommendations are made:

1. The Customs Authority should use a higher level of automation, including an intelligent risk engine, to reduce the time delay of 14 to 17 days to assess declarations. This should not take more than one to two days.
2. An eSWS should be implemented that allows local and foreign importers to exchange all required information with customs and ports authorities through one system; this will prevent late issuing of port invoices to foreign agents or repetitive customs requests for additional documents due to unavailability of data.
3. The required minimum list of documents to be submitted into the eSWS should be sufficiently complete to prevent frequent requests for additional documents after an initial declaration has been accepted by the system.

4. The requirement for all containers to be x-ray scanned should be replaced by a system where the risk profile of all containers is assessed and only high-risk containers are scanned. It is expected that this will reduce the time that transit containers spend in the port by several days.
5. The ports operator should employ enough trucks in the port to allow it to always take containers directly to the scanner after discharge from a ship. This will eliminate double movements of containers in the port.
6. Information that is collected inside the port through terminals installed in trucks and cranes should be uploaded to the central system in real time to allow the scrutiny of field operations and the immediate detection of deviations.
7. Data collected at the x-ray scanner about the time when containers are processed should be uploaded to the Customs Information System in real time to allow delays in the scanning of containers to be detected in real time.

Future research will focus on the development of a customs risk engine based on historical data reflecting the characteristics of cargo consignments and the frequency of infractions found through inspections. This will indicate the extent to which the current methods used by the Customs Authority can be improved to allow a lower inspection rate without increasing the risk posed by import cargo.

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## Schalk Rabé

Schalk Rabé studied as a computer and electronics engineer at Northwest University, South Africa from 2010 until 2015. He is currently finishing his master degree in Engineering on implementations of corridor performance dashboards. During his studies he developed data visualisation solutions for projects from DFID (Department of International Development, UK) and GIZ (Deutsche Gesellschaft fur Internationale Zusammenarbeit, Germany). Currently he is involved in developing a data visualisation solution for a Cost and Performance Comparison Study for the Central and Dar es Salaam Corridors and the development of a Corridor Performance Monitoring System for Dar es Salaam Corridor. This involves the implementation of a cloud-based dashboard that presents key performance indicators for a wide range of corridor stakeholders.

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