A study of container truck movement in Tanjung Priok port, Jakarta, Indonesia

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Abstract. Tanjung Priok is a port with a high level of import-export activity, and the flow of container movement is dominated by the Jakarta International Container Terminal and KOJA terminals. In addition to dwelling time problems, there are problems with the movement of the container trucks to and from both terminals, especially during peak hours of activity. The movement of trucks is dominated by single-move trucks (90–94% of the total movement of container trucks). An ineffective movement pattern can lead to a long queue that jams the existing road network around the port area. One solution to the problem is to develop an information system that can regulate the pattern of truck movements and adjust this to the level of service in the terminal and the ship docking schedule. A good distribution pattern will then optimize the movement of the trucks and reduce ineffective and inefficient movement.

1. Background

The universal functions of a port are: (i) as a gateway or an official gate for goods traffic; (ii) as a link or a link chain; (iii) as an interface or place for the transfer of goods between two modes, consisting of the sea side and the land side; and (iv) as an industry entity or port, i.e. as a collection of industries that are closely related to ports in the form of basic and supporting businesses [1].

Tanjung Priok was the 22nd largest port in terms of the number of containers handled in 2013. The five largest container ports in the world are Shanghai (China), Singapore, Shenzen (China), Hong Kong, and Busan (South Korea), with a total volume of 33.6 million, 32.6 million, 23.3 million, 22.4 million, and 17.7 million TEUs [2], respectively.

Tanjung Priok is the largest port in Indonesia, and is located in the capital city of DKI Jakarta, which is a gateway for the flow of freight movement into and out of Indonesia. Of the five main ports in Indonesia, Tanjung Priok handles 45% of goods exports and 65% of imports. The current service capacity of Tanjung Priok port is around 4 million TEUs per year, and this is predicted to reach 5.1 million TEUs in 2018 [3]. As a port with a high level of import activity, Tanjung Priok is currently the main focus in terms of dwelling time; compared to several other countries in Asia, the dwelling time in Tanjung Priok is still considered high. From data obtained from Tanjung Priok port, the average dwelling time is six days; in comparison, Malaysia has a dwelling export time of three days, Thailand four days, Vietnam seven days, and Philippines five days, while the dwelling times for Hong Kong and Singapore are two days and less than two days, respectively [4].

Flows of containers at Tanjung Priok are dominated by the Jakarta International Container Terminal (JITC) and KOJA terminals, serving the loading and unloading activities of containers for export and import purposes. These two terminals have a limited container yard (CY) capacity, which
causes problems with loading and unloading, especially during peak hours of activity, where this problem can lead to a queue length [5] that burdens the existing road network around Tanjung Priok. This is made worse by the implementation of a policy that limits the operating time of heavy vehicles, thus further increasing the queue length and increasing the movement of empty trucks.

This research will describe how the pattern of export and import truck operations to the port seems to be very ineffective, as the current existing system does not allow a truck to send exported goods and collect imported goods at the same time [6].

2. Tanjung Priok port
Tanjung Priok port currently consists of several terminals serving the loading and unloading of goods to be sent to or from international or domestic destinations. The terminal at Tanjung Priok consists of an international terminal container or container served by the JICT and KOJA terminals, a domestic terminal container (DCT) or container terminal, the international multipurpose terminal (IMT), a domestic multipurpose terminal (DMT), a dry bulk terminal, a liquid bulk terminal, a car terminal, and passenger terminals.

![Terminal areas of Tanjung Priok port](image)

Data for Tanjung Priok from 2017 show that 60% of the movement of heavy vehicles to the port originated from the east, 30% from the south, and 10% from the west. The largest movement occurred in the toll road corridor in the city of DKI Jakarta. Changes in traffic volume will affect the average speed in the corridor. A circulation sketch and the percentage of vehicles heading to Tanjung Priok can be seen in figure 2 below.
The existing port consists of several terminals that allow the loading and unloading goods to be sent to or from international or domestic destinations. Data on the total movement of goods flow in Tanjung Priok port are shown in figure 3 below.

![Figure 3. Movement of goods at Tanjung Priok port. Source: PT. Pelabuhan Tanjung Priok.](image)

### 3. Study area (JICT and KOJA Terminals)

Export and import (international) activities at the port are served by the JICT and KOJA terminals, the purpose of which is to serve the loading and unloading of container ships and facilitate container inspection by customs officers.

#### 3.1. Jakarta International Container Terminal

At the beginning the JICT terminal was handling 1.8 million TEUs. This capacity has gradually increased to 2.1 million TEUs and has currently reached 2.4 million TEUs. Thus, JICT is the largest and busiest container terminal in Indonesia. Data on the facilities and equipment available at the JICT terminal are given in table 1 below.
Table 1. Data on facilities at Jakarta International Container Terminal.

| Description       | Terminal I  | Terminal II | Total   |
|-------------------|-------------|-------------|---------|
| **I. Berth**      |             |             |         |
| - Length          | 1640 m      | 510 m       | 2150 m  |
| - Width           | 26.5 - 34.9 m | 16 m       |         |
| - Draught         | 11 - 14 m   | 8.6 m       |         |
| **II. Container Yard** |         |             |         |
| - Area            | 40.00 Ha    | 9.24 Ha     | 49.24 Ha|
| - Capacity        | 35,399 TEUs | 5,894 TEUs  | 41,293 TEUs |
| - Ground Slot     |             |             |         |
| 1. Import         | 4,614 TEUs  | 960 TEUs    | 5,574 TEUs |
| 2. Export         | 4,317 TEUs  | 984 TEUs    | 5,301 TEUs |
| 3. Reefer         | - 220 V     | -           | -       |
|                   | - 380 V     | 260 Plug    | 328 Plug |

3.2. KOJA container terminal
KOJA container terminal is a joint venture management between PT (Persero) Pelabuhan Indonesia II (52.12%) and PT Ocean Terminal Petikemas (47.88%), and has been operating since 1999. Every day, the average export-import truck serving the KOJA TPK transports 1,200 units, and this can reach more than 1,600 units at peak times. Data related to the facilities and equipment available at KOJA terminal are shown in Table 2 below.

Table 2. Data on facilities at KOJA container terminal.

| Description       | Total |
|-------------------|-------|
| **I. Berth**      |       |
| - Length          | 650 m |
| - Width           | 40 m  |
| - Depth/LWS       | 14 m  |
| **II. Container Yard** |     |
| - Area            | 21.80 Ha |
| - Static capacity for CY import | 7,560 TEUs |
| - Static capacity for CY import | 7,696 TEUs |
| - Reefer plug     | 150 Plug |

4. Truck movement analysis at JICT and KOJA terminals
Container transfers at ports are divided into three types: transshipments, exports, and imports. In a container destination transshipment, a container is removed from a ship and is subsequently loaded onto the destination ship. For import purposes, containers originating from ships are moved to the dock using a quay crane (QC in figure 4). From the dock, the container is then taken to the container-stacking location with an internal truck (YT). Stacking onto container stockpiles is carried out with yard cranes (YC). The container from the yard is then taken to the gate with an internal truck, and the container is loaded into an external truck.
Container trucks are needed to transport containers to and from the terminal. The movement of a container truck starts and ends in the truck pool. The movement of a container truck for export purposes begins when the truck leaves the pool, heads to the depot to pick up an empty container, and then to the factory to fill the container; the filled container is then transported to the terminal (JICT or KOJA TPK), and finally the truck returns to the pool. The movement of a container truck for import purposes begins when the truck leaves the pool and heads to the terminal (JICT or KOJA TPK) to take a container holding imported goods; it then goes to the factory to unload the goods, brings the empty container to the depot, and finally returns to the pool.

From an analysis of the loading and unloading services at the JICT and KOJA TPK terminals, it can be seen that the average arrival rate of monthly trucks going to and from the JICT and KOJA TPK terminals are 3,994 trucks/day and 1,328 trucks/day, respectively.

The graph shows that for the JICT terminal, the number of import activities is higher than export activities. The maximum truck arrival rate in May 2013 for export activities was 3,042 trucks/day, with an average rate of 1,858 trucks/day. For import activities, the maximum rate of truck arrivals was 3,206 trucks/day, with an average rate of 2,136 trucks/day.

Another factor affecting the efficiency of truck movement to and from the terminal is the information and booking system. Truck entrepreneurs tend to wait for orders to arrive, due to the limited information available. The regulations on the movement of trucks outside the area also causes a build-up of trucks around the port area of Tj. Priok. The level of truck movement that exceeds one delivery for both export and import activities is shown in figure 6 below.
Figure 6. Truck movement patterns (single and dual trips).

From the figure above, it can be seen that trucks that only make transactions once per day are still dominant over those that carry out two delivery activities (single delivery trips make up about 93–96% of the total truck movement). This may be one of the factors causing the high logistical costs for container loading and unloading processes at the terminal.

5. Analysis of results
The proposed system will be able to provide information in real time to the user about each container, including information about the movement patterns of the trucks driving from and to the terminal.

Information will be provided in real time, and it is expected that the truck movement pattern will be made more effective and efficient (i.e. reducing the movement of empty trucks), since trucks entering for export activities will also be able to carry containers from import activities in the terminal.

The pattern of truck operations and activities at the terminal will be integrated with the information system, which will be developed on a web basis. Operation patterns that are considered in the development of information systems include the truck round time, shipping and data collection phases, the container ID, and the delivery phase.

The information system developed here can simplify paperwork and working permits. The port should provide a buffer zone in which trucks can park while waiting for work, and should manage the paperwork so that this system can operate effectively.

6. Conclusions
The rate of movement of trucks per day for JICT terminal at peak conditions is as follows: total movement due to dual trips is 305 trucks/day (+7% of the total) and the total movement due to single trips is 3,656 trucks/day (+93% of the total) with total truck movements at the terminal of 3,962 trucks/day.

The movement of trucks per day for KOJA TPK is as follows: average movement due to single trips is 1,479 trucks/day (+96% of the total) and average movement due to dual trips is 60 trucks/day (+3.6% of the total) with total truck movements at the terminal of 1,540 trucks/day.

The results of an analysis of the truck movement patterns to and from the terminal demonstrate the inefficiency of truck movements for export and import activities at the terminal, as there are large rates of single trip movements by trucks for export and import activities.

One solution to the problem of truck movements for export and import activities in the terminal is the development of an information and communication system to help allocate the distribution of truck movements moving to and from terminals (including file management and licensing).

This information system is expected to be able to adjust the pattern of truck movements, which can be controlled to give the optimum level of service in the terminal based on the ship dock schedule. A good distribution pattern can optimise truck movements and reduce the number of movements that are ineffective and inefficient.

It is necessary to provide a buffer zone/truck shelter so that trucks can wait and the drivers can complete the necessary documents for the next job.
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