International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 02 February 2024
DOI: 10.47191/ijcsrr/V7-i2-45, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

Improving Refuelling Flowtime at Fuel Terminal X PT AAA

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ABSTRACT: This research evaluates the performance of fuel distribution services by PT AAA at Terminal X, focusing on meeting the operational target of 14 hours per day. The average service level during the assessment period was 56%, revealing a significant operational gap of 44% exceeding the target due to delays in truck refueling attributed to long queues, administrative processes, and technical disruptions. By analyzing data with the SIOD application and employing the 5 Whys method for root cause analysis, delays in refueling trucks, exceeding contract targets by 20%, were identified. Reducing refueling time could save PT BBB, a stakeholder, IDR 574 million annually in overtime expenses and mitigate worker fatigue and incidents during late-night work. Practical recommendations include improving operational hours, efficiency, and safety by identifying constraints and defects to align with target operational time in contractual obligations between PT AAA and PT BBB.

KEYWORDS: Cycle Time, Fuel Distribution, Flowtime, Flow Process, Service Level.

1. INTRODUCTION

PT AAA was founded on 5th July 1996. The company strategically positions itself in the downstream sector, with a focus on logistics and fuel distribution throughout Indonesia. PT AAA operates as a key player in fuel distribution, responsible for delivering fuel products to petrol stations in specific regions. With 134 truck and 421 drivers, PT AAA facilitates distribution mainly from the BBM X terminal managed by PT BBB.

In Operations Management Handbook Volume 2(Pertamina,2016)[1], key terms are defined as follows:

- Fuel Terminal: A location owned by PT BBB for receiving, storing, and distributing fuel (BBM/BBK) using sea/river and pipeline transport, then distributing to consumers via land transport.
- Throughput: The amount of fuel dispensed from the fuel terminal to the receiving institution.
- MS2 (Gas Station Stock Management): A system for fuel sales applications, including a fuel delivery schedule plan based on gas station stock priority.
- SIOD (Distribution Operational Information System): A system storing and presenting data on tank trucks and drivers, scheduling fuel deliveries, and providing information on fuel transportation operation efficiency.

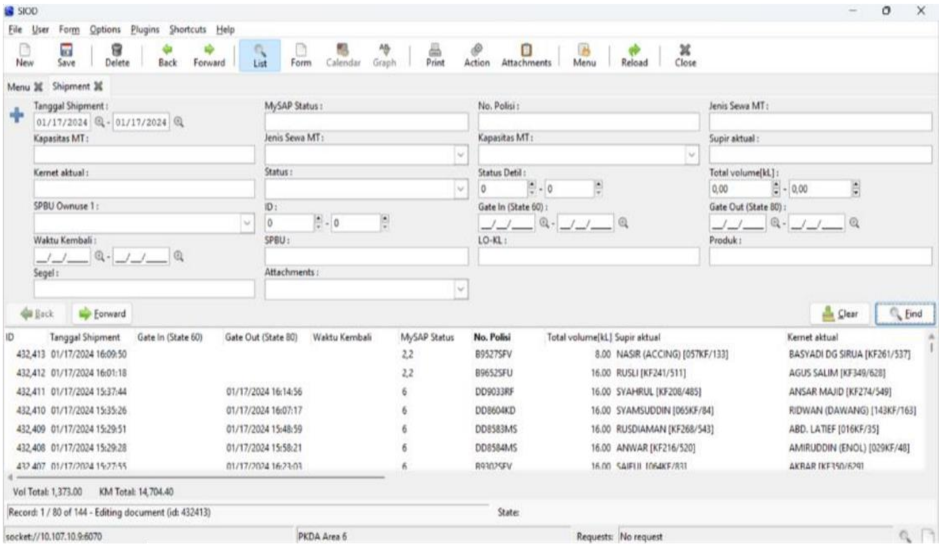

Figure 1. SIOD system interface

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- Fit to Work: This feature monitors the driver's condition before they begin driving the truck. Drivers undergo a check-up that includes screening for blood pressure, alcohol level, and concentration. These screenings aim to enhance drivers' occupational safety and health, ensuring safe operations, zero incidents, and excellent service.

PT AAA is tasked with preparing product deliveries based on petrol stations demand data. This task involves coordinating truck driver information and consolidating products according to the delivery schedule. For more information on the movement of trucks and drivers at Terminal X, please refer to Figure 1.

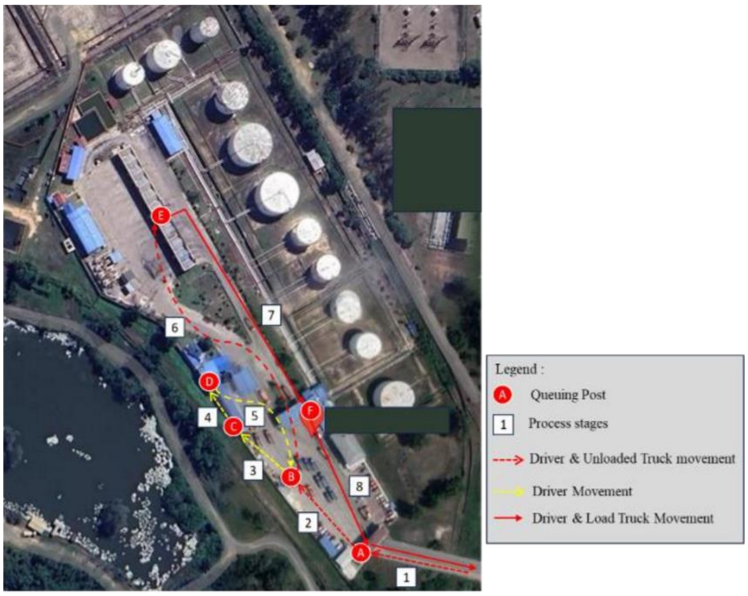

Figure 2. Flow of refuelling process in Fuel Terminal X

From Figure 2, The Queuing Post at Terminal X comprises several key areas:

A. Main Gate: Functions as the entry and exit point for drivers and trucks accessing PT BBB premises.
B. Main Park: Provides parking space for trucks awaiting service.
C. Health Check Room: Where medical personnel conduct health checks on drivers before authorizing them to work.
D. Automated Validation Machine (AVM): Where drivers obtain entry tickets before filling up at the fuel loader.
E. Filling Shed/Fuel Loader: Where fuel cargo is filled into trucks; Terminal X has 10 fuel loaders.
F. Gate Keeper: Location for checking the quality and quantity of products loaded onto trucks before departure

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Figure 3 is the process flow for the refuelling process at Fuel Terminal X.

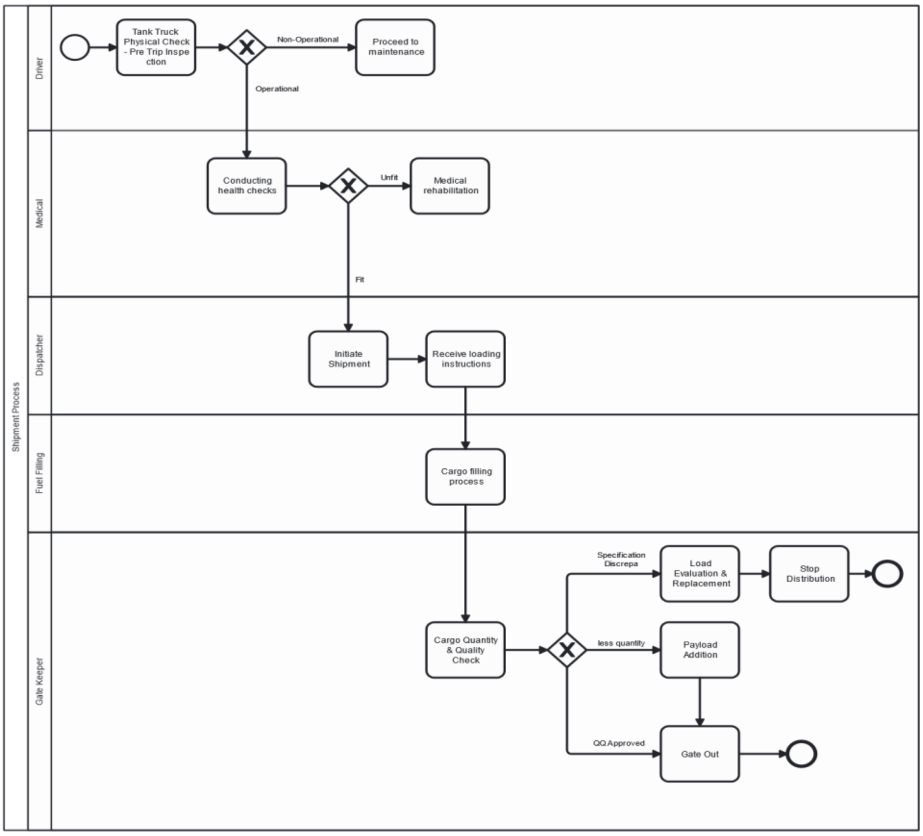

Figure 3. Standard operating procedure of the refuelling process at Terminal X

Figure 3 outlines the sequential processes adhering to Standard Operating Procedures (SOP) that truck drivers must follow at Terminal X:

- Upon completing delivery at the customer's location, the driver returns to Post A, the Main Gate of Terminal X.
- At Post B, the driver conducts a pre-trip inspection of the parked truck, assessing its physical condition with the fleet supervisor.
- The driver proceeds to Post C for a health check-up, ensuring they meet the required health criteria for work.
- The Dispatcher creates a Dispatch Plan based on the health check results and product to be delivered. Dispatch Scheduling allocates trucks and drivers, considering truck capacity, delivery route, and fuel volume. The driver collects an AVM entry ticket at Post D.
- Refueling at Post E is a scheduled process. Detailed instructions are provided beforehand regarding fuel quantity and collection location. Upon arrival, refueling is executed precisely to maximize fuel capacity.
- Post F verifies the quantity and quality of fuel filled, ensuring alignment with the order. Accurate data recording facilitates tracking and reporting for management and analysis.
- Permission to leave Post A is granted upon verifying fuel dispensation according to the order, allowing the driver to proceed with fuel delivery to the intended petrol station.

Operational time is the duration calculated for how long Fuel Terminal X operates to complete all truck and driver fillings in a day. Operational efficiency is a challenge, as demonstrated by the disparity between contractual and actual working hours, as illustrated in Figure 4.

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Figure 4. Comparison of actual operation time with contracted time.

An analysis of the distribution of operating hours reveals in figure 3 that based on data from January 2023 to June 2023. The contractual target of 14 hours of operation, with an average service level of 56%. Delays in the delivery process lead to blockages and inefficiencies, with risks such as worker fatigue and increased costs due to overtime payments. To address these challenges, the research aims to identify operational constraints, develop strategies to improve service levels and assess the practicality and sustainability of proposed solutions.

This study focuses on three main issues: finding and fixing defects that affect service levels, developing cost-effective strategies to raise service levels and implementing these solutions effectively. By improving uptime, the goal is to enhance PT AAA's performance, with potential benefits for similar organizations aiming for better operational efficiency. The study only looks at PT AAA's operational duration and doesn't consider factors like the number of tank trucks or available drivers per day, or other uncontrollable variables that could affect operational time.

2. LITERATURE REVIEW

Process Analysis

Categorising processes based on their design is an important way to understand the differences in their operation, particularly in relation to blocking, starvation, and bottleneck issues. A Buffer refers to a storage area between stage where the output of a stage is placed prior to being use in adownstream stage. Blocking occurs whe the activities in the stage must stop because there is no place to deposit the item just complete. Starving occurs whe the activites in a stage must stop because there is no work (Robert & Richard, 2018, p.270)[2].

Waste Analysis

Waste refers to any action within a process that doesn't add value, commonly known as "non-value-added activities." Waste or muda is anything that is wasteful and doesn’t add value, strive for total elimination. Muda adds unnecessary cost, quality problem, and lead-time to business process (Sutherland, J., & Bennett, B. (2007)[3].

Ohno (1988)[4] identified several categories of waste:

- Defects
- Overproduction
- Inventories
- Unnecessary processing
- Unnecessary movement of people
- Unnecessary transport of goods
- Waiting

Five Ways Analysis

Root cause analysis is the process of identifying and analyzing to uncover the underlying issue. It helps us understand what causes defects by pinpointing the main variables responsible for process variation. One useful tool for this is the Five Whys diagram. The aim of the Five Whys is to approach used to delve ever more deeply into causal realtionships (Anderson & Fagerhaug, 2006)[5].

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Business Process Modeling Notation (BPMN)

It was developed by the Business Process Management Initiative (BPMI) in May 2004 (A.White.2004)[6] . BPMN, which stands for Business Process Model and Notation, is a graphical modelling language for business process operations. A Business Process Model is essentially a network of graphical objects consisting of activities (i.e. jobs) and flow controls that define the order in which they are performed.

3. CONCEPTUAL FRAMEWORK

The study's conceptual framework will assess the current operational issue at PT AAA. The aim is to determine the total operating time needed to achieve the desired indicators, requiring further analysis of each shipment process. To analyze lead time, Lean Product Development (LPD) will be utilized. LPD is a system adaptable to any company and is categorized into Process, People, and Technology (Morgan & James, 2006, p.5)[7]. The conceptual framework illustrates the factors related to the problem as shown in Figure 5.

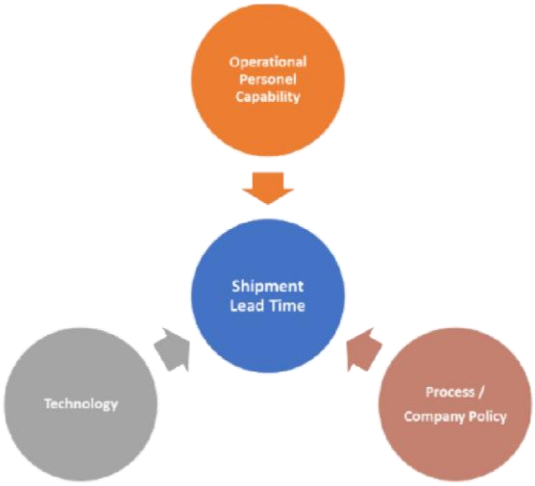

Figure 5. Determining factor of Shipment lead time

Process or Company Policy

The 'Efficiency Movement',which was dedicated to the removal of waste not only from production systems, but from other spheres of life, such as education & services (Koskela, 2012,P6)[8].

Operational Personel Capability

According to the 'PT Pertamina Operations Management Volume 2 Guidebook[1], it's important to monitor drivers' work schedules to match the company's fuel distribution rules. These rules ensure drivers' schedules follow legal requirements and fair labor practices.

Technology

At the Fuel Terminal's Filling Station, bottom loader are connected to trucks. The Fuel Terminal X comprises 10 charging sections, each designated for a different product. The product types of gasoline and gasoil vary across sections. The Filling Shed is equipped with tools, such as mass flow meters or flow meters, to measure the flow rate of fuel (Maulana,2017)[9].

4. RESEARCH METHODOLOGY

Research Design

This study investigates the impact of waste reduction on the operating time of the shipment process at PT. The analysis includes a redesign of the process flow to minimize waste and improve efficiency and performance. AAA. The research methodology is presented in Figure 6.

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Figure 6. Research Methodology

The methodology section of this report outlines several key stages: data collection and interpretation from internal sources at PT AAA, identification of significant factors using SIOD, and root cause analysis. Two types of data will be collected: qualitative and quantitative. Qualitative data will focus on the queuing process for drivers and the ergonomic layout, while quantitative data will be obtained from time records in SIOD. Historical data will be analysed to evaluate current performance. Simulation analysis will be used to determine the optimal solution, including the ideal number of trucks and improving uptime. The simulation will compare current and improved delivery approaches and reconfigured operator positions. Subsequently, an analysis using the 5-whys Diagram will identify improvement strategies, and suitable alternatives will be selected.

Data Collection Method

The historical data for this final project was gathered from PT AAA's SIOD (Distribution Operational Information System). Using Microsoft Excel, the data was consolidated to calculate cycle time figures for each process. Figure 7 provides a flowchart outlining the necessary stages.

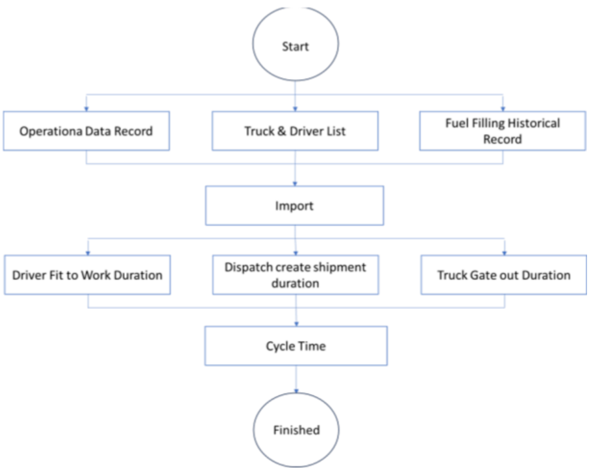

Figure 7. Research Methodology

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SIOD Data Extraction

The SIOD system provides data on fuel delivery activities, including delivery records, employee information, and truck operation legality. This thesis focuses solely on driver movement time data within the process flow to evaluate PT AAA's performance. The analysis uses shipment data from the past 6 months imported directly from the SIOD application. The recorded time only includes when the driver moves the shipment from one advanced stage to another. This time is used to calculate performance time, which determines the cycle time of each shipment.

SIOD Data Base Manipulation

Data collection within this system focuses on three primary areas. Firstly, drivers undergo attendance and health checks to confirm their physical condition before starting work. Secondly, the dispatch team monitors various stages in the shipment creation process. Finally, loading trucks before they leave the gate is a crucial aspect of the distribution chain.

5. RESULT & DISCUSSION

Contractual Operating Time

When queuing for filling process, each driver must follow the applicable Standard Operating Procedure (SOP). The general process of refuelling at the fuel terminal is shown in Figure 8.

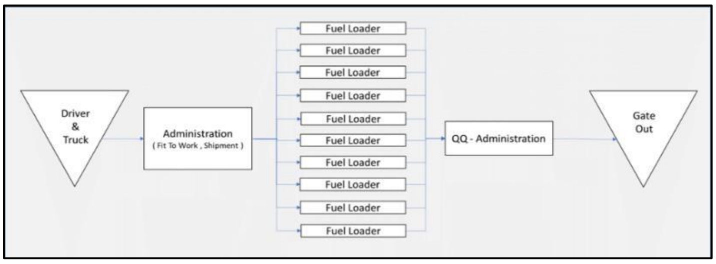

Figure 8. Flowtime Fuel loading stage process at Fuel Terminal X

Figure 8 illustrates the sequence of processes that drivers must follow to fill fuel at the fuel terminal, divided into four main groups:

- Administration before the filling process: This includes health checks or fit-to-work assessments, which take 5 minutes, and the shipment entry process, which takes 1 minute. Both processes must be completed within a maximum time limit of 10 minutes.
- Loading at Filling Shed/Fuel Loader: PT BBB owns the infrastructure of the fuel loader. During the fuel filling process into trucks, the pump operates at a standard filling speed of 900 litres per minute. It takes approximately 8.9 minutes to fill a load of 8 KL, 17.78 minutes for 16 KL, and 26.67 minutes for 24 KL. There are currently 10 active fuel loaders available for use.
- Quality – Quantity Administration: After the filling process, each truck must be checked within a maximum of 10 minutes. This includes quality and quantity checks before distribution to consumers.
- Gate Out: At this stage, the truck retrieves the necessary road documents and prepares to depart from the fuel terminal to deliver the goods to the specified destination.

The contract specifies that there are currently 90 trucks with a capacity of 16 KL and 36 trucks with a capacity of 24 KL available to meet the 14-hour operating target of 2946 KL/day. Table 1 provides details on the frequency of the number of trucks filling in the filling shed.

Table 1. Number of Fuel-Loading Trucks per Day

TOTAL THROUGHPUT	TRANSPORT ONNAGE STRENGTH	TRUCK CAPACITY	FREQUENCY OF FILLING PROCESS	TOTAL UNIT
2946 KL	1808 KL	16 KL	113 Times	90 Unit
	1152 KL	24 KL	48 Times	36 Unit

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The table shows that to transport 2946 KL/day, 90 tank trucks (each holding 16 KL) need to make 113 trips, and 36 trucks (each holding 24 KL) need to make 48 trips in a day. Among the 90 trucks with a 16 KL capacity, 23 will make two trips per day. According to the contract, the 36 trucks with a 24 KL capacity will handle a total of 161 daily trips, with 12 of them making two trips.

Based on the interview with the pump control officer, the pump's flow rate was set to 800 litres/minute (contracted in 900 Liter/Minutes). This resulted in theoretical increases in cycle times per compartment from 17.78 minutes for 16 KL filling to 20 minutes per cycle and to 30 minutes for 24 KL truck capacity. Field data supports this, showing that each 8000 L fill takes an average of 10 minutes in each fuel loader. The SIOD system comprises two sets of time data: fit-to-work time to shipment time, and shipment time to gate-out time data. In this study, we consider the time records for fit-to-work as constant and do not directly integrate them with the other dataset. Figure 7 illustrates the time scheme of the SIOD system.

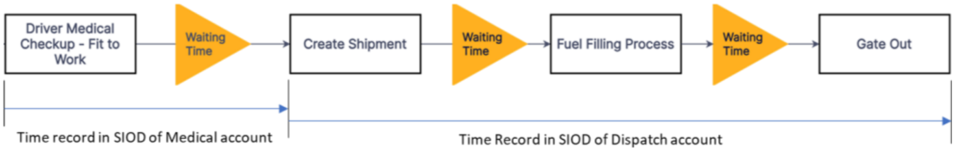

Figure 7. Time recording split in SIOD account

Table 2 demonstrates that the refueling process boasts the lengthiest cycle time compared to all other tank truck filling processes. This finding underscores that the fuel loading process serves as the bottleneck in the fuel filling queue. According to the contract, trucks with a 16 KL capacity require 34 minutes, while those with a 24 KL capacity necessitate 43 minutes from the fitting start to gate out or QQ Administration check.

Table 2. Average Cycle Time for all processes based on contract

PROCESS	CYCLE TIME
Fit to Work	5 Minutes
Creating Shipment	1 Minutes
Fuel Loading	17,78 Minutes @ 16 KL 26,67 Minutes @ 24 KL
QQ Administration	10 Minutes

Actual Operating Time

In June 2023, 4669 data points were collected randomly over a period of 13 days to track the process from shipment creation to gate out. The distribution of the fueling data is illustrated in Figure 8.

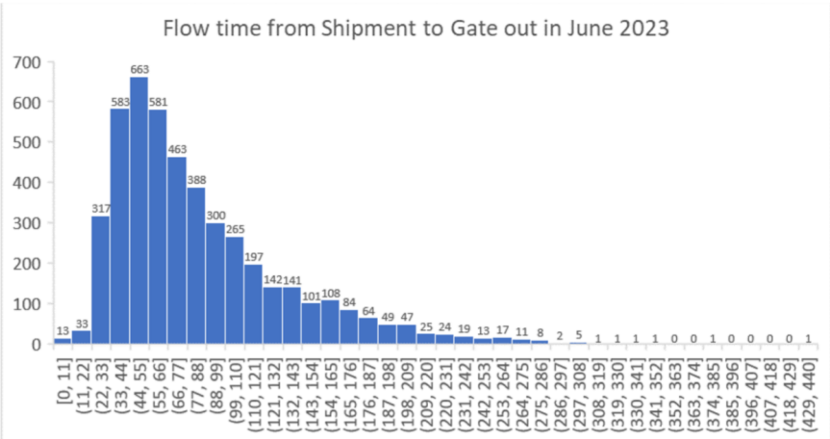

Figure 8. Histogram of flow time per truck from Shipment - Gate out in June 2023

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Based on the histogram data for June 2023, three categories emerge:

- The flowtime data distribution ranges from 0 to 33 minutes, with 363 data points, comprising 7% of the distribution, falling below the flowtime target. This suggests adjustments in the delivery process before refueling, potentially due to deviations from standard operating procedures (SOPs) or changes in plans within the SIOD system.
- Flowtime data spans between 33 and 44 minutes, with 536 data points, constituting 11% of the total data. These figures align with the target flowtime set by the contract for executing filling cycles of trucks with 16 KL and 24 KL capacities.
- Flowtime data extends from 44 to 440 minutes, with 82% of the data, or 3770 points, indicating slower-than-expected processes. The constant refueling cycle time suggests delays may stem from truck phases, where drivers do not promptly proceed to the next stage after shipment. Delays in truck entry to the refueling stage may result from long queues, administrative processes, technical disruptions, or operational issues at the terminal, significantly impacting refueling process efficiency.

Root cause Analysis

The 5 Whys analysis is a problem-solving technique that aims to uncover the root cause of an issue by iteratively asking 'Why' until the fundamental cause is exposed. High flow time represents an unfavorable state in operations, which can lead to delays in fuel supply to customers or the public. Figure 11 shows the 5 Whys analysis of the ongoing filling scenario at PT AAA, aiming to pinpoint the underlying cause of the problem.

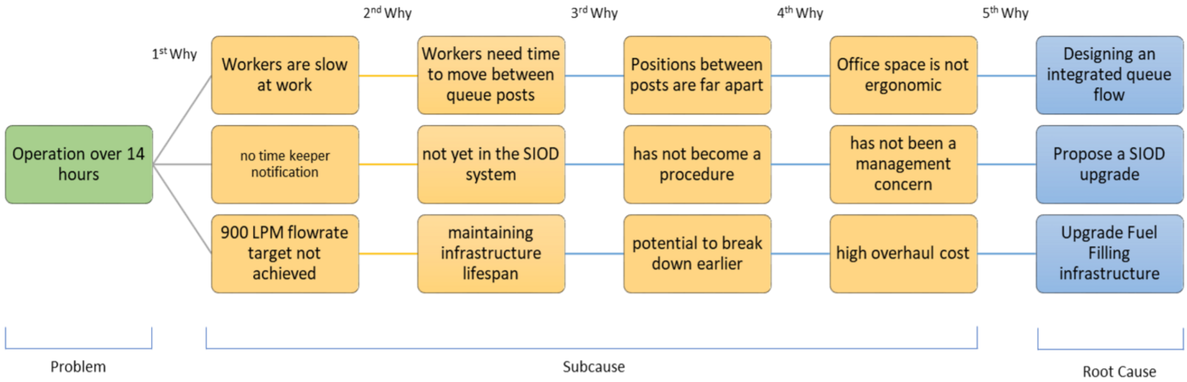

Figure 9. Root cause analysis in 5 ways

In this analysis, three main problems were identified:

a. Redesign the driver queue flow. The current layout of the queue is not user-friendly, causing drivers to take longer to complete tasks. This wastes time and can lead to more mistakes. It is more expensive due to overtime.

Company Impact :

- The estimated value of overtime is projected to rise to IDR 574 million annually based on operational data from June 2023, leading to increased costs for PT.BBB.
- Missed loading targets have negatively impacted the company's image with customers, leading to delayed order deliveries.

Employee Impact :

- Excessive overtime among operators heightens the risk of fatigue and consequently increases the likelihood of workplace incidents.
- Delayed processes at the fuel terminal may compel drivers to drive at night, elevating the risk of accidents.

b. Upgrade SIOD System. The current system only tracks when a truck enters and leaves the terminal, without alerting anyone if trucks or drivers take too long. At present, the SIOD application only records historical process times and lacks active control or notification features. It is crucial to maintain operational flowtime to ensure compliance with the applicable Standard Operating Procedures for all drivers and trucks. Any deviation from the target flowtime indicates a violation of the procedure by the driver or truck, which negatively impacts operations.

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c. Infrastructure Upgrade. To improve efficiency, we require a system that monitors loading times. Infrastructure Upgrade Required. The current equipment used for filling trucks is inefficiently slow. Improved machines are necessary to expedite the process. Currently, the process relies heavily on human input, which significantly slows down the process. Table 3. illustrates the impact of the current conventional fuel loader compared to the new technology fuel loader.

Table 3. Fuel Loader capability on 24 KL Truck

24 KL FILLING COMPARISON	CONVENTIONAL - CONTRACT	CONVENTIONALACTUAL	NGS
Number of Loaders (a)	10 Unit	10 Unit	4 Loader
Filling time (b)	27 Minutes	30 Minutes	11 Minutes
Cycle time (b/a)	2,7 Minutes	3 Minutes	2,7 Minutes
Operational Time (c)	825 Minutes	825 Minutes	825 Minutes
Loader Ability	305 Truck 30 truck /Loader	275 Truck 27 Truck/Loader	300 Truck 30 Truck 24 KL/Loader

New gantry System (NGS) or new technology on fuel loader is expected to speed up refuelling by 32-37% by cutting down on flowtime. When comparing the time it takes to fill trucks with a 24 KL capacity using NGS versus traditional methods, a slower pump flow rate results in less filling capacity. For instance, a 100 Lpm drop in flow rate can reduce the capacity by about three trucks per loader or around 30 trucks for 10 loaders. Switching to NGS requires only 4 loaders to match the filling speed of traditional methods, demonstrating that NGS is faster.

Alternative Business Solution

In the previous discussion, three main factors affecting operations were identified: people, processes, and technology. Solutions were sought by consulting stakeholders such as the fuel terminal, SIOD service provider, field staff, and drivers. These solutions were then rated on a scale from 0 to 10, taking into account their impact and ease of implementation.

Table 4. Business Solution Analysis on Fuel Terminal X Problem

	IMPACT		COMPLEXITY TO IMPLEMENT	
	DETAIL	SCORE	DETAIL	SCORE
Reorganise driver queue	Will reduce potential waste in driver movement during queues	5	Acquiring a portacamp as an integrated queuing infrastructure necessitates drivers to adapt to the new queue system within it.	4
Fuel Loader Infrastructure development	- The filling flowtime will be reduced by 37%. - Accommodate operational increase in throughput for the long term.	7	Negotiation between PT AAA and PT BBB is necessary for the construction of NGS, which takes about eight months and cost to build the infrastructure IDR 90 billion from PT BBB.	9

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Upgrade SIOD System	- Facilitate operational supervision to ensure timely completion.	6	Upgrading SIOD features demands inter-functional coordination, with a oneweek development period necessary before testing any additional features.	3

Table 4 compares the impact and implementation complexity of the three solutions. For a visual representation of each solution's position, please see Figure 10.

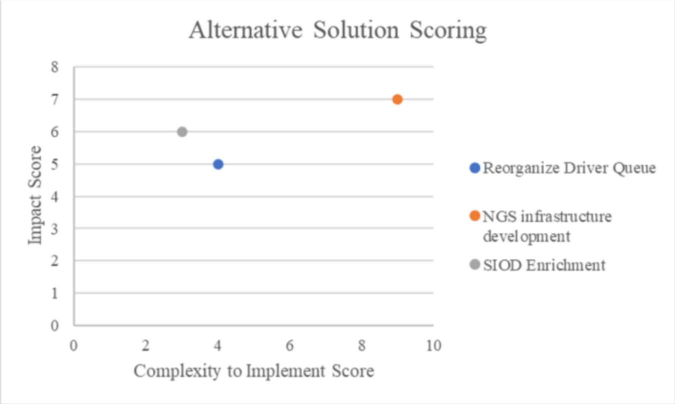

Figure 10. Business solution Assessment

Berdasarkan hasil assessment dari ke 3 solusi yang tersedia, dipilih lah 2 solusi berdasarkan perbandingan Impcat score & Complexity to implement score yaitu Recognise driver queue & SIOD Upgrading system. The construction of the NGS has the greatest impact on reducing cycle time, although it requires considerable effort. The construction process requires approval from the CEO to build the necessary infrastructure, which can make implementation very complex.

The first option is to improve SIOD to better organize drivers in the field, ensuring flowtime and operational targets are met. This solution is considered the best because it significantly reduces processing time and is easy to implement. It involves adding a timing feature to notify drivers when they exceed the set refueling time, with notifications placed at key points. The timekeeping features that will be available later in SIOD System :

a. Fit to work time - driver health check
b. Shipment input time in the SIOD system
c. Gate out truck time.
d. Notification that the driver has performed the pre-trip procedure.
e. Driver notification has been logged in to queue to the charging location
f. Driver notification has finished charging and heading to the gate keeper

The second solution is to introduce portacamps to reorganize the current queue design for drivers and trucks, aiming to improve driver movement efficiency during refueling. The portacamp consolidates the verification posts for Pre-trip Inspection for trucks (B), Health Check Post for drivers (C), and Automatic Validation Machine or AVM Post (D) into one location. Figure 11 illustrates the flow of this new refuelling process.

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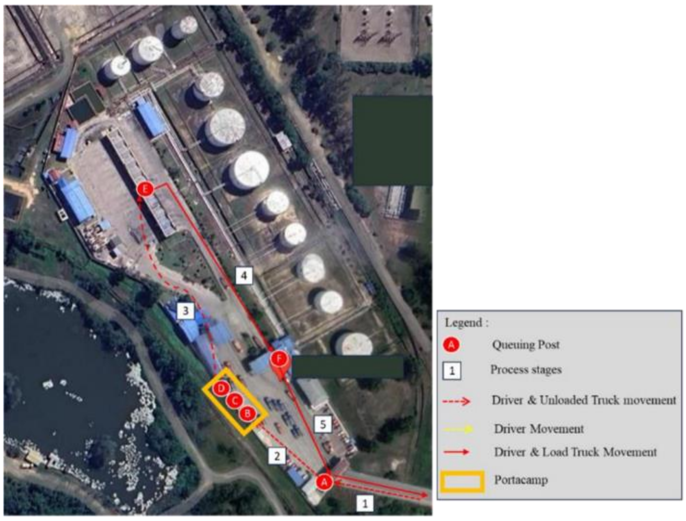

Figure 11. New flow for refueling process in Fuel Terminal X.

Using portacamps to combine BCD posts will cut down driver movement steps from seven to five. This change can improve driver queues, shorten waiting times, and speed up refueling.

Based on best practices in the filling process, the bottleneck occurs during fuel loading, resulting in a 12% delay or 4-minute delay from the target time set in the contract, which is attributed to outdated equipment. To achieve the desired flowtime target, it is necessary to regulate human movement. For more information on reducing flowtime during the loading process, refer to Table 5.

Table 5 The expected flowtime of refueling process after implementing the business solution alternative.

TRUCK CAPACITY	FLOWTIME REALISATION	EXPECTED FLOWTIME
16 KL	44 Minute	36 Minutes
24 KL	55 Minute	46 Minutes

6. CONCLUSION & RECOMENDATION

After analysing the current business situation and root causes, the following conclusions have been drawn to achieve the optimal flowtime target and address existing business issues:

- It is crucial to enrich SIOD to maintain flowtime during the filling process. Upgrading it to provide cycle time notifications to the timekeeper will help monitor driver movement between posts effectively.
- Implementing portacamps to streamline driver movement is also recommended. Centralizing all administrative queue posts, including Tank Truck Pre-trip Inspection, Driver Health - Fit to Work, and Start Shipment, is expected to have a significant impact on driver movements between posts, making them more efficient.
- This will reduce flow time in the filling process, resulting in decreased operating hours at the fuel terminal and lower costs for PT BBB. Overtime expenses for operators will also be reduced, ultimately improving operational efficiency.
- Shortening the flow time of the filling process can also reduce drivers' working hours. Lengthy periods away from the fuel terminal increase the likelihood of drivers working or driving at night, raising fatigue risks on the job.

The change process will start with top management at PT AAA and progress through socialization, SOP approval, procurement requests, and field implementation. Short-term efforts will involve meetings to design new SIOD features and propose portacamp procurement. Coordination with departments like fleet-transportation, HSSE, IT, and procurement will be key. The goal is to familiarize drivers with the changes and reduce flowtime.

Recommendation for Futere Research

Here are some recommendations for future research:

- Study the long-term impact of the proposed solutions on reducing flow time and improving operational efficiency. This could involve tracking their implementation and outcomes over time.
- Compare different queuing infrastructure solutions, such as portacamps versus traditional queues, to determine which is more cost-effective and beneficial in different situations.
- Examine the impact of organisational culture and employee involvement on the implementation of improvements and new technologies in refuelling. This may require gathering feedback from employees to gain insight into their perspectives on these changes.

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Cite this Article: S. Isroq, M. H. Basri (2024). Improving Refuelling Flowtime at Fuel Terminal X PT AAA. International Journal of Current Science Research and Review, 7(2), 1262-1274