Key Performance Indicators Analysis for Quay Container Crane Performance Assessment (Case Study at Jakarta International Container Terminal)

PT Jakarta International Container Terminal (JICT) is the largest container port in Indonesia. Currently, JICT capacity is 2.5 million TEUs (Twenty-foot Equivalent Units) per year, it continues to strive to improve international services and is supported by adequate container loading and unloading equipment. The requirement to establish common standards in different types of container port equipment and identify performance indicators to assess the performance of container handling equipment has increased. Although the Quay Container Crane (QCC) operating system may be different at each container terminal, there are similarities in its main movements, namely: Main Hoist, Trolley, Gantry, and Boom. By knowing the clock metric for each movement, it is possible to determine the Key Performance Indicator (KPI) that has been adopted and assess the performance of the Quay Container Crane (QCC). The results of the study identified that the value of MMBF (Mean Move Between Failures) decreased due to the accumulation of long-lasting heavy load operations, while the number of maintenance activities for machine parts and working hours continued to increase. Key Performance Indicator (KPI) as a management tool can guide QCC inspections and the results can provide useful insights for improving the performance of equipment and container loading and unloading operations in the future.

Keywords: Key Performance Indicators, MMBF, MMTR, QCC, PT JICT

1. INTRODUCTION

International trade by sea route, contributes more than 80% of the total cargo volume in world trade [2]. Terminal customers are many and very different, but the requirements they all require are very basic: the frequency of service and the regularity to transport their loads quickly, economically and with minimum risk of damage and loss. Indonesia is a maritime country with the largest sea area in the world. However, with a total of more than 17,000 islands spread throughout the archipelago, the maritime sector currently only contributes 7.86% to the national economy [22]. Shipping containers, as a productive sector, must be competitive and respond to customer needs effectively [3]. In the container terminal operating system, gantry crane is not only the most expensive and importantly handling machinery, but also a major bottleneck restricting the working efficiency of the entire marina. All container terminals hope quay cranes can conduct operations at best efficiency [17].

Container terminal is a port zone that contains loading and unloading activities of containers both export and import, then the container is stored in a buffer area called yard. Logistics is the management of the flow of goods movement from a point of origin that ends at the point of consumption to meet certain demands, for example directed to consumers or companies [10]. Container terminal pay more attention to improving the operational efficiency of container cranes [4]. In the container terminal operating system, gantry cranes are not only the most expensive and important part of the cargo handling machine but also the main obstacles that limit the working efficiency of the entire marina. All container terminals hope quay cranes can perform operations with the best efficiency. The presence of industries in hinterland region encourages the creations of dry port concept that has functions like a seaport in general, and support to export, import and distribution of goods also

Corresponding Author: jictmufti@gmail.com
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Port performance is critical to supporting the economy, which plays an important role in the logistics supply chain. Port efficiency needs to be analyzed and studied to improve the competitiveness of ports and terminals in the country and region. The competitiveness of container ports is characterized by different success factors, especially the time of serving a vessel at the port. Port performance is no standard yet, and inefficient land transportation and cargo imbalance [14]. Therefore, to improve the performance of the port that has not been standardized, the government focuses on improving services to the port as one of the improvements in the port Initiative.

In Indonesia, there are many ports both long and newly built to contribute the best as supporting domestic and international trade activities. The port that has been built for a long time one of them is the port of Tanjung Priok which is also the main gate Indonesia in conducting international trade and is the largest and busiest port in Indonesia. One of the loading and unloading terminal companies is PT Jakarta International Container Terminal (JICT)[18]. PT JICT is an affiliate of the company established in 1999 with a partnership between Hutchison Port Holding Group (HPH Group) and PT Pelabuhan Indonesia II (Persero). In the last four years PT JICT continues to be awarded as the best container terminal in Asia in terminal capacity below four million TEUS. To support container loading and unloading services, PT JICT has reliable and adequate equipment facilities: QCC 14 units, RTGC 60 units, Head Truck 115 units, Reach Stackers 4 units & Side Loader 6 units.

One of this equipment is Quay Container Crane (QCC), a very vital loading and unloading equipment used in a container terminal. QCC has now been developed with technology to ensure durability and reliability under any conditions, but this equipment will inevitably lead to conditions where the number of breakdowns gradually increases over time from heavy loads that are always repeated with high-speed operation.

Quay Container Crane continues to be developed by handling high loads, with high speed, and safety through the development of technology to accommodate the needs of shipping companies as the volume of offshore transportation through containers has increased [1]. Quay Container Crane (QCC) have been developed with technology to ensure reliability of durability in these conditions, but this equipment will inevitably lead to situations where the number of failures gradually increases over time under harsh conditions of heavy operation and high speed. Comparing the number of failures in the early stages of equipment introduction with the number of failures after a few years is the fact that repetitive tasks will inevitably lead to increased failure rates when fatigue builds internal structures and components, which can lead to fatigue failure. Efforts to identify the frequency of failures and their patterns for standard indicators have been tried continuously. The specifications of QCC vary by terminal and company because when the initial specification of the crane is set in the container terminal, details such as size for the handling and operation of twin lifts, tandem lift operations, etc., may vary [19]. QCC to be used are determined by the container terminal according to their needs.

It is difficult to measure the performance of cranes with different QCC specifications in each of these container terminals, but there is something similar emerging: even if each crane movement has different characteristics and specifications, the four main movements match any country in the world and the container terminal. These four main movements are hoist, trolley, gantry and boom, each of which has a counter lock meter installed for each movement, and individual usage time detection can be used to determine and calculate the crane performance index.

Key performance indicators offer management tools to guide future inspections of ship container cranes to shore and the results provide useful insights for future improvement of container crane equipment. As a result of research and efforts on how much preventive maintenance time can be quantitatively calculated in the event of breakdown by detecting pure crane behavior and number of failures, performance indicators have been defined and assessed for 14 QCC at PT JICT from January to December 2020.

**Introduction to QCC (Quay Container Crane) and Performance Indicators**

a. **Quay Container Crane**

Quay Container Crane (QCC) or Ship to Shore (STS) crane is equipment used for unloading or loading containers. The main function of this crane is as the name implies, to lift the container from and to the container ship. But in some conditions, it can also be used to lift objects or other items. In addition, this crane can also move goods or containers from one place to another because quay container crane stands on an elongated rail so that it can be moved following the track from the rail. It is operated through a cabin that hangs on the trolley. The operator enters the cab and turns on the crane, then begins the operation of the crane to move the container.
It can be categorized based on the shape of the crane itself, divided into Smaller size, Panamax, Post Panamax and Super Post Panamax types.

![Quay Container Crane](image)

**Figure 1. Quay Container Crane**

As seen in Figure 1, all QCC structures generally consist of booms, girders, legs, top legs, top beams, diaphragms, tension bars, and mechanical units are gantry devices that move the entire crane left or right, trolley devices that drive trolleys to booms and girders, hoist devices that move spreaders and containers vertically, and as additional devices there may be anti-snag load devices and wire rope catenary support systems.

<table>
<thead>
<tr>
<th>QCC No.</th>
<th>MANUFACTURE</th>
<th>SAFE WORK LOAD (TON)</th>
<th>POSITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SPREADER</td>
<td>HOOK</td>
</tr>
<tr>
<td>03B</td>
<td>GUNA NUSA</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>04</td>
<td>NOELL</td>
<td>40</td>
<td>45</td>
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<tr>
<td>05</td>
<td>NOELL</td>
<td>40</td>
<td>45</td>
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<tr>
<td>06</td>
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<td>40</td>
<td>45</td>
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<tr>
<td>07</td>
<td>GUNA NUSA</td>
<td>35</td>
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<tr>
<td>09</td>
<td>DOOSAN</td>
<td>41</td>
<td>51</td>
</tr>
<tr>
<td>11</td>
<td>BARATA-NOELL</td>
<td>45</td>
<td>55</td>
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<td>12</td>
<td>BARATA-NOELL</td>
<td>45</td>
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<tr>
<td>13</td>
<td>DOOSAN</td>
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<td>61</td>
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<td>14</td>
<td>DOOSAN</td>
<td>51</td>
<td>61</td>
</tr>
<tr>
<td>15</td>
<td>ZPMC</td>
<td>61</td>
<td>71</td>
</tr>
<tr>
<td>16</td>
<td>ZPMC</td>
<td>61</td>
<td>71</td>
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<tr>
<td>17</td>
<td>DOOSAN</td>
<td>61</td>
<td>71</td>
</tr>
<tr>
<td>18</td>
<td>DOOSAN</td>
<td>61</td>
<td>71</td>
</tr>
</tbody>
</table>

**b. Crane Performance Indicators**

All performance indicators should be related to the company’s business objectives remotely. If the company indicator highlights weaknesses, then the next lower-level indicator should provide further definition and clarification for the cause of the weakness. When the level of functional performance indicators reached, the problem function should be highlighted. Then it will be up to manager responsible for taking action to correct the condition of the problem. When the problem is fixed, indicators, monitored and recorded correctly, will result in an increase at a higher rate.
This Crane Performance Indicator is based on hours meter or counter lock per every crane detail movement. When we apply all its maintenance times and hours meters to the crane for specified performance indicators, we only apply the time at the time when the equipment is turned off for preventive and corrective maintenance. This means that although some workers perform different types of maintenance (electrical, mechanical, or outside maintenance processes) in certain parts, we can only detect and apply absolute values for a certain time even though they perform different types of maintenance tasks at the same time. Crane performance indicators that have been applied in the operation of container terminals are as follows:

A. **Netto Operation Time**
   \[ T_{no} = \text{Main Hoist Time} + \text{Trolley Time} - \text{Main Hoist/Trolley Overlapping Time} \]

B. **Theoretical Handling Capacity**
   \[ \text{Container / Hours} = 60 / \text{Net Cycle Time} \]

C. **Net Cycle Time**
   \[ \text{minutes / container} = \left( \frac{\text{Netto Operation Time} \times 60}{\text{TLC}} \right) \]

D. **Total Downtime**
   \[ \text{Total Downtime} \% = \text{PM} \% + \text{EM} \% \]

E. **Emergency Maintenance**
   \[ \text{EM} \% = \left( \frac{\text{EM Time (Tem)}}{\text{Machine Time (Tmc)}} \right) \times 100 \% \]

F. **Preventive Maintenance**
   \[ \text{PM} \% = \left( \frac{\text{PM Time (Tpm)}}{\text{Machine Time (Tmc)}} \right) \times 100 \% \]

G. **Broken Percentage**
   \[ \text{BKDN} \% = \left( \frac{\text{Downtime (Tem)}}{\text{Occupied Time (Toc)}} \right) \times 100 \% \]

H. **Availability & Occupied Time**
   \[ \frac{\text{A}}{\text{Toc}} = \left( \frac{\text{Occupied Time (Toc) – Downtime (Tem)}}{\text{Occupied Time (Toc)}} \right) \]

I. **Inherent Availability**
   \[ \text{Ai} = \left( \frac{\text{Machine Time (Tmc) – Down Time (Tem) – PM Time (Tpm)}}{\text{Machine Time (Tmc)}} \right) \]

J. **Utilization**
   \[ \text{U} \% = \frac{\text{Netto Operation Time} \times \text{Ai}}{\text{Machine Time (Tmc)}} \]

K. **Mean Time To Repair**
   \[ \text{MTTR} = \frac{\text{Down Time (Tem)}}{\text{Breakdown Freq. (Fem)}} \]

L. **Mean Move Between Failure**
   \[ \text{MMBF} = \frac{\text{TLC}}{\text{Breakdown Freq. (Fem)}} \]

M. **Twist-lock Counter**
   \[ \text{TLC} = \text{Twist lock count (lock + hoisting-lowering + unlock)} \]

N. **Total machine time**
   \[ \text{Tmc} = (24\text{-hour / day for 24-hour terminal operations}) \]

**MMBF and MTTR** are representative and most widely used for container terminals. General actions on the maintenance of equipment managed from a point of view such as how often to perform maintenance and maintenance costs. First, as a maintenance frequency element, MMBF and MTTR are defined in this paper and can be applied. Due to reliability and ease of maintenance, the number of container handling includes failure, called MMBF, which is a reliability factor, and is the basis for determining the frequency of failures. Maintenance is related to minimizing preventive maintenance as well as corrective maintenance, intended to improve the reliability of equipment. However, too much money is spent on such maintenance so that it can exceed the equipment department's budget. Therefore, maintenance must maintain the right balance between maintenance costs when failure and preventive maintenance.

**Mean Time To Repair (MTTR)** is the average time required between unit failure, the basis for determining parts needs, and in some cases, maintenance can be performed without replacement parts, but most maintenance cases require multiple parts replacement. The equipment department at the container terminal should prepare this to maximize the average replacement cycle of parts by anticipating and regulating the life of the parts. Second, as a component of maintenance costs, the maintenance costs of a system or part of equipment
account for a significant portion of R&M costs. Maintenance costs should minimize technicians’ need for proper maintenance and use, replacement and failure of parts during their lifetime.

The maintenance size of the container terminal equipment is a quantitative measure of the re-adjustment of equipment operations in the container terminal, which indicates whether the equipment can be restored to normal condition within the time specified by the preventive maintenance level in case of system or equipment failure. Maintenance measurements are not only closely related to the design of the equipment itself, but to the level of technical skill acquisition by technicians and the availability of spare parts. The meaning of quantitative size of crane equipment maintenance container terminal by considering the characteristics of port equipment and can be stated as follows:

1) To Realize efficient and effective maintenance
2) To Realize maintenance with better quality
3) To provide maintenance within the scheduled time.
4) To Provide maintenance costs and added value of labor.
5) To realize maintenance, the priority is safety.

In this stage, to facilitate the series of maintenance tasks, it is important to have adequate maintenance personnel. Maintenance personnel must have a certain level of technical skills and at least three to five years of work experience in the same field to perform the necessary maintenance, and securing maintenance personnel with technical skills is considered an important factor in improving the maintenance efficiency and productivity of container terminals. Working hours are factors that have a lot to do with MMBF and MTTR. Delaying timely preventive maintenance with increased handling volume will result in decreased MMBF and increased MTTR.

c. Key Performance Indicators

KPIs are defined as strategic and measurable measurements that reflect critical business success factors [19]. Many companies work with the wrong steps, many of which are incorrectly called key performance indicators (KPIs). Very few organizations actually monitor their actual KPIs [9]. The reason is that very few organizations, business leaders, writers, accountants, and consultants are delving into what KPIs really are. There are three types of performance actions:

1. The main yield indicator (KRI) tells you how you have performed in perspective.
2. Performance indicators (PI) tell you what to do.
3. KPIs tell you what to do to dramatically improve performance.

Many of the performance measures used by organizations are an inappropriate mix of these three types. What are KPIs? KPIs represent a set of measures that focus on aspects of the organization that is most important to and the success of the organization in the future.

Key performance indicators are used by container terminals to assess the performance of their terminals and can help maintain a consistent quality of equipment work. KPIs and how they will be rated vary from terminal to terminal, and there is still much debate about this method, and if this assessment is an accurate reflection of the performance of a container terminal.

<table>
<thead>
<tr>
<th>KPI’s Quay Container Crane</th>
<th>YEARS</th>
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<tbody>
<tr>
<td>Availability (100%)</td>
<td>96%</td>
</tr>
<tr>
<td>MMBF (move/TLC)</td>
<td>1500</td>
</tr>
<tr>
<td>MMTR (Minutes)</td>
<td>35</td>
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</table>

d. Mean Move Between Failures (MMBF)
One of the changes that occurred in equipment maintenance management is the change of evaluation parameters to reflect the achievement of economic activities. PT JICT management tends to measure the performance of equipment related to operations. Due to this purpose, PT JICT management uses measurements for QCC with The Mean Movements Between Failures (MMBF) and Mean Time to Repair (MTTR) methods. MMBF is defined as the number of containers that can be moved or handled between two failures or defects. MMBF pays more attention to production rather than timescales. Production is expressed by the number of containers that can be moved by the equipment. MMBF can also be defined as twistlock count (TLC).

If this is interpreted, the crane corresponding to the denominator must be marked with one physical failure, when the operation of the crane ceases due to partial damage to the crane itself and its required maintenance. Operational conditions using Twistlock (TLC) that correspond to the numerator are three steps that must be met. The first step is the trolley operation forward or backward, the second step is the hoist or lower operation, and the third step is lock or unlock twistlock. MMBF is a numerical representation of how many containers a crane handles during loading and unloading operations. If the TLC count between 2 breakdowns is 1500, then the result of the value of MMBF can be calculated as follows:

$$\text{MMBF} = \frac{\text{TLC}}{\text{Breakdown Freq. (Fem)}}$$

$$= \frac{1500}{2} = 750 \text{ VAN/Fem}$$  \hspace{1cm} (1)

The resulting value of MMBF is 750. This is just one number, but this metric has significance for the equipment department. It shows how much time and resources the equipment department has invested in preventive maintenance so that sustainable work can be carried out without failure under extreme conditions of climate change and heavy load operations in the long run.

e. Mean Time To Repair (MTTR)

MTTR is defined as the average time required by maintenance staff to deal with any failure or malfunction. With such type of parameters PT JICT Management expects equipment productivity can be measured as closely as possible to the actual condition. MTTR can also be defined as the total time for emergency maintenance divided by maintenance at the time of failure (breakdown). If this is interpreted, the crane corresponding to the denominator is characterized by one breakdown when its operation is stopped due to component damage to the crane itself and maintenance is required. The total time for emergency maintenance, which is associated with the numerator, is defined as the time from the time the crane was stopped during operation until the time the crane was reattached to start work as soon as the repairs were completed. MTTR can be expressed numerically.

$$\text{MTTR} = \frac{\text{Down Time (Tem)}}{\text{Breakdown Freq (Fem)}}$$

$$= \frac{0.25+1.00}{2} = 0.625 \text{ hr/Fem}$$  \hspace{1cm} (2)

This figure shows how quickly maintenance per unit during operation occurs and detects the time before the crane resumes operation. Efforts to reduce this figure require workers who have the skills, skills, and understanding the characteristics of the equipment on the crane. Although diagnosing mechanical part failure is quick by visually examining parts and observing their symptoms, for failures that occur in electrical and control systems it may be necessary to find the failed part among a number of hidden or undetected items, so they need to learn how to use and read the Crane Monitoring System (CMS) installed on each crane and to understand the various interlocks in the crane.

Therefore, this research aims to develop and analyze applicable Key Performance Indicators (KPIs), as well as their use to assess the performance of Quay Container Crane (QCC) in container terminal operations. As a result of research and efforts on how much preventive maintenance, time can be calculated quantitatively in the event of a breakdown or failure by detecting crane operation and the number of failures or breakdowns purely. Performance indicators have been set and rated for 14 quay container crane (QCC) units at JICT from 2018 to 2020. Key Performance Indicator (KPI) as a management tool to be a guide in terms of QCC inspection and the results can provide useful insights for improved equipment performance and container loading and unloading operations in the future.

2. RESEARCH METHODS

This type of research is a case study in which research is conducted on KPI Analysis as a QCC Performance Assessment based on data collection and relevant efforts that should be created to fix the problem. The research site was conducted in PT JICT equipment department. The purpose of this research phase is to formulate the steps that will be taken in implementation of this case study. These steps include data collection,
troubleshooting analysis, and implementation/improvement efforts [20].

PDCA is a useful tool for continuous improvement without stopping. [21]

a) **P (Plan)**
The purpose of this study is to develop the key performance indicators for Quay Container Crane performance assessment.
- Reviewing all the factors that have an impact on actual Quay Container Crane performance ranging from the four main movements: Hoist, Trolley, Gantry and Boom and the hour metrics for each movement.
- Improvement on the key performance indicators for Quay Container Crane through the stages of Analysis of all implemented that already exist in the container terminal operations.

b) **D (Do)**
Perform activities that have been made at the Plan stage effectively and efficiently to increase the potential for success and minimize the deviation between the plan & actual implementation.
- Conduct QCC performance assessments using KPIs and reviews with all relevant stakeholders.
- An actual review of the data for the current performance assessment at PT JICT and compare with the key performance indicators.

c) **C (Check)**
Evaluating the implementation of the plan to achieve research objectives and stages implementation of recommendations and reviewing recommendations.

d) **A (Action)**
The existence of the results of the review together with the relevant stakeholder, if there are still found irregularities in the performance assessment of Quay Container Crane or implementation of this improvement has another impact on the operation process that will be followed up again.

Research related to KPIs to Assess the Performance of Quay Container Crane in container terminals has been conducted by researchers. This type of research uses descriptive methods. So, this study emphasize fact gathering and identification data. Components in this research method is to discriminate, analyze and interpret findings in clear and precise terms. Subjects and Objects Quay Container Crane Performance Assessment Research using Mean Move Between Failures (MMBF) and Mean Time to Repair (MTTR) calculation methods. The data is MMBF and MTTR data, between January and December 2020 already recorded in the databased. Research Analysis Method, Data analysis will be conducted to answer the problem in research.

3. RESULTS AND DISCUSSION

A. **Availability Assessment**
Availability measurement used in QCC performance assessment is Inherent Availability. Inherent availability is stable company availability when considering only system downtime. This is defined as the expected availability level for corrective maintenance performance only. Inherent availability is determined purely with equipment design. This assumes that parts and labor are 100 percent available without delay. This does not include logistics time, waiting or administrative times, and preventive maintenance downtime. This includes corrective maintenance downtime. Inherent availability generally comes from engineering design analysis. Inherently meets the need to distinguish expected performance between shutdowns. In table 3 of Inherent Availability measurement results identify that the average availability from January - December 2020 is 98.45%, this figure is still above the company’s KPI target of 97%.

B. **MMBF and MTTR Measurement**
Data was collected from 14 QCC units of PT JICT from January 2020 to December 2020. The company’s KPI target for MMBF is 1550 (move/box), and MTTR is 25 minutes. Table 3 identifies the results of MMBF and MTTR, which are the highest performance assessments in January 2020. This is already above the KPI target set by the company. And this can also be interpreted that when MMBF is high means the volume of service is increasing. This shows good results for MMBF if the TLC corresponds to the numerator being higher even if the frequency of breakdown corresponds to the higher denominator. However, it is not the same as high value MTTR. The increase also has advantages, but it also has a disadvantage among performance indicators, as the frequency of time for repair increases and resulting in a decrease in the overall Availability value (Ai).
indicates that equipment maintenance should be improved again due to the many equipment breakdowns during operation.

Figures 3 and 4 show MMBF is increasing in January 2020 due to increased handling volume. Although there has been an increase in volume since January 2020, it appears that MTTR during the maintenance period has increased due to EM, then MMBF and MTTR decreased simultaneously in October 2020 due to a slight decrease in volume. This means the lifetime crane causes problems gradually through the entire fatigue component accumulating in some parts of the crane.

Table 3. Performance Indicator QCC

<table>
<thead>
<tr>
<th>Indicator</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jan</td>
</tr>
<tr>
<td>Availability (100%)</td>
<td>98.3</td>
</tr>
<tr>
<td>MMBF (Move/TLC)</td>
<td>22.8</td>
</tr>
<tr>
<td>MTTR (Minutes)</td>
<td>2451.0</td>
</tr>
</tbody>
</table>

Figure 2. Inherent Availability
Based on the above results and discussions there are similarities with previous research [5] that performance assessment using KPIs in container terminals can be applied with four main movements. MMBF and MTTR assessment indicators are considered standard criteria for many of these arithmetic indices. However, the difference with current research is that it uses factor Availability tools.

4. CONCLUSIONS
This research explains that equipment department at PT JICT can use and adapt KPIs in Quay Container Crane with four main movements. By using KPIs, the equipment department can calculate numbers that indicate QCC performance in operations and actual circumstances. MMBF can describe how much time and resources the equipment department has invested in preventive maintenance in quantity. MTTR may indicate the efforts of the equipment department at the container terminal to reduce this number, which requires workers in the equipment department to have the necessary skills and skills and understand the characteristics of the equipment on the crane in ongoing use. MMBF and MTTR completed by hour meter accumulated through crane movements that previously did not exist. Without man-made intervention, the pure reference to the hour meter allows us to determine the good and the bad. The value of these figures is based on the maintenance time spent on equipment, and most importantly, can differ container terminals operating around the world.

If the equipment department in PT JICT can generate numbers every month by setting targets for MMBF and MTTR, it can identify common declines in MMBF with results, and MTTR will identify which areas are experiencing multiple failures, and MTTR results allow equipment to be replaced so that that there will be no disruption to ship operations and the intended productivity of ship operations. In addition, MMBF and MTTR are directly related to the working hours themselves, sending the given workforce and staying to the exact place where they should do PM and EM by correctly predicting the expected resource requirements and that will allow doing PM and EM without using or hiring outside labor if there is a lack of working hours to be addressed in one's resources, and this will eventually go to the goal that all companies in the world pursue: cost savings.

Performance indicators, which can be used in general in container terminals, are very important, as are common indicators in all other industries. Availability, MMBF and MTTR, are considered standard criteria for many of these arithmetic indices. Lastly, suggestions for future studies using simulations, experiments, or running actual machines are required.

KPIs can be used and adapted to quay container cranes (QCC) in PT JICT container terminals with four main movements on cranes. With KPIs, Equipment Department at PT JICT can calculate figures that show QCC performance in operational and in real time. MMBF can describe how much time and resources have been invested in preventive maintenance. MTTR can demonstrate the efforts made by the Equipment Department at PT JICT to reduce this number, and it takes human resources who understand the characteristics
of the equipment and have expertise and skills in the analysis of trouble-shooting crane equipment.

MMBF and MTTR are completed based on hours of meters accumulated through the main movement of the previously none-existent crane. In the absence of human intervention, a pure reference to the hours meter indicator allows us to determine the magnitude of these figures based on the maintenance time spent on the most important equipment.

5. ACKNOWLEDGMENTS
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6. REFERENCES


