Increase the Efficiency Rate of Container Loading and Unloading Using Six Sigma Method

Hassan jafari

M. Sc student in Marine Transportation, Faculty of Maritime Economics & Management, Khoramshahr marine science & technology university, Khoramshahr, Iran.

Corresponding author email: hassanport53@yahoo.com

ABSTRACT: The present research has been conducted to investigate the efficiency Rate of container loading and unloading in the studied port, in three dimensions; ships in port quay and loading and unloading operations using Six Sigma method. Six Sigma methodology is a method for measurement of performance deviations using statistics concepts. This method analyzes performance measurement and recommends improvement solutions for organization processes. SixSigma gives guideline to managers for reduction of errors, wastes saving and increasing competitiveness. In this research, container cargo loading and discharging operations BIK evaluated by DMAIC methodology. First step of DMAIC is problem definition in which loading and unloading ratio identified as CTQ of process. Second step is measurement of sigma level of loading and discharging process that is calculated 2.5sigma. On third step, root causes of delays in loading and discharging operations are identified by FMEA method. Defect of vertical quay transportation equipment (576)technical malfunction and defect of horizontal quay transportation equipment (576)unpreparedness of port external factors including owners (480)inelasticity of containeryard (448) are identified to be the root causes by FMEA method. In forth step of DMAIC, the optimum inputs arrangement of discharging operation is studied by Taguchi DOE method. Result of this method is that vessels with container shipment and more than 900 TEU tonnage cargos that berthed at 8 – 16 o'clock have the best discharge performance.

Key words: containers loading/unloading operation, Bandar Studied port, Six Sigma, FMEA, Taguchi DOE method, performance.

INTRODUCTION

Ports as part of the sea transport are one of most important nodes and loops in global supply chain. A complex service which forms the global business infrastructure plays an important role in the distribution and optimization for the cost of transportation of goods. Quality of service is an important issue in the development of global trade and more economic competition has been discussed. The port authorities are trying with provide more quality services to ships, encourage them to be loaded and unloaded, and thus to stimulate their ships into port obtain higher profitability (Tongzon, 2009). Continually review and improve the performance of seaports can enhance the competitiveness power of ports and will also help them in the development process. One of the best and most reputable methods of evaluating the quality and performance of the ports is Six Sigma methodology. The present research has been conducted to investigate the efficiency Rate of container loading and unloading in the studied port, in three dimensions; ships in port quay and loading and unloading operations using Six Sigma method.

The initial idea for the name of Six Sigma is attributed to Bill Smith. He observed error rate and the increasing complexity of products and the addition of their parts realized the ineffectiveness of three sigma quality levels and combining the reliable concept and technique of quality engineering and suggested the initial idea of Six Sigma at Motorola CEO Galvin. In recognition of his deep thinking, Galvin Smith encouraged him to develop Six Sigma (σ is one of the Greek alphabet and an important indicator of the scale and distribution of the standard deviation for the measurements. It is express how much a given series of data has deviated from the
mean value. Sigma levels ($\sigma_2$, $\sigma_1$) indicates the likely presence of a bell-shaped curve shown in Figure 1 is the normal distribution. (Figure 2. in the production process or the provision of services by an organization definite limit to permit variation of the optimum products is demanded by customers. The lower specification limit volatility is called LSL and USL is upper specification limit. Sigma quality level (or the brief sigma level. is the distance between the process mean and the nearest property boundary (Kumar, 2006).

In practice, it is most desirable that the amount of goal conform to the process the average. Of course, however, the average over a period of time usually is different with the average time to process in a variety of reasons. This means that the average value of the process in around of the target amount continuously be moved. To indicate the maximum common displacement, Smith added amount ±1.5 to the average (Kumar, 2006).

**Express the problem and the need for research**

Optimizing Loading and unloading operations in ports to reduce time transferring goods from producer to consumer is seen as an important issue (Tongzon, 1995). Due to the growing need of Iran to economic development the evaluation of ports performance as major bases for economic development, seem to be more important than before.

**Solving approach**

Six Sigma depending on the circumstances, to assess and improve the products or services offered, propose two models. The first on is when the process is running and organization trying to improve it. The proposed model was known as DMAIC improvement cycle and by continuing in the implementation of the model and the use of appropriate statistical tools, organizations will be able to make good qualitative and quantitative objectives (Kumar, 2006). The second case, is when that by using the DMAIC model in order to improve cannot move more than a certain level, Or the decided to develop a process or a new process takes place to establish. DFSS method is proposed in this condition. By using this model, organizations will be able to design the quality for process and in this way, before providing services or products should make perfect platform to achieve optimal conditions.

DMAIC cycle is effectiveness improved cycle in Six Sigma. DMAIC is a systematic method of operating errors and is based on close monitoring of performance (Yang and Hsieh, 2009). Considering that this study aims to assess the current performance of containerized cargo loading and unloading operations in Bandar Imam Khomeini and improvement strategies, DMAIC improvement cycle will be used. The five-stage model by using statistical quality control tools, will improve the problem definition, measured process performance, analyze reasons the process, exploring how to improve performance and finally implementation of the strategies to improve process control deals. Also for data analysis and quality control of software, software tools MINI TAB 16, Excel 2007 and QUALTEK-4 will be used. Appropriate steps to conduct research with the five phases of this cycle will be implemented as follows: (It should be noted that the study was limited to the fourth initial phase of this cycle and is not entered in the fifth phase:

**Definition Phase**

Define the scope, objectives, resources and time selected in this phase of the project will be determined. In this action it is necessary that the details work and documentation, examined. The general understanding of the structure and defect review and compliance is achieved (Chakravorty, 2009). In this phase by using SIPOC model

![Figure 1. A normal bell curve distribution of resources: (Allen, 2006).](attachment:image.png)
container loading and unloading operations are considered, and critical process parameters are determined as a quantitative measure of performance.

**Measurements Phase**

For we know that we are in what condition, the process should be measured. When all the items are a little feature of the standard deviations, so they can be used as a criterion. The purpose of this phase is to establish a full understanding of the current system by identifying and implementing best performance of way it is measuring, and perhaps it is better to say that it aims to identify and measure the deviation of resources (Tkac and Lyocsa, 2009). At this stage, the introduction of the definition, process sigma level will be calculated.

**Analysis phase**

In this stage, you should identify the causes of the deviations of the measured and confirmed the validity of the root causes of the problems have been identified. We should be able to compare the features of different process and make a decision about the promising option (Kumar, 2006). At this stage, it is trying to provide the correct analysis of the causes of the process performance, in simple terms, we are in the phase of trying to understand what factors are involved in the sigma level and which ones are most important. This analysis helps us to have better view of the decision-making process to obtain in recovery process. Analyzing will be accepted by support tools such as cause and effect diagrams, the potential failure modes and effects analysis (FMEA).

**Improvement Phase**

In this phase, the performance of characteristics of the product, to achieve the objective should be improved are chosen. Analysis in this stage leading to the decisions and finally the key variable conditions improved process are identified. In this phase of the analysis process input by using Taguchi experimental design approach, the solutions are proposed to improve process performance.

**Phase Control**

Develop regulatory mechanisms that guarantee the stability of key changes in range accepted by the establishment of assessment will be addressed at this stage.

**Background of Six Sigma application in marine transportation industries**

Ng and colleagues (2006) to increasing the level of safety of workers in the mid-stream sector of Hong Kong harbor invoices control and reduce errors by using discussed on the DMAIC methodology. According to the study, from 1992 to 2002, fifty percent of fatal accidents in loading and unloading have been done due to the height of the fall. And an average of 4 workers has led to the death toll that all thevents occurred in mid-stream. Reduce the number of accidents down in this section the purpose of this study, Mid-stream operations, including loading and unloading of ocean-going container ships and barges in the harbor and in barge loading and unloading at the wharf. In the definition phase, work accidents, falls on premises of public goods through inspection and review of past events as a Statistics major characteristics adopted to reduce accidents. In the analysis phase, the variables associated with the events of the fall of the critical variables are identified. Finally, improve and control processes, recommendations and suggestions are executed for reducing the critical factors in maintaining the function. Ungand colleagues (2007) examined the application of six sigma quality control process for port security. In the Definition phase of the study, more than 50 minutes is define for security process as critical quality attributes. And in the measure the quality, the 2.4 mode is achieved for short-term sigma process. In the analysis phase by means of statistical inference, the root causes unacceptable changes have been studied. In the improvement stage the control of certain tools not been used and define the steps and recommendations are limited to the use of other tools. Kumar and his colleagues (2008) have examined the distribution chain design to reduce the security risk containerized cargo by using DMAIC methodology. The author of this study provided data of global trade, shipping container have introduced an important component in the process of distributing goods. And then addressed the security risks of theft, smuggling and terrorist states. In the defining research stage by using the Project Charter, the purpose of Six Sigma improvement project, stating the problem, the scope of the problem and the financial benefits has raised. The project objective is showing the benefits of using a standardized approach to the security of containerized cargo in the distribution chain. There is no standard approach or formal containerized cargo security regulations and policies as it is expressed in this research. In the measurement by using map the distribution of goods and cause and effect diagrams, the problem has been assessed. In the analysis of cause and effect chart is extracted from the error states and PukaYuke ideas is presented for wrong or against the distribution chain. In the recovery phase, a new map is provided by using process of change analysis and comments
PukaYuke. Finally, in the stage a standard set of performance indicators has been suggested in relation to the distribution chain security articles.

**RESULT**

**Definition Phase**

**Drawing SIPOC model**

SIPOC is a model method for analyzing the business process and is used for simple expression of symptoms. This model shows activities and operations decisions in relation along process. It is also making it possible to understand the relationship between elements of a process or program in its simplest form. Having overall view of the process led us to define the project scope and location of data collection defines (Jafari, 2011).

To create SIPOC, at first they named the process and then all the inputs and outputs list of the process and all suppliers and customers is determined and finally, the most important steps of the process are identified drawing on the model and named. Drawing SIPOC Model will facilitate loading and unloading works process and the relationships between these factors. The starting point of the process of loading and unloading process begins from Suppliers and Including cargo owners, shipping companies, shipowners, shipping and the loading and unloading companies. The process is connected to the customer ports that include the cargo owners, shipping companies, ship owners and shipping lines (Jafari, 2011). Goods, containers, equipment, manpower and other forms of transportation are the entrances of process and cargo and container movement between the ships at sea and other forms of transport are considered in dry outputs. Figure 2 shows the port of loading and unloading SIPOC model that the operation of this process is shown in the Process column.

![SIPOC diagram of the process of loading and unloading containers at the Port of Imam Khomeini](image)

**Critical Quality Attributes**

Six Sigma oblige the organization to makes the determination what is the customer value and measures each Characteristic value. Then the organization should determine what is essential to obtain customer satisfaction. These factors are critical to quality characteristics (CTQ). UNCTAD (1987, strategies expressed the goal of reducing the cost of customer ports and port users. At first state this goal is coming by savings in operating costs in the form of lower tariffs, and in the second state this goal can be obtained by the services that reduce the cost of moving goods through the port. Ports, as providing goods and services for shipowners can create competitive advantage by reducing costs for shipment to customers. This important from the viewpoint of shipowners will be achieved through the following (UNCTAD, 1993):

1) Shorter time to stop the ships in port that leads to lower costs and amount of time required to complete the Travel.
2) The lower port costs as a result of reduced costs for loading and unloading ships.
3) Community services and facilities for larger ships and special offers to save on scale and thereby reducing transportation costs.
4) Reduce the cost of transporting goods from the owner's perspective is achieved through the following:
5) The number of voyages further reduces the total time of transport.
6) Improve access to the movement of goods, storage and transportation with other methods (rail and road).
7) Better coordination with upstream and downstream data flow distribution.

According to the needs of both user ports, it can be concluded that the number of voyages require further expedite the movement of ships. Time to stop the ships in port can be divided into three parts. The first time the ship entered the harbor, waiting for berthing. The second period is that ships are alongside and loading and unloading operations are conducted finally, after completion of loading and unloading operations, loading and unloading operations, and the transfer time between the completion of the harbor and the ship is leaving port. Interval between the first and second of these three periods is more important. According to the presentation, it can be stated that the waiting time of ships in the harbor to the large proportion of time-dependent loading and unloading, and the by the smallest decline in the loading and unloading ships we will see a dramatic reduction in waiting time (Jafari, 2011). By considering these diagrams, the critical quality attributes the loading and unloading process can be traced.

It should be noted in order to achieve areas on able quantity we still need to replace time spent loading and unloading of ships at the waterfront pier of the time rate of pay at the dock. So according to the chart, the critical Characteristic this research has been the rate of loading and unloading operations.

![Diagram](image_url)

Figure 3. loading/discharging critical quality attribute diagram

**Phase measurement**

As was mentioned in the definition, we reached to the CTQ (Diagram 3. tree with a Characteristic crisis rates or loading/unloading operations that should be assessed at this stage in the process is to understand what is happening to determine the level of sigma phase?

The loading and unloading rates were collected. For this purpose, container loading and unloading rates in Bandar Imam Khomeini in the first eight months of 2010 have been used. According to the PMO, Iran, in 2009, 158 container vessels have been traveling to Bandar Imam Khomeini which the average time spent, exercise (expected), and the service is respectively 36, 7 and 29 hours respectively. Also, function of dock for every time the ship and every time berth occupancy is around 180 and 222 tons per hour. Statistics of the first eight months of 2010 shows the function reduced in Port (167 tons and 222 tons per hour Busy Port). According to statistics presented, in this period 120 ships are in port traffic in which the average time, maneuvering and service, respectively 39, 8 and 29 hours, respectively.
Table 1. Performance in container Berths (11 to 15) Bandar Imam Khomeini in the first eight months of 2010

<table>
<thead>
<tr>
<th>Berth No</th>
<th>Length (m.)</th>
<th>Depth (m.)</th>
<th>Ships Berthed</th>
<th>Berth occupancy rate (%)</th>
<th>Days of empty Berth</th>
<th>The average number of berthing ships per ship</th>
<th>The average number of berthing ships per berth</th>
<th>The average of the occupancy of vessels per berth</th>
<th>Container Handling Berth Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>1052</td>
<td>.214</td>
<td>43</td>
<td>3536</td>
<td>43</td>
<td>.214</td>
<td>1052</td>
<td>11</td>
<td>11239</td>
</tr>
<tr>
<td>12</td>
<td>1052</td>
<td>.214</td>
<td>55</td>
<td>5281</td>
<td>55</td>
<td>.214</td>
<td>1052</td>
<td>12</td>
<td>13906</td>
</tr>
<tr>
<td>13</td>
<td>1052</td>
<td>.214</td>
<td>80</td>
<td>14368</td>
<td>80</td>
<td>.214</td>
<td>1052</td>
<td>13</td>
<td>20091</td>
</tr>
<tr>
<td>14</td>
<td>1052</td>
<td>.214</td>
<td>37</td>
<td>30241</td>
<td>37</td>
<td>.214</td>
<td>1052</td>
<td>14</td>
<td>22360</td>
</tr>
<tr>
<td>15</td>
<td>1052</td>
<td>.214</td>
<td>17</td>
<td>43913</td>
<td>42</td>
<td>.214</td>
<td>1052</td>
<td>15</td>
<td>338</td>
</tr>
</tbody>
</table>

Table 2. Process performance changes for container loading and unloading of goods at this port according to reports of Bandar Imam Khomeini studies department

<table>
<thead>
<tr>
<th>Performance measures</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>Trend of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Container per hour (PT.)</td>
<td>39/11</td>
<td>46/15</td>
<td>51/19</td>
<td>73/16</td>
<td>-2/14</td>
</tr>
<tr>
<td>Container per hour (ST.)</td>
<td>68/18</td>
<td>89/23</td>
<td>71/26</td>
<td>12/22</td>
<td>-2/17</td>
</tr>
<tr>
<td>Container per hour (OT.)</td>
<td>67/24</td>
<td>3/35</td>
<td>45/37</td>
<td>3/28</td>
<td>-4/24</td>
</tr>
<tr>
<td>Average of ships (TEU.)</td>
<td>36/588</td>
<td>46/390</td>
<td>36/588</td>
<td>6/544</td>
<td>-7/50</td>
</tr>
<tr>
<td>Average of PT ships</td>
<td>4/38</td>
<td>3/25</td>
<td>3/23</td>
<td>-6/20</td>
<td>6/38</td>
</tr>
<tr>
<td>Average of waiting</td>
<td>0</td>
<td>9/8</td>
<td>1/8</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Average of ST</td>
<td>4/23</td>
<td>3/16</td>
<td>3/3</td>
<td>1/25</td>
<td>-7/10</td>
</tr>
<tr>
<td>Average of OT</td>
<td>7/17</td>
<td>1/11</td>
<td>7/15</td>
<td>6/19</td>
<td>-8/5</td>
</tr>
<tr>
<td>Average of stoppage</td>
<td>7/5</td>
<td>3/5</td>
<td>3/6</td>
<td>5/5</td>
<td>9/18</td>
</tr>
</tbody>
</table>

Table 3. Statistical profile of current and desirable goods for container loading and unloading process

<table>
<thead>
<tr>
<th>Rate of loading and unloading according to the TEU on time</th>
<th>Statistical properties of this process</th>
<th>Detail of process aim</th>
</tr>
</thead>
<tbody>
<tr>
<td>The number of sampling</td>
<td>The number of sampling</td>
<td>The number of sampling</td>
</tr>
<tr>
<td>process</td>
<td>The number of sampling</td>
<td>The number of sampling</td>
</tr>
<tr>
<td>Loading/unloading</td>
<td>157</td>
<td>88/23</td>
</tr>
</tbody>
</table>

As can be inferred from the above table containership in Port operations has increased that indicates the operational level is undesirable. With the loading and unloading of containers at the port statistics of the time interval is characterized that That most cases both loading and unloading operations and ship containers at the port entry has been made. We are paid to calculate the sigma level.

According to this that Usually the bulk container operation is in Studied port to unload the container, Therefore, to calculate the sigma level operations, loading and unloading operations are considered integrated. Obviously, given the nature of imports and exports most cases of unloading container ships are operating slowly.
Assuming the worst case that the average size the goal of 1.5 σ is transferred to the lower loading and unloading, the minimum acceptable rate of loading and unloading of containerized goods will be as follows: 4.5 (standard derivation of aim. aim average=35_ (4.5 ×5. =12.5) TEU/Hour

This number is somewhat that less than that is the major disadvantage for the process of loading and unloading operations. It can be calculated using the sigma index. Sigma index calculation is done in three steps.

Step 1_ Z values for the current evacuation rate 2.375 are calculated

\[
Z = \frac{(12.5 - 23.88)}{11.84} = -1.00337
\]

Step2. The possibility of 99.435.0 – Z TABLE or calculated by using Excel software to NORMSDIST function. NORMSDIST (-1.00337) = 0.15784

Step3. The possibility of long-term yields obtained in Step 2 is search in column Sigma conversion table indexes. Then we will find the corresponding value in Sigma column. This amount is equal to 2.5. So containerized cargo loading and unloading operations at Bandar Imam in 2.5 σ is in progress.

**Analysis Phase**

McDermott and colleagues (2009) believe that by using the potential failure modes and effects analysis (FMEA) we could identify and prioritize potential failure modes in a system, process, product and service, and define the Measures to eliminate or reduce the incidence of potential failure modes and finally, it is a key that are introduced tool for improving the safety, quality and customer satisfaction. FMEA is a systematic series of activity with the aim of:

1. Identifying and assessing potential failures that are in the system design, product, process, and there are estimates of the occurrence of any of the above factors. Identification of possible measures that can reduce the risk of down time and eliminate
2. Identification and efforts by which the severity of the resulting errors can be reduced as much as possible Identification and efforts by which we can increase the ability to detect in other words, the probability of error increases before reaching clients
3. Documentation of processes

Table FMEA risk analysis determination of probability of error conditions (frequency of occurrence, the effects of the incident (severity, and likelihood of identification before processing (tracking) is performed. Each of these cases, on a scale of 1 to 10 which 10 is the greatest adverse impact on the process, is rated by experts.

These three rank multiplied by another which briefly is called risk priority score RPN. Those with the highest RPN values are higher priority in the recovery process (Dyadem, 2003).

At this stage by using FMEA methods, evaluate and prioritize the causes of stop and slow loading and unloading operations, resulting in decreased performance and efficiency indicators of Sigma.

**Identify the components of the loading and unloading process**

First, identify the components and their functions in this process of loading and unloading will be done that these components can be expressed as follows:

- **Port:** Port of duty in the process of loading and unloading is when the ship is docked in Port until it finishes loading and unloading operations is fully prepared and ready for loading and unloading operations and doesn’t have any deficiency in manpower and equipment to performing the operation without stopping and slowing.
- **Ship:** ship is responsible for the loading or unloading of goods and provides all conditions documents, agreements, manpower and equipment, the vessel must be perfect.
- **Cargo owners:** This section should also process their item fully prepared for delivery, or to clear the port and ships. Prepare financial documents, customs and transportation of goods and arrangements with the agencies and contractors involved in the loading and unloading duties of cargo owners to be fully prepared for this process.

**Cause and effect diagram**

After identification of an effective component in the process of loading and unloading and by Loading and unloading evaluation statistics and from viewpoint of experts causes halt and lag the operation of container loading and unloading of goods obtained and To classify and identify This causes. We use cause and effect diagram method in the fishbone diagram.
Figure 6. Fishbone diagram causes a delay in the loading and unloading of containerized goods

(It should be noted that this study presents have confined the results and analysis of potential failure modes and effects and It was refused.)

The risk priority number is obtained from multiply the three severities, occurrence and detection of error states that it can be by using risk analysis and prioritization of measures increase the efficiency of the payment process.

The abstained results from FMAE model revealed that, the main issues that led to slow's containerized cargo loading and unloading operations at studied port are as follows:
- Equipment failures and technical defects of transport in Port (Vertical).
- Equipment failures and technical defects of transport in Port (Horizontal).
- Lack of preparation outside the port, including cargo owners, shipping agents, cargo terminals and Forwarders.
- No container yard stretch.
- The inability of loading and unloading equipment and infrastructure.
- Failure of documentation.

**Improvement phase**

At this stage Impact of entrances containerized cargo unloading process efficiency is reviewed by using Taguchi experimental design method explains. In this study due to the large volume of computing and method of calculation errors QUALITEK-4 software is used. It is necessary to explain by the solution that meets the Taguchi method and after defining the factors and processes affecting levels. Experiments are designed and carried out and the results are analyzed;

But into our study because of the high costs testing is impossible therefore, the operation records should be used to derive results which more realistic and reasonable than it really help to analyze. By Show All Statistics containerized cargo at the port of loading and unloading operations in the period of Imam Khomeini to investigate the factors used in the Port total TEU unloading and loading the ship docked are that beginning of loading and unloading operations according to three levels are examined in Table 4.

<table>
<thead>
<tr>
<th>Table 4. The factors and levels investigated in the process of loading and unloading of containerized goods.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables or factors</td>
</tr>
<tr>
<td>Port in use</td>
</tr>
<tr>
<td>Total unloaded &amp; loaded TEU</td>
</tr>
<tr>
<td>Ships entering the port</td>
</tr>
</tbody>
</table>

By providing details of the process in terms of three factors and three levels of software QUALITE-4 the software will choose the 9 L Artugunal.9 L Artvgvnal structure is shown in table 5.
Rate of loading and unloading the goods at 9 modes was designed, the data for loading and unloading cargo containers from Bandar Imam Khomeini and the test output with a repetition of phase tests shall be included. Also for optimum application process, loading and unloading rate is defined.

After the input-output analysis procedure for container loading and unloading of goods, software estimates average impact factor ANOVA analysis at every level to provide optimal conditions. Tables 7, 8, and 9 show the results.

As can be seen the results showed that shipments over 900 TEU, in Port No. 13 that have been entered in the range of 8 to16 will have the best performance unloading rate equal to 35.698 20 Ft. containers on time and analysis of variance also shows that about 88% of loading and unloading TEU unloading affects the performance and other factors do not have an impact on process performance.
DISCUSSION AND CONCLUSION

Drawing SIOPC model Containerized cargo loading and unloading operations and the outcome of the survey asked customers to identify CTQ tree port loading and unloading rates of these commodities was characterized as a critical process. According to the Studied port operational process analysis, integrated loading and unloading of containers was considered. By loading and unloading rate statistics collection interval defined According to the type of continuous data, the data was displayed by using histogram the assumption of normal distribution of data, loading and unloading operations against the 5 sigma level/2 was from Sigma. Using FMEA, root causes of a halt and lag the loading and unloading operations have been studied and by the RPN respectively, equipment failure, lack of preparation outside the port, the container yard stretch inability Equipment & documentation Failure as the main factor slow the loading and unloading of containers were found in Bandar Imam Khomeini. Taguchi's design of experiments, three factors used in Port, berthing time of container ships was evaluated at three levels. Based on the results it can be derived that Shipments over 900 TEU, in Port No. 13 in the range of 8 to 16 hours of unloading that entered in the cargo will have the best performance rate equal to 35.698 20 foot containers on time and analysis of variance also shows that about 88% of loading and unloading TEU unloading affects the performance and other factors do not have an impact on process performance.

REFERENCES

Allen T. 2006. Introduction to Engineering Statistics and Six Sigma. Springer, USA.
McDermott RE, Mikulak RJ, Beauregard MR. 2009.The Basics of FMEA.CRC Press, USA.