Improvement Strategies of Container Terminal Shipside Operating Efficiency

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Introduction

- **Mega ships 2006-2013**
  - Opt to berth at a small number of mega hub ports and gateway ports, while small and medium-sized ports serve as transshipment hub ports and feeder hubs.
  - Several mega-hub ports may appear in East Asia creating new hub and spoke systems.
  - To achieve economies of scale and consequent cost reductions.
Introduction

- Container terminals - a vital part of the transportation infrastructure.

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lu (2011)</td>
<td>Evolved from cargo handling points to distribution centers serving as transport hubs in container supply chains.</td>
</tr>
<tr>
<td>Yun and Choi (1999)</td>
<td>Proposed container terminal and container equipment performance indicators, including gantry and transfer crane utilization, and container yard occupancy rate.</td>
</tr>
<tr>
<td>Preston and Kozan (2000)</td>
<td>Looked at the number of container handling facility items (e.g., forklifts, trailers, and gantry cranes), container category, number and size of trailers, distance between pier and container terminal, and minimum operating time of berthed ships.</td>
</tr>
</tbody>
</table>
While larger container ships achieve better economics of scale at sea, they may incur diseconomies of scale in port.

Carriers and terminal operators must to...

- Increase operational efficiency,
- Reduce operating costs,
- Lessen berthing time and,
- Improve the efficiency of container handling.
The goal of this study was to...

Step 1
- Discover the chief factors affecting the operating efficiency of container terminals' shipside areas.

Step 2
- The impact factors were verified by a questionnaire survey aimed at container terminal operators and shipping companies.

Step 3
- Used the AHP method to determine the ranking order of factors affecting container terminal shipside operating efficiency.

Step 4
- Proposed some conclusions and recommendations concerning the improvement of container terminal operating efficiency.
The purpose of this study can be summarized as follows:

**Purpose 1**
Investigate container terminal shipside operating efficiency through a review of the literature and expert interviews

**Purpose 2**
Rely on analysis of performance indicators to find factors influencing shipside operating efficiency and seek out methods of improvement

**Purpose 3**
Compare the stevedoring practices and procedures of the various container terminals at the port of Kaohsiung, and propose improvements
Shipside operating efficiency

Container terminals consist of three subsystems:

- Berths
- Container yard
- Gate

Container handling equipment in these systems includes transfer cranes, gantry cranes, yard tractors, and trailers (Yun and Choi, 1999).

The four main subsystems/operations in a container terminal system are ship to shore, transfer, storage, and delivery/receipt.
<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Song et al. (2003)</td>
<td>Listed wharf length, wharf size, number of gantry cranes, number of yard cranes, number of straddle carriers, and container throughput volume.</td>
</tr>
<tr>
<td>Park and De (2004)</td>
<td>Listed berth capacity, cargo handling volume, cargo handling throughput, number of vessels entering and leaving port, revenue, and customer satisfaction.</td>
</tr>
<tr>
<td>Cullinane et al. (2004)</td>
<td>Listed wharf length, wharf size, number of gantry cranes, number of yard cranes, number of straddle carriers, and container handling throughput.</td>
</tr>
<tr>
<td>Barros (2006)</td>
<td>Considered number of employees, investment capital, operating cost, cargo handling volume, number of vessels entering and leaving port, and business income.</td>
</tr>
<tr>
<td>Rio and Macaca (2006)</td>
<td>Listed number of gantry cranes, number of berths, number of employees, wharf size, number of container handling facility items, container handling volume, and average loading and unloading volume per ship per hour.</td>
</tr>
<tr>
<td>Hsueh (2006) and Lu (2011)</td>
<td>Used various assessment variables, including number of gates, berths, area, length, storage area, reefer area, and number of containers, as a basis for analyzing the relative efficiency of the major container terminals in Asia.</td>
</tr>
<tr>
<td>Author (Year)</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Choi and Ha (2006) and Lee (2012)</td>
<td>Proposed a port productivity index based on the operating performance of handling facilities and encompassing the factors of yard crane productivity, tractor productivity, combined productivity of different equipment, and distance of movement of tractors and equipment.</td>
</tr>
<tr>
<td>Choi and Ha (2007) and Rodriguez-Molins et al. (2012)</td>
<td>Propose several assessment variables for simulated container terminal designs, including container handling volume, container terminal storage volume, tractor operating time, transport route and duration of vehicle motion, and distance from tractors to terminal.</td>
</tr>
<tr>
<td>Berry (1968)</td>
<td>Provides an optimization model to determine the dimensions of a container terminal layout that minimizes handling distance, handling time, space utilization, and cost.</td>
</tr>
<tr>
<td>Ng and Mak (2005)</td>
<td>Yard cranes are the most commonly-used container handling facilities for moving containers on or off trucks in the container yards of land-scarce container terminals.</td>
</tr>
<tr>
<td>Le-Griffin and Murphy (2006); Beskovnik (2008)</td>
<td>Common container terminal productivity measures include crane utilization, crane productivity, berth utilization, service time, land utilization, storage productivity, gate throughput, truck turnaround time, and labor productivity.</td>
</tr>
</tbody>
</table>

This article's research scope is limited to assessing the operating efficiency of cargo handling facilities in shipside areas, and does not include assessment of performance in such other areas as the container yard and gate areas.
Shipside operations involve many of interest communities must be closely coordinated to improve the efficiency of all aspects of relevant processes.

- A ship's mooring and unmooring,
- the stowage plan for container loading and unloading
- workers' dismantling of securing implements
- backline container yard activities
- every unit's personnel management

The trend toward larger ships and greater volume, shipping companies attempt to reduce operating costs and shorten ship turnaround time at port to ensure stable timetables.

How to enhance the efficiency of shipside areas is a subject of critical importance.
Literature Review

- The majority of shipping companies seek to reduce ship berthing time and improve handling efficiency in the shipside area.

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wang (2008)</td>
<td>Identified the chief factors influencing container terminal operating efficiency as container terminal dimensions, container handling equipment employment, full container volume, stowage planning, shipside gantry cranes and transport vehicles, tractor assignment, and traffic route planning.</td>
</tr>
<tr>
<td>Hu (2008)</td>
<td>Suggested that the container terminal areas entailing the greatest risks include the shipside operating area, container stacking area, and empty container operation area. Even while pursuing of high loading and unloading efficiency, terminal operators must ensure the safety of personnel, ships, and cargo in shipside areas.</td>
</tr>
<tr>
<td>Terng (2010)</td>
<td>Pointed out that container ship delays may result from poor shipside operating efficiency due to bad stowage planning.</td>
</tr>
</tbody>
</table>
## Literature Review

### Impact factors obtained from shipping companies

Table 1 Profile of survey subjects

<table>
<thead>
<tr>
<th></th>
<th>Wang Hai</th>
<th>Yang Ming</th>
<th>Evergreen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berth length (m)</td>
<td>525</td>
<td>320</td>
<td>815</td>
</tr>
<tr>
<td>Berth draft (-m)</td>
<td>14.5</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Operating model</td>
<td>Tractor</td>
<td>Tractor</td>
<td>Tractor</td>
</tr>
<tr>
<td>Gantry crane number</td>
<td>5</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Handling efficiency (moves/hour)</td>
<td>32</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Handling equipment category</td>
<td>Rail Transtainer</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Straddle Carrier</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
## Literature Review

### Table 2 Summary of assessment criteria source

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Assessment variable</th>
<th>Evergreen</th>
<th>Wan Hai</th>
<th>YML</th>
<th>Expert Opinion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ship status</strong></td>
<td>Hold cell guide damage or deformation</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Twist lock malfunction</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hatch cover damage</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ship repair work</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ship tilting and shifting</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td><strong>Container terminal management</strong></td>
<td>Containers have not entered gate</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Container yard congestion</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Document revision or error</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Computer and communication failure</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Occupational accident</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>Container yard restowage</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td><strong>Equipment and facilities</strong></td>
<td>Aging equipment</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>Insufficient quantity of equipment</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>Repair and maintenance</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Working space restrictions</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overheight container handling</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
</tr>
<tr>
<td><strong>Personnel qualifications</strong></td>
<td>Insufficient professional knowledge</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>Shift change uncertainty</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>Delay of work</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
<tr>
<td></td>
<td>Overly long working hours</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
</tr>
</tbody>
</table>
## Main failure factors arising at the W company

### Table 3 Shipside failure factors at the ABC company

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Factor</th>
<th>Frequency</th>
<th>Percentage %</th>
<th>Rank</th>
<th>Minutes</th>
<th>Percentage %</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ship Status</strong></td>
<td>Twist lock malfunction</td>
<td>227</td>
<td>4.33%</td>
<td>6</td>
<td>3075</td>
<td>3.15%</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Hold cell damage or deformation</td>
<td>58</td>
<td>1.11%</td>
<td>12</td>
<td>680</td>
<td>0.70%</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Ship repair work</td>
<td>62</td>
<td>1.19%</td>
<td>11</td>
<td>1155</td>
<td>1.18%</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Ship tilting or shifting</td>
<td>91</td>
<td>1.73%</td>
<td>8</td>
<td>1850</td>
<td>1.90%</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Stowage place discrepancies</td>
<td>18</td>
<td>0.34%</td>
<td>17</td>
<td>455</td>
<td>0.47%</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>456</strong></td>
<td><strong>8.63%</strong></td>
<td><strong>3</strong></td>
<td><strong>7215</strong></td>
<td><strong>7.38%</strong></td>
<td><strong>3</strong></td>
</tr>
<tr>
<td><strong>C.T. Management</strong></td>
<td>Containers have not entered gate</td>
<td>44</td>
<td>0.84%</td>
<td>14</td>
<td>1690</td>
<td>1.73%</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Risk label operation</td>
<td>33</td>
<td>0.61%</td>
<td>15</td>
<td>135</td>
<td>0.14%</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Container yard congestion</td>
<td>1127</td>
<td>21.48%</td>
<td>2</td>
<td>15370</td>
<td>15.76%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Document revision or error</td>
<td>97</td>
<td>1.85%</td>
<td>7</td>
<td>4405</td>
<td>4.52%</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Container yard restowage</td>
<td>75</td>
<td>1.43%</td>
<td>9</td>
<td>1045</td>
<td>1.07%</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>1376</strong></td>
<td><strong>26.04%</strong></td>
<td><strong>2</strong></td>
<td><strong>22645</strong></td>
<td><strong>23.16%</strong></td>
<td><strong>2</strong></td>
</tr>
<tr>
<td><strong>Equipment &amp; Facilities</strong></td>
<td>Equipment breakdown</td>
<td>1022</td>
<td>19.48%</td>
<td>3</td>
<td>21535</td>
<td>22.08%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Working space restrictions</td>
<td>517</td>
<td>9.86%</td>
<td>4</td>
<td>7100</td>
<td>7.28%</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Overheight container handling</td>
<td>1466</td>
<td>27.95%</td>
<td>1</td>
<td>29430</td>
<td>30.18%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Container deformation</td>
<td>55</td>
<td>1.05%</td>
<td>13</td>
<td>1220</td>
<td>1.25%</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Lifting crane</td>
<td>284</td>
<td>5.42%</td>
<td>5</td>
<td>6240</td>
<td>6.40%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>3344</strong></td>
<td><strong>63.29%</strong></td>
<td><strong>1</strong></td>
<td><strong>65525</strong></td>
<td><strong>67.00%</strong></td>
<td><strong>1</strong></td>
</tr>
<tr>
<td><strong>Personnel qualifications</strong></td>
<td>Container misplaced or restowed</td>
<td>19</td>
<td>0.36%</td>
<td>16</td>
<td>285</td>
<td>0.29%</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Woodwork dismantling</td>
<td>6</td>
<td>0.11%</td>
<td>18</td>
<td>110</td>
<td>0.11%</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Revised stowage plan</td>
<td>73</td>
<td>1.39%</td>
<td>10</td>
<td>1815</td>
<td>1.86%</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Climate factors</td>
<td>5</td>
<td>0.10%</td>
<td>19</td>
<td>135</td>
<td>0.14%</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Shift change uncertainty</td>
<td>5</td>
<td>0.10%</td>
<td>20</td>
<td>65</td>
<td>0.07%</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>108</strong></td>
<td><strong>2.04%</strong></td>
<td><strong>4</strong></td>
<td><strong>2410</strong></td>
<td><strong>2.46%</strong></td>
<td><strong>4</strong></td>
</tr>
</tbody>
</table>
Research Methodology

- Analytic Hierarchy Process
- Data collection and questionnaire design
- Assessment criteria

Table 4. Description of Assessment criteria

<table>
<thead>
<tr>
<th>Category</th>
<th>Factor name</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Ship status</td>
<td>A1 Hold cell guide deformation or damage</td>
</tr>
<tr>
<td></td>
<td>A2 Twist lock malfunction</td>
</tr>
<tr>
<td></td>
<td>A3 Hatch cover damage</td>
</tr>
<tr>
<td></td>
<td>A4 Ship repair work</td>
</tr>
<tr>
<td></td>
<td>A5 Ship tilting or shifting</td>
</tr>
<tr>
<td>B Container terminal management</td>
<td>B1 Containers have not entered gate</td>
</tr>
<tr>
<td></td>
<td>B2 Container yard congestion</td>
</tr>
<tr>
<td></td>
<td>B3 Document revision or error</td>
</tr>
<tr>
<td></td>
<td>B4 Computer &amp; communications breakdown</td>
</tr>
<tr>
<td></td>
<td>B5 Occupational accident</td>
</tr>
<tr>
<td></td>
<td>B6 Container yard restowage</td>
</tr>
<tr>
<td>C Equipment &amp; facilities</td>
<td>C1 Aging equipment</td>
</tr>
<tr>
<td></td>
<td>C2 Insufficient quantity of equipment</td>
</tr>
<tr>
<td></td>
<td>C3 Repair &amp; maintenance</td>
</tr>
<tr>
<td></td>
<td>C4 Working space restrictions</td>
</tr>
</tbody>
</table>
### Analysis of respondent attributes

#### Table 5. Overview of respondent attributes

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>Persons</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Work</td>
<td>Shipping company</td>
<td>21</td>
<td>80.8%</td>
</tr>
<tr>
<td></td>
<td>Terminal operating company</td>
<td>5</td>
<td>19.2%</td>
</tr>
<tr>
<td>Working experience</td>
<td>5 and below</td>
<td>1</td>
<td>3.8%</td>
</tr>
<tr>
<td></td>
<td>11~15 years</td>
<td>4</td>
<td>15.4%</td>
</tr>
<tr>
<td></td>
<td>16~20 years</td>
<td>4</td>
<td>15.4%</td>
</tr>
<tr>
<td></td>
<td>21 years or more</td>
<td>17</td>
<td>65.4%</td>
</tr>
<tr>
<td>Job Title</td>
<td>Staff</td>
<td>3</td>
<td>11.5%</td>
</tr>
<tr>
<td></td>
<td>Director</td>
<td>4</td>
<td>15.4%</td>
</tr>
<tr>
<td></td>
<td>Supervision</td>
<td>2</td>
<td>7.7%</td>
</tr>
<tr>
<td></td>
<td>Deputy director</td>
<td>4</td>
<td>15.4%</td>
</tr>
<tr>
<td></td>
<td>Manager</td>
<td>11</td>
<td>42.3%</td>
</tr>
<tr>
<td></td>
<td>General manager</td>
<td>2</td>
<td>7.7%</td>
</tr>
</tbody>
</table>

#### Table 6. C.R. values of assessment dimensions

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>C.R value</th>
<th>Overall C.R value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship status</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Container terminal management</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Equipment and facilities</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Personnel qualification</td>
<td>0.01</td>
<td></td>
</tr>
</tbody>
</table>
## Improvement strategies for shipside operating efficiency

### Table 7 Overall weights of assessment criteria influencing shipside operating efficiency

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Weight</th>
<th>Assessment Criteria</th>
<th>Weight</th>
<th>Overall weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>A  Ship status</td>
<td>0.126</td>
<td>A1 Hold cell guide damaged and deformed</td>
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<td>A2 Twist lock malfunction</td>
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<td>A3 Hatch cover damage</td>
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<td>A4 Ship repair work</td>
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<td>A5 Ship tilting and shifting</td>
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<td>B  Container terminal</td>
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<td>B1 Containers have not entered gate</td>
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<td>management</td>
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<td>B2 Container yard congestion</td>
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<td>B3 Document revision or error</td>
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<td></td>
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<td>B4 Computer and communication failure</td>
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<td>0.041</td>
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<td>B5 Occupational accident</td>
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<td>B6 Container yard restowage</td>
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<td>C  Equipment and facilities</td>
<td>0.241</td>
<td>C1Aging equipment</td>
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<td>C2 Insufficient quantity of equipment</td>
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<td>C3 Repair and Maintenance</td>
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<td>C4 Working space restrictions</td>
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<td>C5 Overheight container handling</td>
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<td>D  Personnel qualifications</td>
<td>0.291</td>
<td>D1 Insufficient professional knowledge</td>
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<td>D2 Shift change uncertainty</td>
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<td>D3 Delay of work</td>
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<td>D4 Overly long working hours</td>
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## Feasible countermeasures to deal with the problems...

**Table 8 Problems and solutions**

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
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</table>
| Occupational accidents        | 1. Establish the zero occupational accident concept  
                                  2. Strengthen labor safety education and training  
                                  3. Develop standard operating procedures  
                                  4. Faithfully implement safety norms                                                                                   |
| Insufficient professional knowledge | 1. Appraise job performance based on operational efficiency statistics  
                                          2. Pay equal attention to pre-service training and pre-duty education  
                                          3. Adopt advanced stowage systems  
                                          4. Let shipping companies lead stowage operations                                                                                  |
| Repair and maintenance problems | 1. Perform periodical repair and maintenance  
                                          2. Use off-peak hours for repair & maintenance  
                                          3. Notify the terminal before repair & maintenance to avoid conflicts with container handling  
                                          4. Keep adequate spares on hand                                                                                       |
| Insufficient quantity of equipment | 1. Organize containers before working to avoid unnecessary restowage  
                                          2. Focus on unloading containers, and minimize operation involving different areas  
                                          3. Mobile dispatching for mutual support                                                                               |
| Container yard congestion     | 1. Implement traffic control and temporarily pause incoming traffic.  
                                          2. Strengthen full container operations in container yard  
                                          3. Adjust operating bay area; when necessary, pause shipside operations  
                                          4. Transfer import containers to off-dock container terminal  
                                          5. Relocate vessels to other terminals                                                                                      |
Recommendations for the container terminal industry on the improvement strategies...

1. The increased volume of container handling operations that has occurred

   Reduce the frequency of the foregoing problem by distributing the amount of work in each bay evenly when formulating loading stowage plans.

2. The main cause of delay is in the handling of overheight

   Purchase extra overheight spreader and increase the number of racks.
Conclusions

- Recommendations for the container terminal industry on the improvement strategies…

3. Compile equipment and facility breakdown and troubleshooting time databases to find ways of reducing failure time and improving the transmission of expertise

- Evaluation of the performance of maintenance and repair personnel
- Determination whether equipment operators have correct operating skills
- Provide on-site shipside personnel with a means of making correct judgments
- Appropriate strategies for minimizing failures

4. Develop new operating software, increase stowage planning efficiency, and lessen human errors in the use of container yard storage areas.

- Adopt up-to-date handling equipment with larger spans, higher elevations, and faster movement
Suggestions for further academic research on related topics

- Shipping companies and terminal operators hold different views on the issue, which deserves further research by scholars and experts working in the field.
- The case study company had no such failure factors, which was chiefly attributable to the professional skills and working attitudes of stowage planners and dock workers, also reflected the company's unique management and evaluation practices.
- Further data collection should be extended to international shipping companies, terminal operating companies located in other countries to collect more optimal assessment criteria of container terminal shipside’s operating.

Suggest that researchers study the human resource management of dock workers.
The end
Thank you for listening

Yi-Chih Yang, Yao-Lang Hong

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