EFFECTS OF THE IMPLEMENTATION OF 5S IN HEAVY MACHINERY MAINTENANCE WORKSHOPS

Cristina Ruiz, Tito Castillo and Marcel Paredes
1. Background

The intensive use of machinery is the **PRODUCTION CORE** of a road construction company.

- **Maintenance works**
- **Availability of the equipment**
- **High machinery mobility costs and several days of work stoppage**
- **Conventional techniques**
- **Unskilled personnel**
- **Inadequate site conditions**

Heavy equipment maintenance workshops
2. PROBLEM

If 5S is implemented in the workshop of a road construction company, will improve its efficiency and availability of heavy machinery and occupational safety indicators.

3. HYPOTHESIS AND OBJECTIVES

HYPOTHESIS

If 5S is implemented in the workshop of a road construction company, will improve its efficiency and availability of heavy machinery and occupational safety indicators.

GENERAL OBJECTIVE

Know the effects of 5S implementation.

SPECIFIC OBJECTIVES

Implement 5S in the machinery maintenance workshop of a road construction company.

Measure the current situation of the workshop under study, using indicators of maintenance of road equipment and occupational safety.
4. Methodology

- Bibliographic review of 5S
- Technical visit was made to a Toyota car maintenance workshop
- Meeting with the workers of the company under study
- Opinion survey (Seven questions) carried out on 20 workshop workers
KPI (CALCULATION AND EVALUATION EQUATION)

1. EQUIPMENT AVAILABILITY

\[
DA = \left( \frac{\text{Worked hours}}{\text{Number of stops}} + \frac{\text{Hours under repair}}{\text{Number of stops}} \right) \times 100
\]

\[
DA = \%, \text{ Equipment availability}
\]

2. AVERAGE TIME IN MAINTENANCE

\[
\text{MTTR} = \frac{\text{Hours in repairs}}{\text{Number of stops}}
\]

\[
\text{MTTR}, \text{ Average time in maintenance}
\]

3. REPAIRED EQUIPMENT

\[
\text{PT} = \frac{\text{Repaired equipment}}{\text{Man hours employed}} \times 100
\]

\[
\text{PT} = \frac{\text{Repaired equipment}}{100\text{HH}}
\]

\[
\text{PT}, \text{ Repaired equipment}
\]

4. WORK OVERLOAD

\[
B = \left( \frac{\text{Work pending to be executed}}{\text{Man hours available}} \right) \times 100
\]

\[
B = \frac{\text{Non repaired equipment}}{100\text{HH}}
\]

\[
B, \text{ Work overload}
\]

5. ACCIDENTS INDEX

\[
\text{IFA} = \left( \frac{\text{Number of accidents}}{\text{Man hours available}} \right) \times 100
\]

\[
\text{IFA} = \frac{\text{Accidents}}{100\text{HH}}
\]

\[
\text{IFA}, \text{ accidents index}
\]

6. TRAINING HOURS

\[
\text{Training} = \frac{\text{Training hours}}{\text{Maintenance hours}}
\]
Adaptation of the worker to the 5S methodology
Implementation 5S

- Frequent use
- Occasional use
- Rare use
- Improbable use

Can it be located in another warehouse?

- YES
  - Repair
  - Ordenar
  - Relocate

- NO
  - Re-use
  - Waste
  - To sell

FIRST S, SORT
SECOND S, SET IN ORDER

WITHOUT 5S

WITH 5S
THIRD S, SHINE

FOURTH S, STANDARDIZE

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### 5. RESULTS AND DISCUSSION

#### BASE LINE OF WORKER PERCEPTION

<table>
<thead>
<tr>
<th>AREA</th>
<th>SYMBOL</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUSINESS MANAGER</td>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>ADMINISTRATION</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>CELLAR</td>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>WELDER</td>
<td>W</td>
<td>4</td>
</tr>
<tr>
<td>MECHANICS</td>
<td>M</td>
<td>5</td>
</tr>
<tr>
<td>MACHINERY OPERATORS</td>
<td>O</td>
<td>7</td>
</tr>
<tr>
<td>CLEANLINESS</td>
<td>CL</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>20 WORKS</strong></td>
</tr>
</tbody>
</table>

- **TOTAL** 20 WORKS

#### OPTIMUM
- CL1
- M3
- W1
- A1
- M2
- C1

#### DREADFUL
- B1
- W2
- W3
- O4
- O5
- O6

#### BEFORE 5S
- M4
- O3
- M1
- M5
- O7
- O1
## INDICATOR BASE LINE

<table>
<thead>
<tr>
<th>1. EQUIPMENT AVAILABILITY</th>
<th>2. AVERAGE TIME IN MAINTENANCE</th>
<th>3. REPAIRED EQUIPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>45%</td>
<td>03:00</td>
<td>12</td>
</tr>
<tr>
<td>90%</td>
<td>06:00</td>
<td></td>
</tr>
<tr>
<td>21.05%</td>
<td>03:45 Repair / Stop</td>
<td>22.03</td>
</tr>
<tr>
<td>HIGH repair frequency</td>
<td>Maintenance carried out CORRECTLY</td>
<td>Machinery CORRECTLY repaired</td>
</tr>
<tr>
<td>NO WORK OVERLOAD</td>
<td>ACCIDENTS INDEX</td>
<td>TRAINING HOURS</td>
</tr>
<tr>
<td>46</td>
<td>14 Acc</td>
<td>16H:00</td>
</tr>
<tr>
<td>55</td>
<td>25 Acc</td>
<td>20H:00</td>
</tr>
<tr>
<td>8.84</td>
<td>8.00 Acc/100HH</td>
<td>0.00H:00</td>
</tr>
<tr>
<td>Unrepaired Machinery/ 100HH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACCEPTABLE accident rate</td>
<td></td>
<td>DO NOT INVEST hours of training</td>
</tr>
</tbody>
</table>
WORKER PERCEPTION AFTER 5S

<table>
<thead>
<tr>
<th>AREA</th>
<th>SYMBOLOGY</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
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<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>20 WORKS</strong></td>
</tr>
</tbody>
</table>

OPTIMUM

DREADFUL

AFTER 5S
### WITHOUT 5S

<table>
<thead>
<tr>
<th>1. EQUIPMENT AVAILABILITY</th>
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<th>3. REPAIRED EQUIPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
<td>03:00</td>
<td>12</td>
</tr>
<tr>
<td>45%</td>
<td>03:45</td>
<td>22.03</td>
</tr>
<tr>
<td>21.05%</td>
<td>06:00</td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td>05:57 Repair/Stop</td>
<td></td>
</tr>
<tr>
<td>22.22%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**HIGH repair frequency**

**Maintenance carried out CORRECTLY**

**Machinery CORRECTLY repaired**

### WITH 5S

<table>
<thead>
<tr>
<th>4. WORK OVERLOAD</th>
<th>5. ACCIDENTS INDEX</th>
<th>6. TRAINING HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrepaired machinery/100HH</td>
<td>30.77</td>
<td>00H:00</td>
</tr>
<tr>
<td>8.84</td>
<td>25 Acc</td>
<td>16H:00</td>
</tr>
<tr>
<td>0</td>
<td>0 Acc</td>
<td>08H:86</td>
</tr>
<tr>
<td>46</td>
<td>55</td>
<td>08.00 Acc</td>
</tr>
<tr>
<td>55</td>
<td>8.00 Acc</td>
<td>3.00 Acc/100 HH</td>
</tr>
</tbody>
</table>

**NO WORK OVERLOAD**

**IMPROVEMENT of the accident rate**

**INCREASED hours in staff training**
6. CONCLUSIONS

The hypothesis raised at the beginning of this investigation was confirmed for the work efficiency indicators and not for all indicators of machinery availability.

Several indicators did not improve because the machinery has exceeded its useful life.

5S achieved a significant improvement in occupational safety indicators measured as accidents.

7. RECOMMENDATIONS

The time allocated for the implementation of 5S must be constant and methodical process.

Use incentives to motivate and maintain implementation of 5S and continuous improvement.

The use of visual tools is recommended, since its use generate interest in senior management and engagement of workers in the development of the methodology.