Multi-faceted Solutions for Test Cells Downtime Reduction

Department of Industrial Systems Engineering and Management (ISEM) | IE3100M Systems Design Project AY2020/2021
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Project Overview

COMPANY BACKGROUND

TechnipFMC is a global leader in oil and gas equipment manufacturing in subsea and surface projects.
Its vision is to enhance the world's energy industry performance. This is achieved through integration of practices and technologies to simplify systems and processes.

PROBLEM DESCRIPTION

>76 Breakdowns in a year

31.5% Disruption in operating hours

Only **reactive maintenance** being practiced

No spare parts **inventory**

Lack of data recording and analysis

ROOT CAUSE ANALYSIS

Pareto Analysis Using the 80/20 Pareto principle, it was found that 80% of the test cell breakdowns in the A&T department are caused by door, hose, platform and roof. The following areas will be analysed further.

TARGETED (DOOR) IMPROVEMENTS
highest incidence rate, yet nothing is being done

OVERALL PROCESS IMPROVEMENTS
proposed to craft a more holistic strategy.

PROJECT OBJECTIVE

Develop a holistic maintenance plan to
- ✓ Reduce total unplanned downtime
  - ✓ Reduce breakdown frequency
  - ✓ Reduce downtime duration
- ✓ Achieve Total Productive Maintenance

Ultimate goals
- ➔ Lower operating cost
- ➔ Improve competitiveness

Methodology

Data pre-processing
- WhatsApp chat
- Experts
- Literature

→ Problem identification
- Data analysis - Pareto analysis

→ Solution formulation
- Total Productive Maintenance
- Framework

→ Solution Implementation
- Cost-benefit analysis
- MCDA

DOOR SOLUTIONS

Regular Door Maintenance

Conducted at regular intervals to keep the door functioning effectively during its expected lifetime.

An analysis based on the following method is conducted to achieve the optimal maintenance strategy.

1. Determine cost involved → 2. Calculate cost of failure and maintenance → 3. Conduct scenario analysis → 4. Analyze optimal maintenance strategy

Results: conduct planned maintenance semi-annually → up to 75% reduction in breakdown frequency

- ✓ Minimises breakdown
- × Potential extra maintenance conducted

Door Condition-Based Maintenance

A form of predictive maintenance that predicts future door breakdown using machine learning tools and the real-time speed of the door opening and closing.

- ✓ Timely door maintenance
- ✓ Eliminates redundant maintenance
- × Structurally challenging because of the door mechanism

Remote Door Alignment

Remote control of door which eliminates the need to ascend the test cell to align the doors.

- ✓ Improves workplace safety
- ✓ Reduce fixing duration
- × Potential damage to ball screws of the door

OVERALL SOLUTIONS

Digitalised Daily Checks

Daily inspection of test cells by technicians via a digitalised checklist.
- The data can be stored for data analysis in the future.

- ✓ Early identification of problem
- ✓ Increase technician ownership
- × Training required for technicians
- × Extra work for the technicians

Alarm Management

- Record and store alarm history
- Targeted troubleshooting manual for each alarm

- ✓ Reduce diagnosis time
- ✓ Lighten maintenance team's workload

Breakdown Troubleshooting Indicator

Use of a digital interface that will visualize the interpretation of common I/O lights, reducing the problem diagnosis duration and hence downtime duration.

Inventory Management

- An approach to control the level of inventory to ensure that the right amount of stock is available at the right place, time and cost.
- The following method is used to achieve the optimal inventory strategy with Q,R policy.

1. Gather spare parts list → 2. Determine demand, criticality and value → 3. ABC analysis → 4. Determine required service level → 5. Determine optimal Q*,R*

Parameter

τ	*lead time*
K	*fixed cost*
I	*opportunity cost (WACC)*
c	*variable cost*
h	*holding cost ($I * c$)*
α	*service level*
μ_τ	*average demand during lead time*
σ_τ	*std deviation of demand during lead time*

Formula

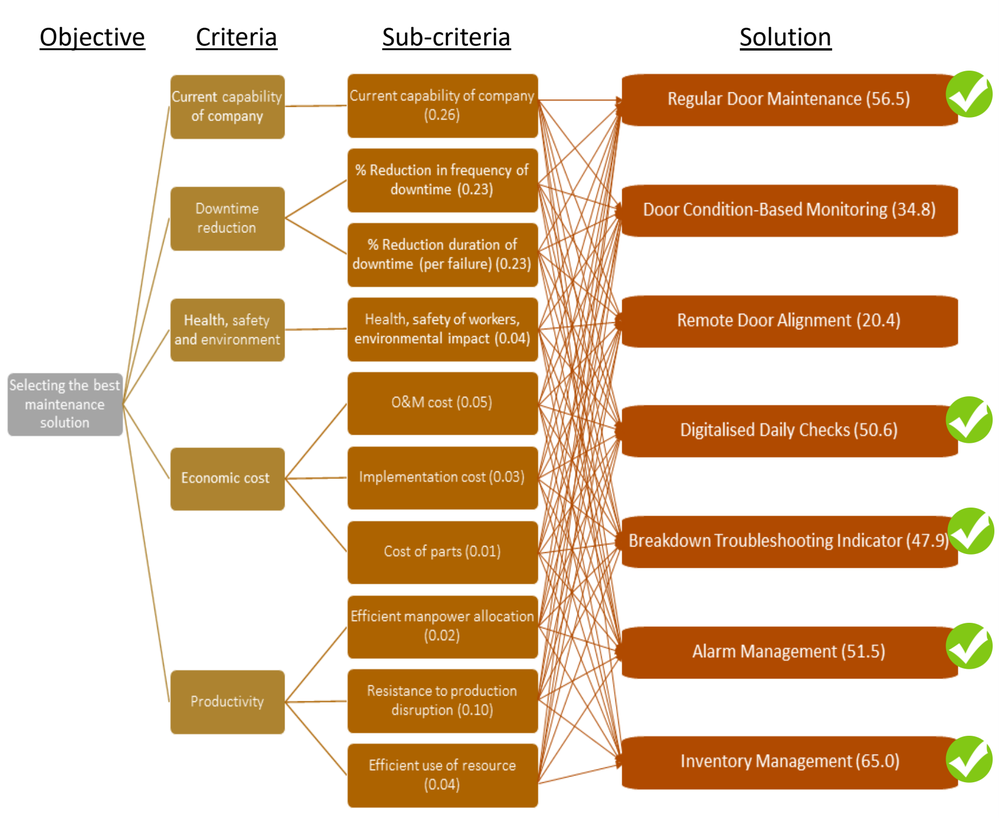
$$Q^* = \sqrt{\frac{2KD}{h}}$$

$$R^* = \sigma_\tau z + \mu_\tau$$

- ✓ Mitigate demand uncertainty
- ✓ Ensures that spare parts are readily available
- × Holding inventory is costly

Ranking of Solutions – MCDA

A Simple Additive Weighting method was used to determine the top 5 solutions.
- Adds up the weighted sum of performance scores for all alternatives.



SOLUTION IMPLEMENTATION

Human-Machine Interface (HMI)

PROPOSAL

REGULAR DOOR MAINTENANCE
- Include a door counter to track door usage
- A prompt to conduct maintenance when the usage target is reached

DIGITALISED DAILY CHECKS
- Record and save daily checks
- An alert will be triggered if the check has not been done

ALARM MANAGEMENT
- **Alarm alert** – a pop-up that alerts the user immediately when an issue is detected, direct user to the troubleshooting guide
- **Troubleshooting guide** – step by step guide which contains a targeted response
- **Alarm history** – record of past alarm information for further analysis

IMPLEMENTATION (PILOT)

- Liaised with vendor
- Cost and feasibility checks
- Multiple design revision while prioritising functionality and ergonomics

- ✓ Ensures that the solutions are in one single platform
- ✓ Ease of adoption
- ✓ Efficient data management

Inventory Management

INVENTORY MANAGEMENT
Utilise the existing tooling management software, Indysoft, to track the current stock count and alert the relevant stakeholders when the reorder point is reached

WAREHOUSE MANAGEMENT
Maintain the current manual method since limited items are involved

PURCHASING
Maintain the current method in short term

REGULAR AUDITING
Tally actual stock count with data in Indysoft

Limitations

- Raw data with limited timeframe for problem identification & RCA
- Analysis done in COVID-19 period need to be re-evaluated
- Limited resources to accelerate solution implementation

Key Achievements

- **7** Targeted and overall solutions proposed
- **5/7** Solutions approved and implemented
- **Up to 80%** Unplanned downtime reduction
- **Up to $50k** Annual savings per test cell

Future Recommendation

DATA INTEROPERABILITY
Centralised system to collect, store and manage data

ROBOTIC PROCESS AUTOMATION
Automate the ordering of parts when the reorder point is reached

HMI
Portable HMI, Continuity of solution (predictive analytics)

Key Technical Skillsets

- **DATA ANALYTICS** Pareto Analysis
- **INVENTORY MANAGEMENT** Q, R Policy
- **QUANTITATIVE ANALYSIS** Cost-Benefit Analysis
- **MULTI CRITERIA DECISION ANALYSIS** Simple Additive Weighting