Failure Diagnostic System

Schlumberger

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IE3100R Systems Design Project | Department of Industrial & Systems Engineering

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I. Objective

"How might we expedite and improve the "Dismantle-Inspection & Failure Analysis" process for each of its stakeholders?"

a. **Inspectors:** A more intuitive and faster documentation process
b. **Failure Analysis Engineers:** A clearer presentation of important information
c. **Service Centre:** Easy access to failure data and improve customer satisfaction

II. Preliminary Hypothesis

"Lack of standardization in dismantle-inspection report adversely affects report cycle time and quality"

a. **Impact on Turnaround Time:** Inadequate dismantle inspectors affect report turnaround time
b. **Impact on Quality:** Omission of key details needed by failure analysis engineers . Time is lost rectifying such omissions (i.e. when more information is requested). Decreased readability due to non-standardization.

III. Problem Overview

Equipment Breakdown
- Shortage of Inspectors
- When more than one equipment breaks down on site, wait time increases exponentially as utilisation easily exceeds 100% at times.

Dismantle-Inspection
- Inspectors have to convert handwritten inspection forms to digital format. Redundancy increases report cycle time unnecessarily.
- Lack of details and prompts in forms when recording observations.

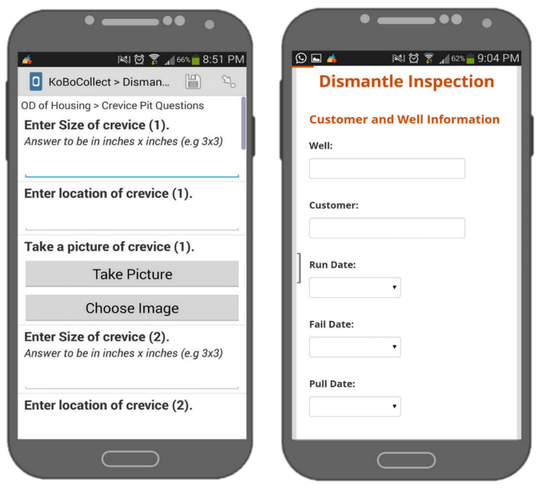
Failure-Analysis
- Lack of report standardization makes failure analysis difficult.
- Omission of key details lead to poorer failure analysis recommendation or lengthen time taken for recommendation as more time is spent requesting for more information.

Post-Failure Evaluation
- Key component performance data not readily accessible. Has to be retrieved from individual reports.
- Thus, trend analysis or customer requests can only be fulfilled by manually summarizing each report (from pdf). Cumbersome process increases time taken for such actions.

IV. Envisioned Process

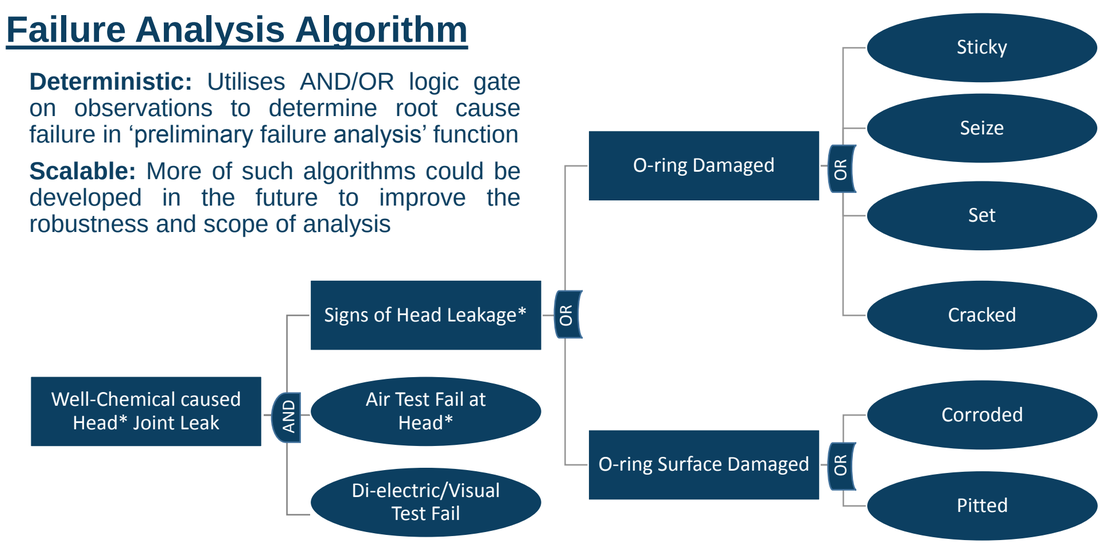
Digitalised Inspection Form

- **Intuitive Flow:** Line of inquiry adheres to how the equipment is dismantled and inspected.
- **Semantically Meaningful:** Labels and question sets are clustered with respect to individual components to create 'natural' pauses in damage recording.
- **Clutter Free:** Questions generated will be specific to configuration. Prompts for more detailed capture of damage will appear when damages are noted. Thus, reduces clutter.
- **Save Option:** Allows user to save drafts. An essential feature as fault documentation is a lengthy process.
- **Photographic Input:** Complements fault documentation by linking photos to relevant component damages. Photos taken will be named accordingly, facilitating the failure analysis process.

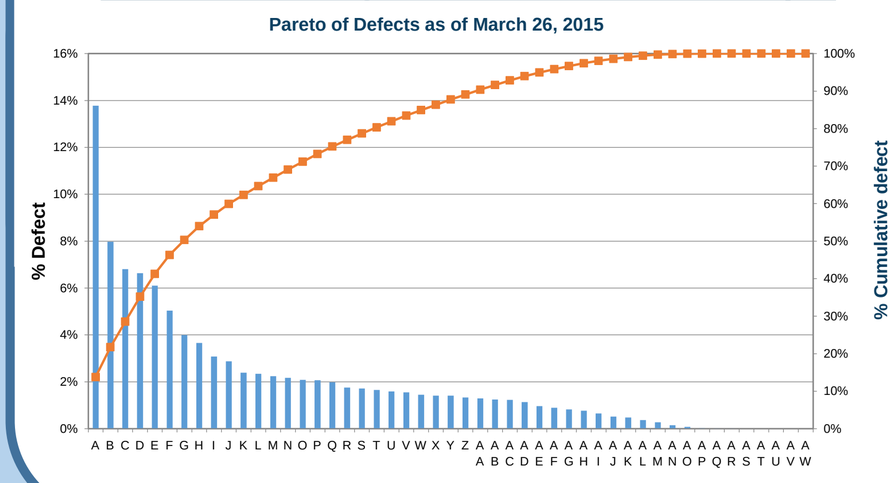


Failure Analysis Algorithm

- **Deterministic:** Utilises AND/OR logic gate on observations to determine root cause failure in 'preliminary failure analysis' function
- **Scalable:** More of such algorithms could be developed in the future to improve the robustness and scope of analysis



Statistical Analysis – Pareto Chart Sample



- **Pivot Table:** Pulls and compares a variety of failure data (i.e. component failure, well location, etc) & compares it against performance data (i.e. run life, report count, etc)
- **Pareto Charts:** Can be plotted to identify most frequent failures based on how different types of data are compared in the pivot table. Can be used to validate trends.

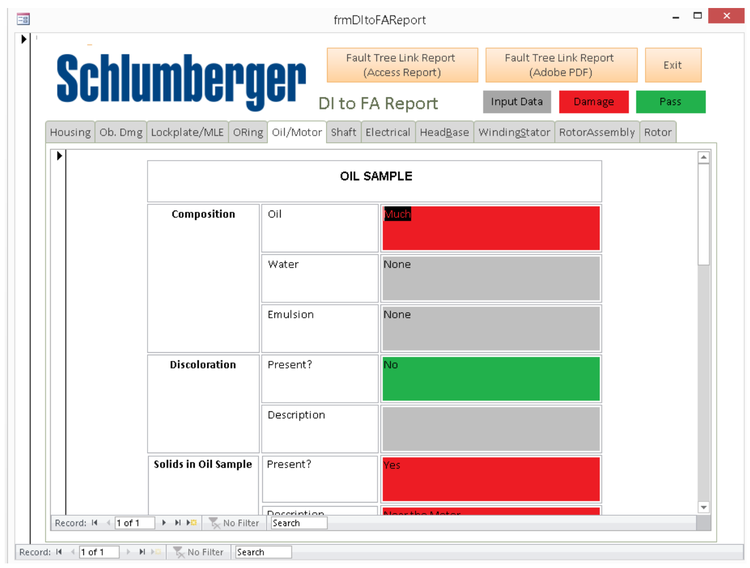
Equipment Breakdown
- ***Digital Inspection Form*** & ***Report Generator*** lowers training demands for inspectors
- More personnel to do inspections
- Dismantle inspection could be performed without delay

Dismantle Inspection
- Inspectors use ***Digital Inspection Form*** to capture observations
- Inspectors import inputs from form to ***Dashboard***
- Generates and edits dismantle inspection report via ***Dashboard***

Failure Analysis
- Failure analysis engineers read report from ***Dashboard***
- ***Failure Analysis Algorithm*** identifies potential root-cause failures in report
- Engineers make their recommendations via ***Dashboard***

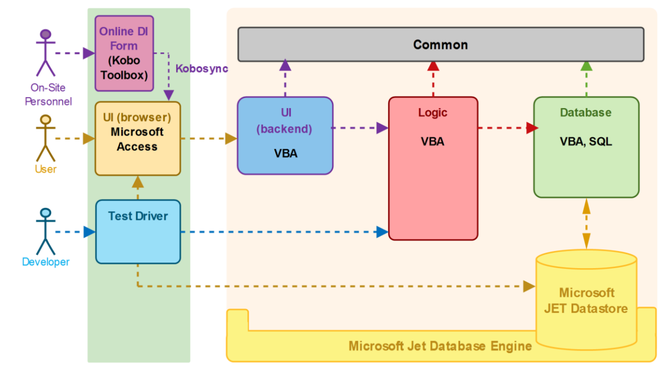
Post-Failure Evaluation
- Service centre personnel retrieves relevant failure information from ***database*** for client
- Use Pivot table & Pareto chart functions to perform statistical analysis to review trends in failure

Dismantle-Inspection Report Generator



- **Improved Readability:** Form design guided by HFE (Human Factors Engineering). Techniques such as colour coding and semantic categorisation facilitate readability by reducing mental workload.
- **Customisable:** Allows inspectors to review and edit recorded damages before handover to failure analysis engineers.
- **Preliminary Failure Analysis:** In-built function generates a diagnostic report based on observed damages for the engineers. In doing so, it supplements their diagnosis of root-cause failures.

Software Architecture



- **User Interface:** The UI are forms that are built on and generated by Microsoft Access. Inspectors can use an app or fill up an online inspection form hosted on Kobotoolbox and using Kobosync. Data captured ports into the application through Microsoft Access forms.
- **Logic:** The main logic is run in VBA.
- **Storage:** Storage uses the persistence framework provided by Microsoft JET Engine framework (in-built Microsoft Access engine). The relevant data are also stored in tables.
- **Common:** The Common component contains utility code used across the application.

V. Implementation & Impact

Digitalised Inspection Form
- Intuitive flow of inquiry makes it easier to train more inspectors for dismantle-inspection
- Prevent omission of key damage observations by capturing the right level of details

Dismantle-Inspection Report Generator
- Quick generation of report saves time for inspectors
- Comprehensive display of observed damages
- Improve readability and failure analysis through use of HFE concepts in report design

Preliminary Failure Analysis
- Expedite the failure analysis process by presenting said relations to failure analysis engineers
- Highly scalable as robustness of algorithm can be improved by building on existing relations

Database of Failure Information
- Supports quick retrieval of key data for customer requests in service centre
- Ease of performing trend analysis and validate hypothesis via Pivot table and Pareto chart functions