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A STUDY OF PROCESS ANOMALIES LEADING TO PLANT TRIPS AND THE EFFECTIVENESS OF A SOFTWARE TOOL IN TRIP PREVENTION

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ABSTRACT

In the hydrocarbon process industry, financial losses resulting from plant trips can be significant. In this study, reliability loss events or trips in 2018 at a sizeable hydrocarbon process plant are analysed to determine if they were preventable. Of particular interest is those loss events that exhibited early signs of process anomalies—such as temperature, pressure, and flow—at least twelve hours before the event. Using the concept of 'reliability incident pyramid' where plant process anomalies outnumber production slowdown and trip events, a software tool is deployed to help process engineers detect the anomalies. The idea is that troubleshooting these anomalies before they escalate to plant trips would reduce the number of trips and prevent production losses. Post-deployment plant process data for 2019 are analysed to determine if process engineers could pick up on the anomalies indicated by the software and intervene to prevent potential plant trips. Results indicate that in conjunction with vigilance by the process engineers, such software can reduce the number of reliability loss events in a hydrocarbon process plant.

Keywords: *Process anomalies, reliability incidents, loss events, reliability incident pyramid, CUSUM, EWMA, SPC*

INTRODUCTION

Loss events affecting reliability in a sizable hydrocarbon process plant can range between 10-11% of total production in 2016-2019 (Figure 1). The authors' plant translates to between USD 4-5 billion of annual sales revenue. Based on post-event investigations, it became apparent that some of the loss events were preventable many hours before the actual plant trip. So then, the business impetus is to ask the question: *If telltale signs could be detected early before plant tripping, what method and tool(s) can be deployed to detect these signs?*

In this study, the use of a software tool called Dynamic Risk Analyser (DRA) is assessed in a live plant. In addition, losses from plant trip events before and after the deployment of the software are analysed. The objective is to verify its applicability and attest to its effectiveness when deployed in a big-scale plant operation involving equipment and plant processes and the dynamics of the organisation and its people running the plant.

METHODOLOGY

Reliability practitioners sometimes use the 'reliability incident pyramid' concept to describe loss events involving plant production (Figure 2). It is similar to the Occupational Safety and Health (OSH) incident pyramid proposed by Heinrich [1]. Although Heinrich's original idea has now been shown not to represent low frequency, high impact incidents such as those related to process safety [2]-[3], the idea about 'reliability incident triangle' is relevant in production equipment and production equipment processes a plant [4].

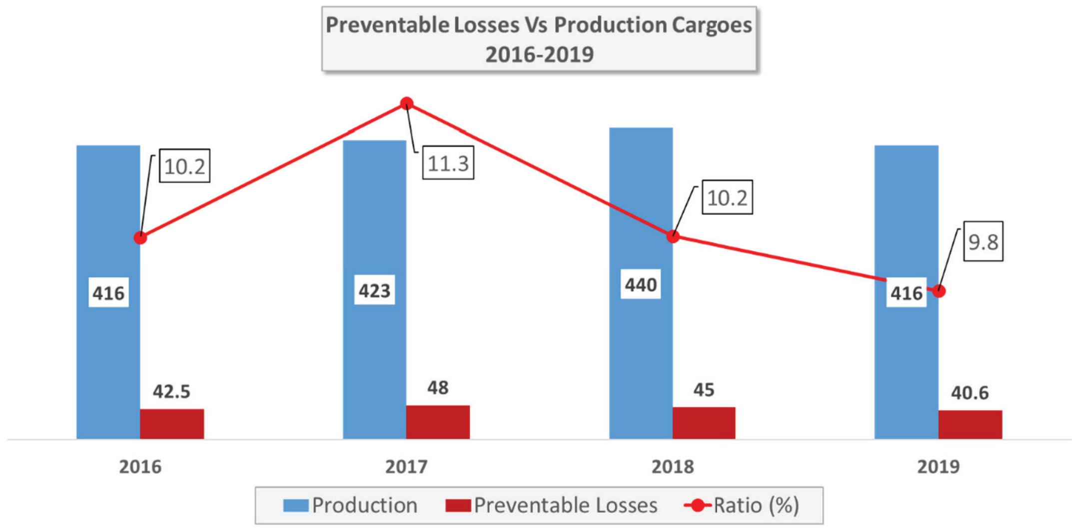

Figure 1 Unplanned production losses in a hydrocarbon plant can range between 10-11% of total plan production in 2016-2019

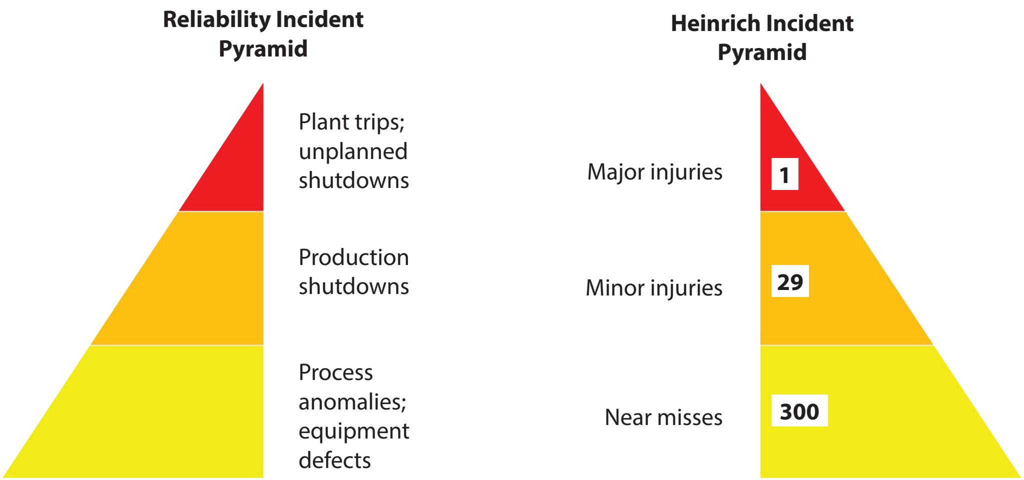

Figure 2 Occurrences of reliability incidents in a plant draw some parallels with the OSH incident pyramid proposed by Heinrich

Several authors stated that plant trips could be prevented if there are means to monitor anomalies in process parameters, intervene early, and bring them back under control [5],[6]. Often, this involves analysing real-time process parameters using approaches such as statistical process control (SPC) and techniques such as cumulative sum analysis (CUSUM) and exponentially weighted moving average analysis (EWMA).

Using actual plant trip data, we ask: To what extent could these trips *have been prevented if we had intervened to stop process anomalies from escalation?* The answer to this question is essential to plant management. If it is significant, a business case (or otherwise) can be made to embark on a program and deploy a software tool for early detection of these anomalies.

Figure 3 shows the methodology used in this study. First, plant trip events in 2018 are analysed to identify their causes. These causes are then categorised into preventable and non-preventable. Next, out of the preventable causes of the loss events, further analysis is carried out to check if the loss events came with process anomalies at least twelve hours ahead of the events. Twelve hours is selected because it is considered a reasonable period during which trouble-shooting can bring the process parameters back in control. Finally, this category of loss events is used

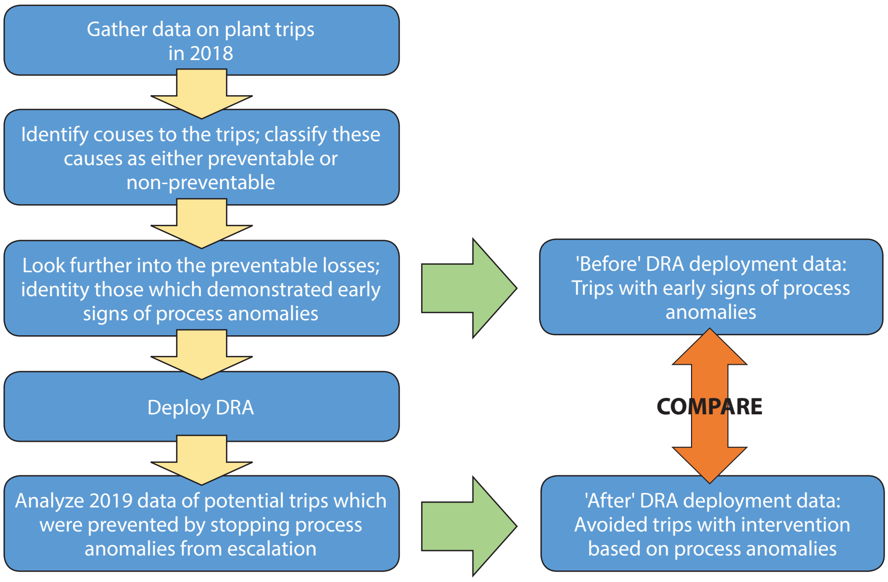

Figure 3 Steps used in this study to find out if deployment of software to detect process anomalies would be able to reduce the number of preventable plant trips

as the baseline for comparison between 'before' and 'after' deployment of DRA to detect early signs of process anomalies. The 2019 plant trips are the 'after' deployment data.

RESULTS AND DISCUSSION

Thirty-seven out of forty-four loss events in 2018 are classified as preventable. Causes of these preventable events include errors during maintenance activities and operations. Out of the 37 events, five showed signs of process anomalies at least six hours before the trip events. Due to this downtime, the plant suffered an estimated loss production opportunity of RM 97 million.

Analysis of 2019 loss events—after DRA was deployed—shows that 18 potential plant trips were avoided because process engineers could detect process anomalies, allowing early intervention to prevent the trips. In addition, one actual trip event showed early signs of anomalies but was not picked up by the engineers due to some undetermined reasons. Thus, in total, DRA provided indications of impending failure during 19 occasions.

CONCLUSIONS

The use of software tools such as DRA can assist process engineers in detecting early signs of process anomalies. This allows them time to troubleshoot to bring the process parameters back under control. However, the ability to detect signs of impending failures is non-trivial in a hydrocarbon process plant where every minute of production counts—a one-hour trip event of a production module can cost as much as USD 0.5 million in the case of the plant studied in this work.

In this study, empirical data were not gathered and analysed to prove or disprove the concept of the reliability incident triangle. Nevertheless, it would be interesting to compare the number of process anomalies detected with production slowdowns and plant trip events. The collection of data for anomalies and plant trips is within the practical realm of future studies. However, challenges remain in collecting data on production slowdowns; on any given day, a multi-module production plant such as the one used in this study can experience several slowdown events. Therefore, a detailed and time-consuming analysis of the plant information system is required for this purpose.

Commercial software such as DRA comes at a price. Eventually, the decision to deploy such software comes down to a business decision. However, if the cost-benefit analysis favors deploying such software, the value it brings can quickly pay for the investment.

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