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Impact of PFMEA Implementation with Fuzzy Approach on Improving Overall Equipment Effectiveness in the Sugar Industry

Mohammad Baghbani¹, *Soleyman Iranzadeh²,
Majid Bagherzadeh khajeh³

1-Ph.D Student, Department of Industrial Management, Tabriz Branch, Islamic Azad University, Tabriz, Iran

2-Prof, Department of Industrial Management, Tabriz Branch, Islamic Azad University, Tabriz, Iran. (Corresponding author). Email: Dr.iranzadeh@yahoo.com

3-Assistant Prof, Department of Management, Tabriz Branch, Islamic Azad University, Tabriz, Iran

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Extended Abstract

Abstract

The purpose of this study was to investigate the effect of the implementation of the PFMEA on the improvement of the overall equipment effectiveness (OEE) in a sugar factory. First, the average Overall Equipment Effectiveness in the production process in eight consecutive working weeks was extracted as a pre-test. Then, the types of potential failures in the production process were identified and the three parameters of the severity of the failures, the probability of occurrence of the failures and the probability of failures detection for each failure mode were extracted in linguistic variable and determined by group discussion and by collective agreement and multiplied by corresponding numerical values. These three parameters in each other, the number of priority numbers for each failure, was calculated. In the next step, 24 priority failures were identified by the severity-occurrence matrix and risk ranking table. Then, appropriate strategies for reducing the effects or eliminating prioritized failures were identified and implemented, corrective actions and necessary interventions were planned over a period of eight weeks. During the implementation of the interventions and at the end of each week, the Overall Equipment Effectiveness was calculated as a post-test. At the end of the study, the relationship between the risk priority number (RPN) and OEE was studied in the form of the Pearson correlation.

Introduction

Previous studies have shown that reducing or eliminating of failures, effects on machinery and equipment and increasing their availability, quality and performance will lead to improve the quality and quantity of products and services provided by various organizations (Hassan, Siadat, Dantan, & Martin, 2010; Helvacioğlu & Ozen, 2014). Many techniques have been developed to identify, assess and manage the risks involved in various processes. FMEA is one of the most efficient of these techniques (Banduka, Mačuzić, Stojkić, Bošnjak, & Peronja, 2016; Căndeaa, Kifor, & Constantinescu, 2014; Elahi, 2018). OEE, on the other hand, is one of the tools used to improve the efficiency of the manufacturing process. This simple and practical tool, identify major and common sources of production related losses and divides them into three main groups to improve equipment efficiency (Ahire & Relkar, 2012). The purpose of this research is to investigate the impact of PFMEA implementation on OEE in a sugar manufacturing company .

Case study

The research was carried out at the Kurdistan Sugar Factory.

Materials and Methods

At first, the PFMEA implementation team was formed with the participation of process owners and the then process of sugar production from raw sugar to crop production was thoroughly studied and analyzed. In the next step, as the production processes were extracted, the rate of OEE in the production process was extracted over a period of two months and as one-week intervals as a pre-test. Then, in the next phase of the study, within two working months, a variety of possible errors and failures that had an impact on reducing the quantity and quality of product and process outputs were identified. In the next step, according to the types of failures, the three parameters of severity, occurrence probability and detection probability of each failure by collective agreement were extracted in linguistic scales and then fuzzy risk priority number was calculated. Afterward, by using the severity-occurrence matrix and risk ranking table, failures that were on the priority of needing corrective action were identified. Next, during brainstorming sessions, appropriate solutions were suggested for corrective actions, and these strategies were implemented in priority over eight weeks. In order to ensure the effectiveness of the measures taken, OEE was calculated as a post-test at one-week intervals over two working months. By comparing the post-test results with the pre-test results, the effectiveness of the interventions taken was analyzed. In fact, the innovation aspect of this research compared to the past research is the use of appropriate pre-test and post-test to ensure the effectiveness of interventions taken. Also, at the end of each week, the fuzzy risk priority number for the new situation was

extracted from the project implementation team and finally, considering the normality of the parameters of the two tools, the correlation coefficient between RPN and OEE during the eight working weeks were tested.

Discussion and Results

In this study, the OEE technique was used as pre-test and post-test to ensure the accuracy and effectiveness of the actions and interventions implemented in the framework of PFMEA technique implementation. According to the results of this study, fuzzy PFMEA implementation has increased the overall equipment effectiveness, so it can be said that the implementation of PFMEA with the participation of process owners will improve production status and achieve higher effectiveness.

Conclusion

In this study, the relationship between risk priority numbers and overall equipment effectiveness was negative. Based on the data gathered, the relationship was defined as follows.

$$OEE = 0.773 - 0.024 * RPN$$

According to the above correlation formula, by reducing one RPN unit, the overall equipment effectiveness will increase 0.024 units. In other words, proper implementation of corrective actions will reduce the average risk priority number, and this reduction in RPN will in turn increase the overall equipment effectiveness.

Keywords: PFMEA, OEE, RPN, Fuzzy