# Correlating Failure Mode Effective Analysis (FMEA) & Overall Equipment Effectiveness (OEE)

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*Abstract :* To compete in global market, no organization will tolerate losses. Overall Equipment Effectiveness (OEE) is such a performance measure metric which will indicate performance rate with very simple calculations. It considers all important measures of productivity. Implicitly it indicates amount of losses each parameter contributes to reduce productivity. By applying quality improvement tool such as failure Mode and Effect Analysis (FMEA) root cause of any OEE measure can be found out. It will help to improve OEE and correspondingly productivity. In this paper an attempt has been made to establish a relationship between OEE and FMEA. All the parameters of OEE (i.e. Availability, Performance Rate and Quality Rate) are evaluated with respective to FMEA (i.e. severity, occurrence and Detection). Total 32 hypothesis are considered to establish relation between OEE and FMEA. A case study conducted in one of reputed process industry gives very significant insight for OEE improvement. Power of Excel tool is explored in this paper.

Keywords- OEE, RPN, FMEA, Hypothesis

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## I. INTRODUCTION

In the face of current global competition and increasing demand , there is basic business demand to improve manufacturing performance.OEE is a "best practices" way to monitor and improve the effectiveness of manufacturing processes (i.e machines, manufacturing cells, assembly lines).OEE is simple and practical, it takes the most common and important sources of manufacturing productivity loss and places them into three primary categories and distills them into metrics that provide an excellent gauge for measuring where you are and how you can improve.[1]

A Failure Mode and Effect Analysis (FMEA) is an engineering technique used to define, identify and eliminate known or potential failures, problems, errors from the system, design, process and or service before they reach the customer. It is a systematic approach and a mental discipline that an engineer normally goes through in any manufacturing process. It is also problem prevention tool and a living document of engineers' thoughts based on experience, past concerns and quality performance indicators. FMEA is an established reliability engineering activity that also supports fault tolerant design, testability, safety, logistic support, and related functions. FMEA is "a systematic, analytical approach to properly plan for defect prevention and

It is a technique for identifying and focusing on those areas in the design and manufacturing process for the prevention, reduction, and elimination of non-conformances in the product or production". The Failure Modes and Effects Analysis (FMEA) is a document to identify the associated with something potentially going wrong such as creating a defect or out of specification in the production of the product. The FMEA identifies what controls are placed in the production process to catch any defects at various stages on the processing. [2]

According to Nakajima (1989) definition, OEE is measured in terms of the six big losses, which are essentially a function of the availability, performance and quality rates of the machine, production line, or factory, whichever is the focus of OEE application.

OEE (%) = Availability (%) x Performance rate (%) x Quality rate (%)

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After a introduction of FMEA and OEE ,we develop a model which can determine the effect of fluctuation of OEE function (availability, performance and quality rates) on RPN and related parameter ( Severity ,Occurrence ,detection ) by investigating relation between the function of OEE and FMEA.

HO: No relation between RPN in FMEA and OEE

Hl: Fluctuation of RPN  have effect on OEE H2 :Fluctuation of RPN has effect on A in OEE

H32: Fluctuation of P in OEE has effect on D in RPN [3] All the above discussion is present in figure 1

## II. METHODOLOGY USED

A case study from the Process industry is used to explain a correlating phenomenon between OEE and FMEA. To compute OEE and RPN, it is required to calculate the value of each parameter. For this company's last 8 month data is collected. By computing the data the values of Availability, Performance and Quality rates are calculated and shown in Tablet. Similarly Severity, Occurrence, detection and RPN is also calculated and shown in Table 2.

Table 2.1 Calculation of OEE (8 months data)

| Month• | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug |
|---|---|---|---|---|---|---|---|---|
| Availability | 0.8525 | 0.845833 | 0.8845 | 0.795673 | 0.843229 | 0.8925 | 0.847917 | 0.79 |
| Performance rate | 0.982472 | 0.917722 | 0.958813 | 0.984503 | 0.987212 | 0.975 | 0.983607 | 0.986086 |
| Quality rate | 0.928502 | 0.918403 | 0.920804 | 0.921403 | 0.921202 | 0.9078 | 0.9445 | 0.938503 |
| OEE | 77.76743 | 71.29008 | 78.09062 | 72.17741 | 76.68512 | 78.99562 | 78.77285 | 73.11013 |

Table 2.2 Calculated Values of RPN (8 months data)

| | Jan | Feb | March | April | May | June | July | Ang |
|---|---|---|---|---|---|---|---|---|
| Severity | 67 | 62 | 58 | 50 | 45 | 40 | 35 | 30 |
| Occurrence | 11 | 13 | 12 | 14 | 10 | 6 | 9 | 4 |
| Detection | 57 | 50 | 42 | 37 | 32 | 25 | 22 | 20 |
| RPN | 42009 | 40300 | 29232 | 25900 | 14400 | 6000 | 6930 | 2400 |

The data collected is used for calculating OEE and RPN of each month i.e. from Jan to Aug. as shown in table 1 and table 2.
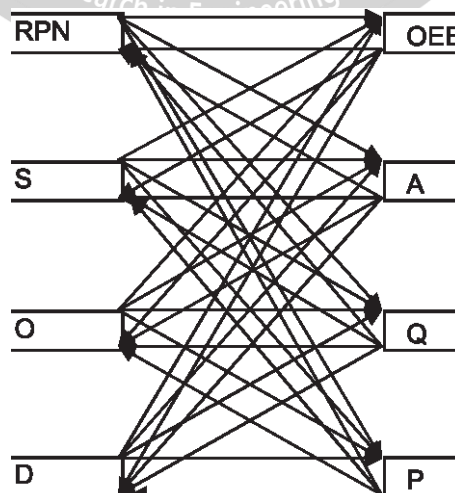
Fig 1 shows the different hypothesis established in between RPN and OEE. Consequently it also shows hypothesis established in between the different parameters of RPN and OEE that are Severity, Occurrence and Detection with respect to Availability, Quality and Performance rate. For Ex

HO :No relation between RPN in FMEA and OEE Hl :Fluctuation of RPN has effect on OEE

H2 :Fluctuation of RPN has effect on A in OEE

H32 :Fluctuation of  P in OEE has effect on D in RPN

Formula given below is used to find out correlation between OEE and FMEA shown in table 3

$$C_r = \frac{\sum XY - \frac{(\sum X \times \sum Y)}{n}}{\sqrt{\left(\sum X^2 - \frac{(\sum X)^2}{n}\right) \times \left(\sum Y^2 - \frac{(\sum Y)^2}{n}\right)}}$$

Table 2. 3:  Summarize RPN and OEE index

| Hypotheele | H1 | H2 | H3 | H4 | HS | H8 | H7 |
|---|---|---|---|---|---|---|---|
| Betw9en | RPN | RPN | RPN | RPN | O | O | O |
| Betw9en | OEE | A | a | p | OEE | A | a |
| Correlation | -0.26059085 | 0.134199601 | -0.27130443 | -0.5542592 | -0.27681479 | 0.0315995 | -0.25059678 |
| **Hypothesis** | **H8** | **H9** | **H10** | **H11** | **H12** | **H13** | **H14** |
| Between | O | s | s | s | s | D | D |
| Between | p | OEE | A | a | p | OEE | A |
| Correlation | -0.41358626 | -0.09834396 | 0.304721749 | -0.39007646 | -0.5181817 | -0.16461978 | 0.197435689 |
| **Hypothesis** | **H15** | **H16** | **H17** | **H18** | **H19** | **H20** | **H21** |
| Betw9en | D | D | OEE | OEE | OEE | OEE | A |
| Betw9en | a | p | RPN | s | O | D | RPN |
| Correlation | -0.30163314 | -0.48697973 | -0.2605909 | -0.09834396 | -0.27681479 | -0.16461978 | 0.031599498 |
| **Hypothesis** | **H22** | **H23** | **H24** | **H25** | **H28** | H27 | **H28** |
| Between | A | A | A | a | a | a | a |
| Between | s | O | D | RPN | s | O | D |
| Correlation | 0.304721749 | 0.03159949 | 0.197435689 | -0.25059678 | -0.39007646 | -0.25059678 | -0.3016331 |
| **Hypothesis** | **H2t** | **H30** | **H31** | **H32** | | | |
| Betw9en | p | p | p | p | | | |
| Between | RPN | s | O | D | | | |
| Correlation | -0.41358626 | -0.5181817 | -0.41358626 | -0.48697973 | | | |

## III. RESULT

We have take advantage of Correlation Technique  and MINITAB  software to calculate relation between OEE and RPN values all hypotheses are measured and presented in Table 3.

We have used Correlation coefficient and regression analysis to show the relation between A, Q, P in OEE and 0, S, D in RPN According to values obtain from  Correlation coefficient between RPN and A we say that if RPN in the factory increased , availability will decreased , however equation between this two factor is RPN = - 27694  + 57570  A

## IV. CONCLUSION

After testing all hypothesis established between OEE and FMEA it has been observed that some factors had a positive relationship and some of them had negative. In RPN, availability established a positive relationship. And remaining factors of RPN and OEE shows a negative relationship. Finally from the study we can conclude that low RPN results into high OEE.

## REFERENCES

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