
Failure Mode and Effects Analysis

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What is FMEA?



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Background

- Analysis of failure modes, causes, and effects
- Aerospace in 1960's
- QS9000 in 1993 (automotive)
- Analysis per function, per failure mode
- $RPN = \text{Severity} \times \text{Occurrence} \times \text{Detectability}$
- Action/Results to reduce risk

FMEA Process

- Identify Function, Failure Modes, and Cause
- Then Severity, Occurrence, and Detectability
- Compute RPN
- Decide cut-off
- Identify Mitigation methods
- Adjust Severity, Occurrence, or Detectability and RPN

Example

- Credit card check
- Results
 - Approve
 - Reject
 - Cancel Card

Severity

- What consequence if failure happens
- 1 to 10 Scale
- 1 means no consequence
- No set categories

Occurrence

- Likelihood the failure happens
- 1 to 10 Scale
- 1 means not likely
- No set categories

Detectability

- Likelihood of missing a failure
- 1 to 10 Scale
- 1 means it will be noticed
- No set categories

Example

- Functions
 - Verify credit availability
- Failure Modes
 - Accepts over limit (OL)
 - Rejects under limit (UL)
 - Calls police in error (CP)
- Causes
 - Software error (SE)
 - Input error (IE)

Example (continued)

- | • Severity | • Occurrence | • Detectability |
|------------|--------------|-----------------|
| – OL = 6 | – OL/SE = 4 | – OL/SE = 1 |
| – UL = 4 | – OL/IE = 7 | – OL/IE = 1 |
| – CP = 9 | – UL/SE = 4 | – UL/SE = 6 |
| | – UL/IE = 7 | – UL/IE = 6 |
| | – CP/SE = 3 | – CP/SE = 9 |
| | – CP/IE = 2 | – CP/IE = 9 |

FMEA Table

Function	Failure Mode/Cause	Severity	Occurrence	Detectability	RPN
Credit Check	OL/SE	6	4	1	24
	OL/IE	6	7	1	42
	UL/SE	4	4	6	96
	UL/IE	4	7	6	168
	CC/SE	4	3	6	72
	CC/IE	4	2	6	48

Mitigation

- Actions to reduce risk
 - Severity
 - Occurrence
 - Detectability
- New RPN computed

Adjusted FMEA

Failure Mode/ Cause	Mitigation	Severity	Occurrence	Detectability	RPN
OL/SE	Test	6	4	1	24
OL/IE	Automate	6	2	1	12
UL/SE	Test	4	4	3	48
UL/IE	Automate	4	2	6	48
CC/SE	Test	4	3	3	36
CC/IE	Automate	4	2	6	48

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Metric Data Computations

- What numeric types are Severity, Occurrence, and Detectability?
- What are appropriate computational functions for the data types?
- How accurate is our measurement of each metric? (What is the margin of error?)
- What do RPN computations mean?

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Conclusions

- Analysis is Good
- FMEA framework supports analysis
- Don't take it too far
- Be wary of statistics

