Failure Modes Effects Analysis : *Analysis of the effects of different failure modes*

Objective : To find the risk of failure associated with the different failure modes of processes / products and propose steps to mitigate them, expressed in a simple quantitative way using the metric of Risk Priority Number (RPN).

How the method works : Once QFD is completed we have many technical options available to meet the customer preferences for a product or process in place. We evaluate each of these technical options in terms of the failure possibilities and assess those options that meet the customers expectations and at the same time offer a reasonable estimation of opportunities to prevent failure of the product. By doing a Ishikawa Fishbone analysis, we are able to find the different reasons for failure of the product, attributable to men, machines, materials, methods, measurements and environment.

Failure Mode Effects Analysis is about finding the different failure modes of any activity or process or product, the causes for the failures mentioned herein and the effects of the failure. It helps to find the relative impact of the different failures and gives indication to the decision maker as to what precautions need to be taken to mitigate the risks and failures.

Severity Rating Scale

Rating	Description	Definition (Severity of Effect)
10	Dangerously high	Failure could injure the customer or an employee.
9	Extremely high	Failure would create noncompliance with federal regulations.
8	Very high	Failure renders the unit inoperable or unfit for use.
7	High	Failure causes a high degree of customer dissatisfaction.
6	Moderate	Failure results in a subsystem or partial malfunction of the product.
5	Low	Failure creates enough of a performance loss to cause the customer to complain.
4	Very Low	Failure can be overcome with modifications to the customer's process or product, but there is minor performance loss.
3	Minor	Failure would create a minor nuisance to the customer, but the customer can overcome it without performance loss.
2	Very Minor	Failure may not be readily apparent to the customer, but would have minor effects on the customer's process or product.
1	None	Failure would not be noticeable to the customer and would not affect the customer's process or product.

From historical data we can find the likelihood of occurence of each of these failures, (likelihood of occurence, out of 10), likelihood of detection (likelihood of error being detected before it reaches the end-customer, out of 10), ie. how many defects were detected in-house than on the field and the severity (out of 10) given by a generic 10 point scale given in the table.

Given the likelihood of occurrence (out of 10, with max likelihood given 10), likelihood of detection (out of 10) and severity of this failure (out of 10), a quantitative output of the Risk Priority Number (RPN) is computed as the multiplicative product of these three parameters.. According to the Risk Priority Number, (1<= RPN <= 1000), the failure modes are arranged in descending order of RPN. The higher RPN failure modes are analysed at first with recommendations of the steps taken to mitigate its occurrence. Then the less RPN failure modes are assessed. The least RPN modes may never need to be considered at all as the risk associated with their failure is so low that they can be conveniently ignored. For example, organisations may have a policy to have RPN of less than 200 for its products and services.

Example:

Let us take the case of planning to go for a long ride, about 500 kms, in our car. The first thoughts that come to our mind is whether the car can withstand such a long distance, whether we can get enough refreshing / dining facilities on the way and what will be our condition, whether we will fall sick, after travelling the long distance in the car, once we reach the final destination. Also there is a possibility that the car may meet with a fatal accident or one where all are injured.

We need to find what are the different failure modes, the failure causes and the failure effects. We also plot the likelihood of occurrence (LOO), likelihood of detection (LOD) and severity (Sev.) measures, the product of which is the Risk Priority Number (RPN) used to categorise the failures.

In the case of car accident, the causes of failure could be due to problems related to the car, driver, signals, traffic, roads, environment and so on. We can have detailed matrices to evaluate each of these.

By analysing the Risk Priority Number (RPN), we identify head lamps, poor brakes and coolant leakage / cooling system failure to be among the important reasons leading to the failures having highest failure consequences and hence higher Risk Priority number. Accordingly the headlamps, signal indicator lamps, brakes and coolant system are checked thoroughly for any faults before a long run.

The failure could also be due to driver related problems, signals on the road, oncoming traffic, environment etc which can again be handled similarly by independently reviewing each failure mode.

Sr. no.	Failure modes (car related)	Failure Causes	Failure effects	LOO	LOD	Severity	RPN
1	engine seizure	coolant leakage / cooling system blocked / overheating of engine	major repair, travel not possible	3	7	7	147
2	car catching fire	petrol leakage	major repair, travel not possible	3	3	8	72
3	car hitting against another car/ object/ pedestrian	brake failure	major structural damage to car / dent / loss of life	3	7	8	168
4	car overspeeding and toppling	overspeed, poor brakes	structural damage / dent / loss of life	3	7	8	168
5	car hitting against object / vehicle / pedestrian / animal	headlamps / signal indicator lamps not working	structural damage / loss of life	3	8	8	192
6	car swerving and hitting object	tyre burst	major structural damage / loss of life	3	4	4	48
7	car not moving	tyre puncture	loss of tyre / repair tyre	3	4	2	24

https://www.isixsigma.com/tools-templates/fmea/fmea-preventing-failure-any-harm-done/