# COMPARISON OF FMEA AND FINE KINNEY METHODS FOR RISK ANALYSIS IN TEXTILE MANUFACTURING

**İzzettin Hakan Karaçizmeli**
**Harran University**
**Şanlıurfa**
**Türkiye**

**ABSTRACT**
*Quality management is very important for sustainability. Satisfying customer expectations and keeping costs under control can only be possible with quality management. Barriers to quality can only be managed by keeping the risks of failures and defects under control. Therefore, risk analysis is an important issue. There are various methods in the literature for risk analysis. Failure Mode and Effect Analysis and Fine Kinney Method are two known risk analysis methods. In this study, the use of these two methods for a textile business will be compared.*

**Keywords:** Quality, risk analysis, FMEA, Fine Kinney, textile

## 1. INTRODUCTION

Textile is a labour-intensive manufacturing that includes many processes. In order to produce a fabric, the fibres are first converted into yarn. Then, raw fabric is obtained by weaving or knitting process. The fibres can be used as dyed, if the fibres are colourless, the yarn can be dyed, or the raw fabric can be dyed after weaving. Finally, finishing processes are carried out, in which the use properties are given to the fabric. Thus, the fabric that will pass to the garment stage is obtained.

A sustainable company must be able to meet customer expectations and at the same time keep costs under control. At this point, quality management emerges as a very important and necessary issue. In quality management, defective product sorting was done through post-production inspections in the past. However, today, failure prevention approaches have come to the fore. An important way to avoid defects is risk analysis. If risks are determined and controlled in advance, it will be beneficial in terms of quality. There are many methods for risk analysis. FMEA and Fine Kinney methods are known and widely used methods.

FMEA is a method that identifies and evaluates potential failures in a product or process and the effects of these failures before they occur [1], reduces the probability of failure occurrence, and puts the work done into writing. FMEA was first defined in the American Armed Forces Procedures Document (MIL-P-1629). Then NASA and the automotive industry used the method. Automotive Industry Activity Group (AIAG) and American Quality Control Society (ASQC) prepared and published FMEA standards for the automotive industry in 1993 [2]. FMEA, which is a risk reduction method, is a preventive tool that can also be used to improve production quality by reducing production defects. The Fine Kinney method was developed by Kinney and Wiruth in 1976. Oturakçı et al. (2015), stated that the method is easy to apply.

Again, the authors stated that the method is used in small and medium-sized enterprises and mostly in the construction and cement industry [3].

In the literature, there are examples of the use of FMEA in the field of textiles. Sabır and Bebekli (2015), explained the use of FMEA in textile finishing processes in their study [4]. Özyazgan and Engin (2013) and Özyazgan (2014) have done successful studies on quality in textiles by using the FMEA [5, 6]. Yücel (2007) and Küçük et al. (2016) also used the FMEA to reduce garment defects [7, 8]. The Fine Kinney method is not very common in the literature on the textile industry. Dağsuyu et al. (2020), used the method to identify risks in a textile business [9]. Ak et al. (2021), also used the method for occupational risk assessment in a textile business [10].

In this study, it is aimed to evaluate the risk of quality defects in a textile finishing company by using both FMEA and Fine Kinney methods. The use cases of the two methods are compared. The next section explains how to use both methods. In the third section, the results of the implementations are shared. In the last section, practical results are interpreted.

## 2. THE WORKFLOW OF FMEA & FINE KINNEY METHOD

Both methods proceed with similar logic. First, risky situations on the subject to be examined with a study team are listed. This risky situation can be a quality defect, a machine malfunction or a safety issue.

In the FMEA method, the severity, frequency of occurrence and detectability of risky situations that may cause problems are scored. Then, these three factors are multiplied, and the risk priority number is calculated. A sample scale for FMEA is given in Table-1 [11].

*Table 1. Scale of FMEA*

| Scale | 1 | ……….. | 10 |
|---|---|---|---|
| Severity | Safe | ………... | Hazardous |
| Occurrence | Hardly any | ………… | Very often |
| Detectability | Almost certain | ………… | Almost impossible |

In the Fine Kinney method, a similar path is followed as in FMEA. In this method, the probability of occurrence, frequency of occurrence and severity of risky situations that may cause problems are scored. The risk score is calculated by multiplying these three factors. Necessary improvement actions are planned from the highest risk score to the lower one. The factor scales of the Fine Kinney Method are shown in Table-2 [12].

*Table 2. Scale of Fine Kinney Method*

| Severity | Value | Occurrence | Value | Likelihood | Value |
|---|---|---|---|---|---|
| Catastrophe | 10 | Continuous | 10 | Might well be expected | 10 |
| Disaster | 6 | Frequent | 6 | Quite possible | 6 |
| Very serious | 3 | Occasional | 3 | Unusual but possible | 3 |
| Serious | 2 | Unusual | 2 | Only remotely possible | 1 |
| Important | 1 | Rare | 1 | Conceivable but very unlikely | 0.5 |
| Noticeable | 0.5 | Very rare | 0.5 | Practically impossible | 0.2 |
| - | | - | | Virtually impossible | 0.1 |

## 3. RESULTS

FMEA and Fine Kinney method were tried to be compared by making a simple study about fabric crease and oil stain defects that may occur in finishing processes. As seen in Table-3, potential causes of defect in FMEA study and existing process controls are also addressed. There may be oil residues in the parts of the machines. They need to be cleaned regularly and properly. If these processes are not done regularly and properly, oil stains may occur on the fabrics. The severity of this condition is high. Because the product cannot be sent to the customer as stained. Stain removal is required. This means both a waste of time and an extra cost. Whether the product is stained or not can be seen visually during quality control processes. In the FMEA, a separate line was prepared for the oil stain due to improper cleaning and the oil stain due to improper cleaning. Because they were two different causes of defect.

Due to the difference in the fabrics entering the machine, permanent crease may occur in the fabric when the operator does not make the appropriate settings. This defect can also be seen by visual inspection during quality control. It is not possible to fix the defect. According to the scoring made in this way, the crease defect gets the highest score among the three causes. The process should be improved first for the crease defect and then for the cleaning that is not done improperly.

*Table 3. FMEA implementation in textile processes*

| **Process/ Subprocess** | **Potential Failure** | **Potential Effects of Failure** | **S** | **Potential Causes of Failure** | **O** | **Existing Process Controls** | **D** | **RPN** |
|---|---|---|---|---|---|---|---|---|
| Finishing | Oiled machine | Stained fabrics | 7 | Improper cleaning | 5 | Visual inspection on fabrics | 3 | 105 |
| | | | 7 | Irregular cleaning | 4 | Visual inspection on fabrics | 3 | 84 |
| | Differences in widths of fabrics | Permanent crease on fabrics | 8 | Improper setting | 6 | Visual inspection on fabrics | 3 | 144 |

S: Severity, O: Occurrence, D: Detectability, RPN: Risk Priority Number.

In Table-4, risk analysis was performed for the same defects with the Fine Kinney method. There are no separate columns for defect causes and process controls in this method. Therefore, the number of rows has also decreased. In the Fine Kinney method, similar to FMEA, crease defect was determined to be riskier than stain defect. According to the obtained risk scores, there is a need for improvements regarding crease defect. However, there is no emergency for the stain, and it needs attention.

*Table 4. Fine Kinney implementation in textile processes*

| Process/ Subprocess | Potential Failure | Potential Effects of Failure | L | O | S | RS |
|---|---|---|---|---|---|---|
| Finishing | Oiled machine | Stained fabrics | 6 | 3 | 2 | 36 |
| | Differences in widths of fabrics | Permanent crease on fabrics | 6 | 6 | 3 | 108 |

L: Likelihood, S: Severity, O: Occurrence, RS: Risk Score.

## 4. CONCLUSION

According to the study, although FMEA and Fine Kinney method seem like each other, there are important differences in practical use. The Fine Kinney method seems to be more suitable for occupational health and safety issues. In particular, the severity scale is mostly on the incident-related fatality rate. In this respect, FMEA scales seem more suitable for manufacturing-based process defects. If the Fine Kinney method is to be used for quality defects, its scales can be modified to suit the process. Since FMEA also considers the process controls, it also includes the determination of the defect in the calculation. However, this factor is not examined in the Fine Kinney method. In future studies, studies can be carried out to use these methods together or to make the scales more compatible with the study area.

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