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# Failure Mode Effect Analysis (Fmea) of Knowledge Management and Achivement of Prospective Teachers

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**ABSTRACT**

*FMEA was formalized in 1949 by the US Armed Forces for identifying and eliminating the defects in the materials and in the process. The objective was to classify failures "according to their impact on mission success and personnel/equipment safety." The main focus of this paper is to adopt the FMEA analytical process in teacher education and to make the evident of using of FMEA in educational research. In this survey method, the tool based on six sigma FMEA and knowledge management was used. The sample comprised of 75 student teachers of private and government aided institution were subjected to FMEA analysis to find the factors related critical to quality ( CTQ) and the results show the government aided institution was better than the un aided institution in all the key process factors noted by the student teachers.*

**KEYWORDS : failure mode effect analysis, knowledge management, prospective teachers**

**Brief history of FMEA**

According to Carlson (2014) The Failure Mode and Effects Analysis (FMEA) was later adopted in the Apollo space program to alleviate risk due to small sample sizes and the use of FMEA gained momentum during the 1960s, with the push to put a man on the moon and return him safely to earth. In the late 1970s the Ford Motor Company introduced FMEA to the automotive industry for safety and regulatory consideration and it was used to improve production and design.

In the 1980s, the automotive industry began implementing FMEA by standardizing the structure and methods through the Industrial Action Groups at various levels. Though developed by the military, the FMEA method is now prominently used in a variety of industries including semiconductor processing, foodservice, plastics, software, aeronautics, automotive, and healthcare. Its use in the educational services are very meagre. So its relevance and importance must be considered for efficient implementation in the academic process which is meant for the ultimate societal growth (Segismundo, Augusto, & Miguel (2008).

**Definition and purpose of FMEA**

Failure Mode and Effects Analysis is a method designed to:

- Identify and fully understand potential failure modes and their causes, and the effects of failure on the system or end users, for a given product or process.
- Assess the risk associated with the identified failure modes, effects and causes, and prioritize issues for corrective action.
- Identify and carry out corrective actions to address the most serious concerns

**Why do FMEAs?**

There are a number of business reasons to implement an effective FMEA Process. When done well, FMEA is a proven tool to reduce academic deficiencies that are stumbling blocks of academic growth. When done well,

FMEAs will reduce the number of "Oops" during academic development. It is far less expensive to prevent the institutional problems early in academic practices than fix problems after launch. FMEAs can identify and address chief issues before a potential catastrophe.

**Understanding the procedures of FMEA**

It is important to begin with an understanding of the basic definitions of FMEAs. Time spent toward understanding the fundamental concepts and definitions of FMEAs will shorten the time in meetings and help ensure high quality results. There is no substitute for having a thorough knowledge and understanding of the FMEA definitions and concepts as mentioned in the tables 9.1, 9.2 and in 9.3.

**Table 1 – showing the severity scale (S) = Impact of failure**

| FAILUR MODE EFFECT ANALYSIS (FMEA) | | |
|---|---|---|
| **Definition of "severity" scale (S) = Impact of failure** | | |
| **Impact** | **Rating** | **criteria: A failure could** |
| Bad | 10 | harm a student or teacher |
| | 9 | Be unlawful academic practices |
| | 8 | Render the academic service unsuitable for future |
| | 7 | cause extreme academic disapproval |
| | 6 | result in partial academic dissatisfaction |
| | 5 | cause a loss of learning or teaching performance likely to result in a compliant |
| | 4 | cause minor performance loss in the educative process |
| | 3 | cause a minor problem; can be overcome with no academic loss or negative effect |
| | 2 | Be unnoticed; minor effect on academic outcome in terms of results, attitudes etc. |
| Good | 1 | Be unnoticed and affect the performance |

**Table: 2 – showing the occurrence (O) scale = Frequency of failure**

| Definition of "occurrence" (O) scale = Frequency of failure | | | |
|---|---|---|---|
| **Impact** | **Rating** | **Time period** | **criteria: A failure could** |
| Bad | 10 | more than once per day | > 30% |
| | 9 | Once every 3-4 days | < = 30% |
| | 8 | Once per week | < = 5% |
| | 7 | Once per month | < = 1 % |
| | 6 | Once per 3 months | < = 3 per 1,000 |
| | 5 | Once per 6 months | < = 1 per 10,000 |
| | 4 | Once per year | < = 1 per 10,000 |
| | 3 | Once per every 1-3 years | < = 6 per (million) (6 σ) |
| | 2 | Once every 3-6 years | < = 3 per (ten million) |
| Good | 1 | Once every 6- 100 years | < = 2 per billion |

**Table 3 – showing the Detection (D) scale = Ability to detect failure**

| Definition of "Detection" (D) scale = Ability to detect failure | | |
|---|---|---|
| Impact | Rating | criteria: A failure could |
| Bad | 10 | institutional defect caused by failure is not detectable |
| | 9 | Occasional academic units are checked for defects |

| | | |
|---|---|---|
| | 8 | various academic units are systematically sampled and inspected |
| | 7 | All units are manually inspected |
| | 6 | Manual inspection with mistake- proofing modifications in an educational institution |
| | 5 | Academic process is monitored with control charts and manually inspected |
| | 4 | Control charts used with an immediate reaction to out-of-control conditions with causable academic variations |
| | 3 | Control charts used as above with 100% inspection surrounding out-of-control academic conditions |
| | 2 | All academic units are automatically inspected or control charts are used to improve the various academic practices |
| Good | 1 | Defect is apparent and can be kept from the academic institution or control charts are used to improve the process with routine monitoring of various academic programs |

**FMEA in the educational research**

Mostly, the private institutions in India are considered to be disliked since many lacuna have been observed. The academic defects can be easily denoted as in the Table 9.4 which is an example of a Generic FMEA Worksheet, truncated after the "Recommended Actions" column. The numbers in the illustration correspond to the key indicators of student teachers, teacher educators and academicians. The definitions are presented in the sequence they are normally developed in an FMEA based academic project.

**Study Design**

The design of the present study comprises the variables, research question and purpose, samples and methodology of the present empirical study.

The guiding question of the present empirical study is: Is there a difference between the quality principles of a prospective teachers of aided and unaided institutions with regard to their knowledge management and achievement?

**The variables are:**

1. Key factors – critical quality that relate knowledge management and
2. The achievements of the students which were assessed in terms of Defects per Million opportunities (DPMO) and process sigma.

**The main objectives of this study are**

1. To measure the sigma mean of the defective factors if any while in the knowledge management and in achievement of aided and unaided institutions.
2. To find / correlate the significance of the difference/relationship between the student teachers of with respect to knowledge management and in achievement of aided and unaided institutions.

The population of study comprised of the student teachers of Tirunelveli District and 75 student teachers were randomly selected from aided and unaided institutions.

Based on the objectives and variables, the following hypotheses were framed for the current study.

There is no significant difference between sigma mean of the knowledge management and in achievement of aided and unaided institutions.

**Table: 4 - The FMEA of the private institution**

| Mode of failure | Effect of failure | S.I | Causes of failure | O | Controls | D | R | Recommended action |
|---|---|---|---|---|---|---|---|---|
| Reduced knowledge Management practices | Lack of learning attainments and knowledge construction | 7 | Lack of dynamic ability in moulding the students | 8 | Periodical inspection of authorities | 5 | 240 | Resourceful Training to and Payment as per the norms |
| | | | Lack of resource facility | 7 | Periodical visit of authorities | 3 | 147 | Creating infrastructural facilities |
| | | | Poor administrative practices | 7 | Effective monitoring | 4 | 196 | Implementation of suitable strategies to Improve the leadership qualities |
| | | | Lack of skill training | 6 | Constant Motivation by feedback | 4 | 168 | Providing motivational programs–counselling |
| | | | Reluctance for continuous evaluation | 4 | Effective monitoring | 4 | 112 | Providing motivational programs– counselling |
| | | | Inadequate disciplined practices | 8 | Effective monitoring | 6 | 336 | Continuous and comprehensive assessment |
| | | | Lack of leadership quality | 7 | In service training and skill attainment | 7 | 343 | Proper Training for Changing the leadership style |
| | | | Lack of fund distribution | 6 | Efficient fund management system | 6 | 252 | Effective monitoring and assessment system |
| **Responsibility :** Authorities of nodal agencies, managements, fads of the institutions, Faculty and students | | | | | | | | |

**R =** S.I × O× D (S.I – Severity Index; O – opportunity; D – Detection possibility; R- Risk priority number)

Additionally, the FMEA has analysed the existence of organisational failures in the both institutions. But the R value is higher in the unaided institution where the immediate attention is required (table 4).

**Table: 5 - The FMEA of the Government Aided Institution**

| Mode of failure | Effect of failure | S.I | Causes of failure | O | Controls | D | R | Recommended action |
|---|---|---|---|---|---|---|---|---|
| Reduced knowledge Management practices | Lack of learning attainments and knowledge construction | 7 | Lack of dynamic ability in moulding the students | 8 | Periodical inspection of authorities | 5 | 60 | Resourceful Training to and Payment as per the norms |
| | | | Lack of resource facility | 7 | Periodical visit of authorities | 3 | 0 | Creating infrastructural facilities |
| | | | Poor administrative practices | 7 | Effective monitoring | 4 | 16 | Implementation of suitable strategies to Improve the leadership qualities |
| | | | Lack of skill training | 6 | Constant Motivation by feed back | 4 | 32 | Providing motivational programs–counselling |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Reluctance for continuous evaluation | 4 | Effective monitoring | 4 | 24 | Providing motivational programs–counselling |
| | | | Inadequate disciplined practices | 8 | Effective monitoring | 6 | 120 | Continuous and comprehensive assessment |
| | | | Lack of leadership quality | 7 | In service training and skill attainment | 7 | 0 | Proper Training for Changing the leadership style |
| | | | Lack of fund distribution | 6 | Efficient fund management system | 6 | 72 | Effective monitoring and assessment system |
| **Responsibility :** Authorities of nodal agencies, managements, heads of the institutions, faculty and students | | | | | | | | |

**R =** S.I × O× D (S.I – Severity Index; O – opportunity; D – Detection possibility; R- Risk priority number)

In the table 5, the FMEA sustains the effectiveness which is defined as the educator's contribution to the prospective teachers' knowledge, skills and attitudes (Zaščerinska, 2011), and knowledge management is aimed at the same.

### Findings / Research experiences

Six sigma methods are relatively new to the teacher education. Furthermore, the current study also reveals that the government aided teacher training college surpasses the private institution in the knowledge management and in academic attainments.

**Table: 6 - The order of priority of key process elements**

| Key process elements (KPE) | mean | S.D | Rank |
|---|---|---|---|
| Dynamic teaching process (DTP) | 3.58 | 1.304 | 1 |
| Well-disciplined process (WDP) | 3.38 | 1.262 | 2 |
| Skill attainment process (SAP ) | 3.15 | 1.329 | 3 |
| Effective mentoring process (EMP) | 2.97 | 1.275 | 4 |
| Continuous evaluation process (CEP) | 2.86 | 1.198 | 5 |
| Resourceful facility process (RFP) | 2.78 | 1.211 | 6 |
| Best administrative practices (BAP) | 2.74 | 1.211 | 7 |
| Funding allotment process (FAP) | 2.70 | 1.124 | 8 |

The present study emphasizes the order of priority of the prospective teachers (Table 6) and, accordingly, the FMEA was processed as these key elements may be lacking in the respective institutions (Table 4 & 5)

**Hypothetical testing:** There is no significant relationship exists between the sigma means of Knowledge Management and Achievement Test of the two kinds of institutions. Similarly, there was no significant relationship between the same in private institution (Table 7)

**Table: 7 – The correlation analysis of the Knowledge Management and Achievement Test**

| Type of institutions | Variables | N | Pearson Correlation | P value | Remarks |
|---|---|---|---|---|---|
| Government aided of Education | Knowledge management | 75 | 0.076 | 0.519 | NS |
| | Achievement Test | 75 | | | |
| Private college of Education | Knowledge management | 75 | 0.178 | 0.126 | NS |
| | Achievement | 75 | | | |

[N.S - Not Significant at the 0.05 level (2-tailed) P>0.05 value]

**Table: 8 – t value of Knowledge Management based on the type of institution**

| Variable | Type of institutions | N | Sigma Mean | Standard deviation | 't' value | P value | Remarks |
|---|---|---|---|---|---|---|---|
| **Knowledge management** | Government Aided | 75 | 1.97508 | 0.338346 | 8.620 | 0.000* | S |
| | Un Aided (Private) | 75 | 1.51151 | 0.320072 | | | |
| **Resource utilisation** | Government Aided | 75 | 1.97925 | 0.413479 | 10.096 | 0.000* | S |
| | Un Aided (Private) | 75 | 1.41965 | 0.243840 | | | |

(*The t value of two tail significance is less than .05 (p<0.05)

**Table: 9 - The total mean of the Key process outcome (KPO)**

| Key process outcome (KPO) | Aided institution | | | | Unaided institution | | |
|---|---|---|---|---|---|---|---|
| | Expected levels | Knowledge management practices | Resource utilisation | Achievement tests | Knowledge management practices | Resource utilisation | Achievement tests |
| DPMO | 66,811 | 326666.7 | 309697.0 | 341333.3 | 501333.3 | 530909.1 | 403733.3 |
| Sigma values | 3.00 | 1.97508 | 1.979253 | 1.92352 | 1.511507 | 1.419653 | 1.7520 |
| Process yield (%) | 93.3189 | 67.334 | 69.031 | 65.867 | 49.867 | 46.91 | 59.627 |

### Interpretation

The correlation analysis reveals that the knowledge management practices of the both type of institutions have not been focused towards the process optimisation of learning outcome. Further, the results of the 't' test show that the aided institution surpasses the unaided institution in knowledge management and resource utilisation (Table 8). Moreover, the expected level of the three sigma level (3σ) process yield (99.96%) has not been attained in any of the key process of the two types of institutions. Hence, it is predicted that the entire organisational practices must be enhanced in both institutions towards perfect level (Table 9).

Basically the FMEA analysis bring the appropriate measure on the various academic shortcomings that affect an educational system.

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