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Failure Mode and Effect Analysis –A Quantitative Technique for Improving Quality of Teaching and Training in B-Schools

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Abstract:
The products and services are developed now-a-days by following the specification developed by R&D wings. The R&D wings consider all possible design aspects specifically targeting the performance of the products. The design specifications consider the functions of the product in the normal condition. The scenario is equally important when we consider the case of services, where the service delivery processes need to meet all the needs of the users group. The services like hospitals, fuel pump, hotels and educational institutes need to carefully design their services process so as to gain complete satisfaction level of the customers. The very design aspects of the services need to incorporate the possible zone of failures and its effect on the service process. This ensures better preventive mechanism for the service process. The current study has considered the scenario of teaching B-Schools courses and its probable failure mode and effects. The quantitative techniques FMEA (Failure Mode and Effect Analysis) is carried out and also ANOVA is used to understand the failure zones and their implications in teaching.

Keywords: Performance, Service, Process, Failure Mode and Preventive mechanism.

Introduction:

In the current dynamic world it the quality that ensures the brand image of an organization. The way the products and services are designed is quite important from the quality point of view. The service organizations need to design their services in a very careful way as the service providers are in direct touch with the customers or the users of the services. Quality which consists of several dimensions like conformance to specifications, value for money, support, fitness for use, psychological impressions, customer support, safety, performance, features, reliability, serviceability, durability and appearance. Quality is very important factor in any organization, be it a non-profit organization or a profit oriented organization. It is the customers who define the quality of the products or the services.

For creating quality products and rendering quality services organizations need to practice Total Quality Management (TQM) principles and practices. The process of quality initiative basically focuses on the zone of customer satisfaction, supplier relationship, continuous improvement, employee empowerment and Leadership issues.

The products and services are developed now-a-days by following the specification developed by R&D wings. The R& D wings consider all possible design aspects specifically targeting the performance of the products. The design specifications consider the functions of the product in the normal condition. The scenario is equally important when we consider the case of services, where the service delivery processes need to meet all the needs of the users group. The services like hospitals, fuel pump, hotels and educational institutes need to carefully design their services process so as to gain complete satisfaction level of the customers.

The teaching in professional courses have lot of challenges as it need to continuously focus on the growing and changing needs of the Industries. There by the components of teaching includes all sort of quality components that best satisfies the growing expectations of the students pursuing their professional courses.

The knowledge of different measures of quality and the measures of quality failure is very important for the service providers. The Institutes and Universities constitute Quality Assurance Cell under the directives of University Grants

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Commission (UGC) and All India Council for Technical Educations to impart better and quality training and teaching to the students who are perusing their professional courses.

The Failure Mode and Effect Analysis (FMEA)-a tool in Quality Management better pin points the probable failure zones of the services and thus also indicates the effects of those failures in real sense. It thus indicates the reliability issues of the service process. The technique of FMEA can be applied in the teaching to know the real failures of teaching and training and also to know about the severity of the faults, occurrences of the faults as well as the detection of the faults in imparting proper training and teaching.

Need Of The Study:

Today's educational institutes that runs the professional courses need to remain cautious as imparting training and teaching in professional courses are highly dynamic and challenging. Failure in the imparting training and teaching in professional courses can create devastating results.

Table1: Number Of Recognized Educational Institutions

	(in '00')				(In absolute numbers)	
Level/ Year	**Primary**	**Upper Primary**	**Secondary**	**Senior Secondary**	**Colleges**	**Universities**
1950-51	2097	136	NA	74	578	27
1960-61	3304	497	NA	173	1819	45
1970-71	4084	906	NA	371	3277	82
1980-81	4945	1186	NA	516	6963	110
1990-91	5609	1515	NA	798	5748	184
2000-01	6387	2063	877	384	10152	254
2005-06	7726	2885	1060	536	16982	350
2006-07	7849	3056	1122	574	19812	371
2007-08	7878	3252	1138	592	23099	406
2008-09	7788	3656	1221	642	27882	440
2009-10	8199	3941	1222	716.8	25938	436
2010-11	7485	4476	1312	720.46	32974	621
2011-12	7143	4788	1283	841.33	34852	642
2012-13(P)	8359	4103	1036	1195.8	35829	665
2013-14(P)	7906	4011	1313	1026	36671	712

Sources: MHRD website,
NA: Not Available

For School Education:
Figures for 1950-51 to 2011-12 taken from the publication Statistics of School Education.

Figure for 2012-13 (P) & 2013-2014 taken from U-DISE-NUEPA
For Higher Education: (i) figure for 1950-51 to 2009-10 from the Statistics of Higher and Technical Education Publication. (ii) Figures for 2010-11 to 2013-14(P) taken from AISHE
It is clear from the above table that the growth of Colleges and Universities are increasing. The different B-schools generally go for aggressive marketing and promotional campaign to draw large pool. It is the quality of service that is rendered by those B-schools is important. Due to better quality of services the name and fame of B-schools generally flourished

Table 2: % Enrollment In Different Disciplines / Subjects At Phd & Post Graduate Level In Higher Education 2012-2013 (P)

Discipline	Ph.D.	Post Graduate
Agriculture & Allied	4.39	0.61
Commerce	3.21	8.04
IT & Computer	1.93	9.34
Engineering & Technology	17.45	6.34
Foreign Language	3.16	4.83
Home Science	0.68	0.21
Indian Language	6.14	8.78
Law	0.84	0.76
Management	4.47	16.92
Medical Science	6.50	4.17
Science	20.61	8.75
Social Science	18.27	20.58
Other	12.35	10.69

Source: AISHE Portal (www.aishe.gov.in)

It is also clear from the above table that the enrollment in Post Graduate courses for Management is the next after the Social Science stream. From the view point of Operations Management we may develop few things; First in a B-school's classroom the customer is the students, the product is the knowledge disseminated, the people involved in the process of providing the knowledge to the student customers are the faculty members.
It is well known fact that the very design aspects of the services need to incorporate the possible zone of failures and its effect on the service process. This ensures better preventive mechanism for the service process. Thus there is a need for the B-Schools to know the probable failure zones in training and teaching in classrooms. Thus FMEA is applied in the study to assess the failure modes. This ensures better reliability of teaching.

Review Of Literature:
Failure Mode and Effect Analysis (FMEA) can be used both for product design as well as for process control. It is implemented in two ways to ensure that the reliability requirements are meet. The results of reliability predictions are taken as feedback to eliminate the design drawbacks and bottleneck issues (Teng & Ho, 1996).
The main factors taken in traditional FMEA for assessing the risks are occurrence frequency (O), severity (S) and detection (D) of an item failure mode. The study also applied fuzzy logic. The fuzzy conclusion then applied in deriving the Risk Priority Number (RPN). The higher the RPN value higher is the risk, the lower the RPN value, lower is the risk. The study was applied in paper industry to understand the FMEA (Sharma, Kumar & Kumar, 2005).
As FMEA techniques extends the risk prioritization beyond RPN method, a new scale is developed in a study and the ranks 1 through 1000 used to represent the risk priority ranks (RPRs). The basic problem observed with FMEA is that it quantifies risk without adequately quantifying the factors that contribute to risk (Sankar & Prabhu, 2001).
The aim of Risk Priority Number (RPN) is used in FMEA it to make it a better measurement tool. The study also suggests combining the RPN model with an expected cost model in quality improvements (Dava & Raouf, 1996)
FMEA is also applied in national and international marine regulations and operations. This technique assumes the failure mode; the effect of the failure is then evaluated. Three factors are considered like occurrence frequency (O), severity (S) and detection (D) of an item failure mode. The study proposed a new approach where the fuzzy rule base and grey theory is presented (Pillay & Wang, 2003).
Another study also applied the fuzzy theory to eliminate the conversion debate by directly evaluating the linguistic assessment of factors and uses grey theory to find the RPN by assigning relative weighing coefficient (Chang, Wei & Lee, 1999).

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The RPN sometimes may be misleading as it lacks proper model as base and thus internally inconsistent. The study proposes an alternative way based on a simple model using expected cost as the basis for ranking failure mode (Gilchrist, 1993).

A methodology based on decision support system (DSS) by qualitative tools provides a rank of the risks of potential causes of production system failures. A fuzzy decision model is proposed for the study (Puente, Pino & Fuente, 2002).

The effective management of risk is the basis for successful project management, the study proposes to systematization of technical risk management through the use of FMEA to optimize proper planning and decisions in new product development (Segismundo, Augusto & Miquel, 2008).

Although FMEA is a good tool for measurement failure zones, but still it is challenge for most of the companies to implement. Knowledge-based approach to FMEA can alleviate most of the problems (Wirt, Berthold, Kramer & Peter 1996).

The RPN is the main pillar of FMEA, by implementing the cost-oriented FMEA, quality management can be improved (Ahsen, 2008).

Iv.Gap In The Literature:

There are very few studies which emphasized on applying FMEA in educational sector especially in teaching and training. So the above topic has its right positioning in the current situation.

Objectives Of The Study:

Following are the objectives of the study:

To know the failure mode measurements (RPN) for different papers (here the five elective papers in operations management for a B School).

To know the differences in RPN scores of different papers.

To know the differences in RPN scores of different students in the same paper.

Hypotheses For The Study:

Following are the hypotheses for the study:

H01: There is no significant difference between the RPN scores of different papers.

H02: There is no significant difference between the RPN scores of different students in the same paper.

Scope Of The Study:

The study focused on a B School (name not mentioned) that to in a particular specialization area. The study considered the views of all the students in the particular year for the Operations Management Specialization Group.

Limitation Of The Study:

As the study only focused on a single specialization that to in a single B School so it may be a limitation.

Methodology And Data:

The study is basically empirical in nature and the basic frame work of the study is as follows:

To develop the Risk Priority Number, three factors were used these are occurrence frequency (O), severity (S) and detection (D) of an item failure mode.

The ranking procedures adopted are as follows:

Occurrence (O)									
1	2	3	4	5	6	7	8	9	10
Rare Occurrence							Very frequent Occurrence		

Severity(S)									
1	2	3	4	5	6	7	8	9	10
No harm is done to the system							Causes severe damage to the system		

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Detection (D)									
1	2	3	4	5	6	7	8	9	10
Very Difficult to detect									Easy to detect

To find the RPN (Risk Priority Number) it is obtained as RPN=O x S x D and the table is

Table 3: Rpn Score

Sl No	Critical Quality Factors	S	O	D	RPN(O*S*D)
1	Fear about Paper				
2	Fear about the Faculty				
3	No link of the content with the real life context				
4	No Scope of Self Study				
5	No team spirit				
6	Tutorials are not useful for the students				
7	No emphais on Personality Development				
8	Not scoring good marks				
9	No remedial classes				
10	Lack of proper ICT support				

Source: Developed for the feedback in the survey by the author

The above table gives the recommended action for the identified failures which have been generated in the class feedback session at the end of the semester. This table is a handy tool for the faculty members for preventing any possible occurrences of failures in the teaching and training process.

The sources of data are primary in nature and it is collected in directly through questionnaire in the classrooms. The components included in the table are used for gathering the data from the student feedback session.

Here the sample is the all students who opted for the Operations Management specialization in the said B School and the number of students are 30 and the number of Operations Management Specialization Papers are 05 (five). The students have been asked to rank the severity, occurrence and detection in respect of the ten critical factors mention in the RPN Score table (table 3). These students have indicated their responses on the RPN table with help of ranking obtained from occurrence frequency (O), severity (S) and detection (D) ranks. The scores were plotted in the table of RPN and likewise all other scores of different 05 (five) elective papers responses were collected. The ANOVA is applied to know certain observations statistically. Following table shows the RPN score generated by 01 (one) student for a single paper, rest of the scores for other students for all papers were calculated in a similar way:

Table 4: Rpn Score For A Single Student On The Paper (P01 Of Operations Specialization)

Sl No	Critical Quality Factors	S	O	D	RPN
1	Fear about Paper	7	8	4	224
2	Fear about the Faculty	8	6	6	288
3	No link of the content with the real life context	7	5	4	140
4	No Scope of Self Study	6	6	5	180
5	No team spirit	6	7	4	168
6	Tutorials are not useful for the students	7	4	5	140
7	No emphais on Personality Development	7	7	8	392
8	Not scoring good marks	6	5	8	240
9	No remedial classes	6	7	7	294
10	Lack of proper ICT support	8	8	8	512
Total RPN Score					2578

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Source: Generated from the feedback in the survey by the author

Analysis And Findings:

The data obtained from the questionnaire are entered and the score RPN is being calculated and ANOVA is applied to find whether there is any difference of RPN scores exists in between the five papers as well as any difference of RPN scores exists in between the students observations in a single paper.

	P01	**P02**	**P03**	**P04**	**P05**
S1	2578	2112	1536	2111	5546
S2	1787	1388	2978	2324	3399
S3	2557	2374	1022	2233	3987
S4	3079	2132	1762	3322	8877
S5	3159	3570	1446	3321	6673
S6	2121	5554	1111	2453	3636
S7	2334	3564	1212	2332	2292
S8	3231	3454	2322	2543	6474
S9	4343	5675	2321	2334	8883
S10	3546	4643	2134	2543	9987
S11	4567	5754	2341	2446	3373
S12	4123	7445	1334	2457	7764
S13	5434	3564	2132	2468	4454
S14	2134	3574	2342	2413	4466
S15	1235	3357	3234	2433	4635
S16	1654	2564	2324	2657	3737
S17	2487	7764	2453	2655	4646
S18	3492	4675	3421	1223	5858
S19	3745	4564	3353	2344	6726
S20	2753	4556	2535	2346	6532
S21	3725	4454	3456	2643	3384
S22	6353	3455	3224	2489	4849
S23	4635	3465	2344	2676	4822
S24	2293	4567	2344	2543	3942
S25	2543	4643	1727	2889	4974
S26	2345	4456	2787	2998	8373
S27	3423	6656	2654	2764	3559
S28	2345	5564	1887	2334	4772
S29	3454	4567	1767	2778	4822
S30	3422	6455	1888	2998	3764

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The results obtained from ANOVA two factor without replication is as follows:

SUMMARY	Count	Sum	Average	Variance
1787	4	10089	2522.25	767408.25
2557	4	9616	2404	1481984.667
3079	4	16093	4023.25	10913572.92
3159	4	15010	3752.5	4689587
2121	4	12754	3188.5	3550937.667
2334	4	9400	2350	924176
3231	4	14793	3698.25	3664370.917
4343	4	19213	4803.25	9887689.583
3546	4	19307	4826.75	13042786.92
4567	4	13914	3478.5	2516331
4123	4	19000	4750	11091375.33
5434	4	12618	3154.5	1124393
2134	4	12795	3198.75	1032719.583
1235	4	13659	3414.75	829616.25
1654	4	11282	2820.5	393003
2487	4	17518	4379.5	6070388.333
3492	4	15177	3794.25	3928475.583
3745	4	16987	4246.75	3555524.917
2753	4	15969	3992.25	3867286.917
3725	4	13937	3484.25	552988.25
6353	4	14017	3504.25	973350.25
4635	4	13307	3326.75	1214719.583
2293	4	13396	3349	1164944.667
2543	4	14233	3558.25	2327467.583
2345	4	18614	4653.5	6699396.333
3423	4	15633	3908.25	3518185.583
2345	4	14557	3639.25	3253947.583
3454	4	13934	3483.5	2136552.333
3422	4	15105	3776.25	3782337.583
2112	29	128453	4429.413793	2304959.037
1536	29	65855	2270.862069	482289.0517
2111	29	73959	2550.310345	145029.8645
5546	29	153660	5298.62069	3849453.315

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Students	49669687.69	28	1773917.417	1.062689711	0.4018349	1.610414619
Papers	186647764.9	3	62215921.64	37.2713065	2.053E-15	2.713227129
Error	140218787.8	84	1669271.284			
Total	376536240.4	115				

Thus from the above table it can be mentioned that the P value for the RPN scores different papers is 2.053E-15 which is less than 0.05 thus the null hypothesis H01 is rejected. Therefore there is significant difference between the RPN scores of different papers. The paper where higher RPN detected need to deal with extra care. The measures that can be adopted like making teaching more interesting, the technique of 'do and learn' can be adopted, conduct few easy test to make students gain some confidence, students assignment and presentation session may be adopted, more live case studies may be incorporated, not to show anger to students, etc.

The P value for the different students RPN scores on the same paper is 0.4018349 which is greater than 0.05. Thus the null hypothesis H02 is accepted. There is no significant difference between the RPN scores of different students in the same paper.

XI.CONCLUSION: Education is the very important service to the nation. It is clear that FMEA is a preventive tool for teaching improvements in B Schools. The teaching in professional courses have lot of challenges as it need to continuously focus on the growing and changing needs of the Industries. There all sort of quality components should be included in teaching that best satisfies the growing expectations of the students pursuing their professional courses.

The Failure Mode and Effect Analysis (FMEA)-a tool in Quality Management better pin points the probable failure zones of the services and thus also indicates the effects of those failures in real sense. It thus indicates the reliability issues of the service process.

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