

**INDIAN STATISTICAL INSTITUTE**  
**SQC & OR Unit, Hyderabad**

**MS in Quality Management Science: 2014-16**  
**III SEMESTER: MID-TERM EXAMINATION**

**Subject: Trouble Shooting and Problem Solving for Quality Improvement (TPQI)**

**Date: 24 August 2015**

**Duration: 2 Hours**

**Max. Marks: 40**

**INSTRUCTIONS**

*This paper contains questions for 50 marks. Answer as many as you can but the maximum you can score is 40 marks. You will also be given soft copy of this question paper for using data for analysis. You are free to use appropriate statistical software for analysis but the answers will have to be given in the answer sheet given to you. You need also to submit the soft copy of your analysis if any, in a word file format opened in your name before the end of the examination without fail.*

Q1. A company engaged in manufacture of 1/16 HP fan motors, tests for different product performance characteristics such as winding resistance, RPM, current, power, High Voltage (HV) test and 160 V stability etc. Currently, 3% of motors are failing within the warranty period of one year. The company is interested in finding an intermediate solution by adopting some selection process at final inspection stage till the process is improved, so that the warranty failures can be reduced. Towards this, the company has collected data on the first four important characteristics for 50 motors and the data is presented in the table below. The company has a perception that the product characteristics have technically interrelationship. In view of this, you need to suggest an approach in giving a solution to the problem as the company is prepared for any raise in internal failures, in comparison to warranty failures, as the failed motors internally can be dismantled and supply as spare parts in the market.

S.No.	Winding Resistance (X1)	RPM (X2)	Current (X3)	Power (X4)	S.No.	Winding Resistance (X1)	RPM (X2)	Current (X3)	Power (X4)
	Spec: 268 - 323 Ohms		Spec: Min 1250	Spec: Max 0.3 Amp		Spec: Max 70 Watts		Spec: 268 - 323 Ohms	Spec: Min 1250
1	282	1310	0.25	56	25	278	1335	0.25	48
2	275	1314	0.25	56	26	273	1365	0.26	52
3	276	1320	0.23	52	27	275	1350	0.25	52
4	277	1318	0.24	52	28	266	1310	0.25	52
5	279	1370	0.25	56	29	268	1368	0.24	48
6	275	1316	0.25	56	30	264	1305	0.24	48
7	280	1310	0.25	56	31	285	1298	0.27	60
8	268	1340	0.25	56	32	305	1300	0.25	52
9	271	1300	0.25	56	33	284	1355	0.25	56
10	271	1305	0.24	52	34	285	1300	0.25	56
11	272	1322	0.22	52	35	285	1315	0.26	52
12	270	1375	0.24	56	36	288	1318	0.25	56
13	266	1328	0.24	48	37	289	1300	0.24	52

14	272	1305	0.26	58	38	276	1295	0.25	56
15	266	1310	0.24	52	39	286	1360	0.26	52
16	275	1360	0.27	52	40	284	1308	0.26	56
17	278	1360	0.25	52	41	286	1286	0.25	56
18	276	1305	0.26	48	42	294	1268	0.26	56
19	274	1315	0.27	60	43	292	1298	0.26	52
20	265	1328	0.24	48	44	290	1293	0.27	56
21	266	1360	0.24	52	45	286	1290	0.26	52
22	268	1320	0.24	48	46	284	1295	0.26	56
23	275	1313	0.25	52	47	290	1306	0.26	60
24	272	1318	0.26	52	48	288	1360	0.25	64
25	278	1335	0.25	48	49	290	1295	0.26	56
26	273	1365	0.26	52	50	283	1286	0.24	52

- Using the data given above, estimate the non-conformance to specifications w.r.t each of the four characteristics.
- Comment on the management perception that the product characteristics are interrelated.
- Use an appropriate graphical and quantitative tool(s) you know for analysis and suggest an approach on what needs to be done for achieving the objective of reduction in warranty failures.
- Is it a right decision, to reduce the warranty failures, if the company desires to revise the specifications for two characteristics RPM (from Min 1250 to Min 1285) and resistance (from 268-323 ohms to Max 290 ohms) and if yes, what would be the impact on the non-conformance? Justify your answer using your analysis.

(3+2+10+5=20 Marks)

Q2. Multi layered (3 layered) Paper boards are used for many printing and packaging requirements such as cigarettes, tooth pastes, medicines etc. These paper boards are produced on machines called Paper machines which are complex in nature and big machines in size with a length of 100-150 meters.

Paper board manufacturing process involves chipping different species of wood, cooking in digesters in a medium for separating the pulp from lignin, bleaching pulp to achieve the required brightness, adding various chemicals and water for pulp to attain the required strength and other properties, producing board on paper machine which is wound on spools to produce big rolls called Jumbo rolls. These jumbo rolls are made to pass through a continuous web inspection system before they are slit to different sizes called child reels. These child reels are either sent directly for packing or further cut into sheets of different sizes depending on the customer order.

The company is facing with a severe and new quality problem due to insects' bodies, which are seen on the board sent to different customers. The customers use this board for a variety of uses including liquid packaging resulting in hygiene problems. Customers are lodging complaints on this problem, asking the company to take actions for preventing from occurrence. As the company's image getting severely affected including the threat of losing customers, the Management has formed a team with personnel drawn from different functions with you as the Team leader. You have decided to adopt a scientific approach and use relevant ideas/approaches in resolving this problem or find a direction to the solution.

The company produces different grades of paper board on this machine and maintains a good data base on various aspects of production such as quantities produced and rejections/ re-pulp quantities due to various internal quality problems, details of customer complaints received such as quantities involved in orders placed, quantities of reason wise complaint etc. The company has a good traceability system to know the production details including the complete web inspection data details should there be any complaint from customer(s) for any product grade. The web inspection system gives incidence any defects on the paper web before it is wound on the spool, based on the training given to the system apriori.

The company has an initial perception that the incidence of insects is more in liquid packaging grade. Further, as a team you may have different ideas such as use of pesticides or insecticides or fumigation but management attaches lot of importance to safety of work environment and as well as effect on product quality due to their nature of use such as liquid packaging etc.

1. In view of the above scenario, as a Team leader outline your approach for finding a solution or direction for solution to this new problem.
2. List various problem solving tools or data analysis methods you would use, highlighting the brief justification for such use.

(10+10=20 Marks)

Q3. What are Quality costs? Mention the different categories of Quality costs and their significance. Explain with an example as why Quality costing is essential for any organization. Briefly discuss the interplay between various quality cost categories and highlight, in your opinion, as emphasis on which quality cost(s) will prove to be beneficial for any organization for improvement.

(10 Marks)