

Homework 1 Solutions

- 1) Provide a definition of quality, and state what the two general aspects of quality are.

Answer:

What is Quality: fitness for use.

Two general aspects:

- a. quality of design (all goods intentionally have different quality or grades – e.g. materials)
- b. quality of conformity (how well a product conforms to these specs required)

- 2) Explain how variability in a product can lead to excess costs

Answer: Variability can cost a company money in a number of ways including: 1) internal failure costs (e.g. scrap, rework, retesting, failure analysis, downtime, yield loss, and downgrading product price), 2) external failure costs (dealing with complaints, returned products, warranty charges, liability costs, and indirect costs like loss of reputation 3) Appraisal costs (include extra inspection and testing of material) and 4) prevention costs (costs to make it right the first time) and burn-in which is running equipment to detect early life failures) – Refer to table 1.4

- 3) Describe what a quality engineer does

Answer: A quality engineer ensures 1) that the quality characteristics of a product are at the desired levels, and 2) the variability around these levels is minimum

- 4) Define the “hidden factory”

Answer: the part of the plant that the customer does not see and deals with bad quality and business inefficiency

- 5) In this problem, refer to the example problem in the lecture notes about using bar coding in a hospital as a basis. For this problem, another hospital decides to launch a relatively thorough investigation of bar-coding. In addition to considering bar-coding investigators consider 1) assigning fewer patients to each nurse, 2) setting a limit on how much time nurses can spend chatting with patients and 3) shortening the nurses shift hours. In addition to the correct dosage administration, they want to evaluate the job satisfaction of nurses.

Answer: Controllable inputs: Bar coding (Y or N), number of patients per nurse (#), time spent with patients (min), shift length (h)

Key output variables (or critical quality characteristics): Discrepancy between amount given and intended amount (cc's), nurse rating (#)

- 6) Describe what a Control Chart is and how it helps Quality Engineers do their job

Answer: A control chart is a process monitoring technique which tracks averages in a quality characteristic with time or sample number. It consists of a centerline – where the characteristic should be if there are no abnormal sources of variation and control limits – which are defined by statistics and alert the user when a process has an unusual source of variability is present

- 7) Define what Six Sigma is, the three elements for its successful execution and why it is called Six Sigma

Answer: Six sigma is statistical-based, data-driven management approach and continuous quality improvement methodology for eliminating defects in a product, process or service. It involves the successful execution of:

Quality Planning: Listening to the Voice of the Customer for what they say is most important and translating it into something measurable

Quality Assurance: Establishing a system to prevent quality issues from arising

Quality Control and Improvement: A set of specific steps and tools to ensure products meet requirements and are continuously improved

The name six sigma refers to the quality level target such that sigma (standard deviation, or level variance) should be small enough such that 6 X sigma is within the acceptable specification limits

- 8) You are working for a company that makes electrodes. One of the quality characteristics is the loading of catalyst (mg/cm^2). The target is $3 \text{ mg}/\text{cm}^2$ and acceptable limits are $2.4\text{--}3.6 \text{ mg}/\text{cm}^2$. With the current process, the standard deviation (remember this is a measure of variance) is $0.3 \text{ mg}/\text{cm}^2$. What sigma quality performance level is the current process at? What would the standard deviation need to be to reach a six sigma level quality performance?

Answer: σ (standard deviation) = 0.3, The acceptable limits – target = $0.6 \text{ mg}/\text{cm}^2$

Specification limit - target = Sigma level X standard deviation

$0.6 = \text{Sigma level} \times 0.3$ Thus, the sigma level is 2.

If the company made a goal to achieve 6 sigma level quality performance, the standard deviation would need to be:

Specification limit – target / sigma level = standard deviation

$0.6/6 = 0.1$ standard deviation.

- 9) Describe why slow processes are expensive and why lean focuses on eliminating waste by increasing process cycle efficiency and decreasing process cycle time

Answer: The hidden factory is one of the reasons slow process times are expensive – it costs money to count and store items. Other reasons long process times are expensive include:

1. Customers don't like waiting for products (lost revenue)
2. More handling means more personnel
3. Longer storage and handling means more opportunities for products to get damaged or lost
4. Inventory is higher (more efficient use of space less of a chance of having "old" product which needs to be discounted)
5. More documentation needed the more it is handled

Increasing process cycle efficiency and process cycle time means you increase the time value is being added to the product versus time that wasted in storage or waiting

10) Describe what the objective of the Define Step is and why it is a vital part of the DMAIC process.

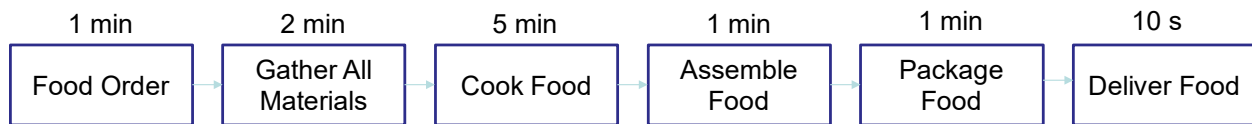
Answer: The objective of the define step is to pick a project that will have the potential for high value opportunity or breakthrough. It is important to align projects such that they benefit the company, listen to the Voice of the Customer, and align with company goals.

11) Create an SIPOC diagram for the process of making a burger at a fast food restaurant (from making to delivery to customer)

| Suppliers: | Input: | Process: | Output: | Customer: |
|---------------------------------|-------------------------|------------------------------|--------------------------------------|-----------|
| Food companies | Burger, bun, condiments | 1) Assemble materials | Burger with correct: | Consumer |
| Utilities | Electricity | 2) Cook burger | 1) Doneness | |
| Paper bag and wrapper companies | | 3) Prepare sandwich to order | 2) Warmness | |
| | | 4) Place in wrapper in a bag | 3) Amount and accuracy of condiments | |
| | | 5) Hand to customer | 4) Packaging | |

- 12) Create a process map for the process of burger making above (include all steps – even those that might not be value added). List estimated process times and suggest ways to improve the process cycle time.

Answer:

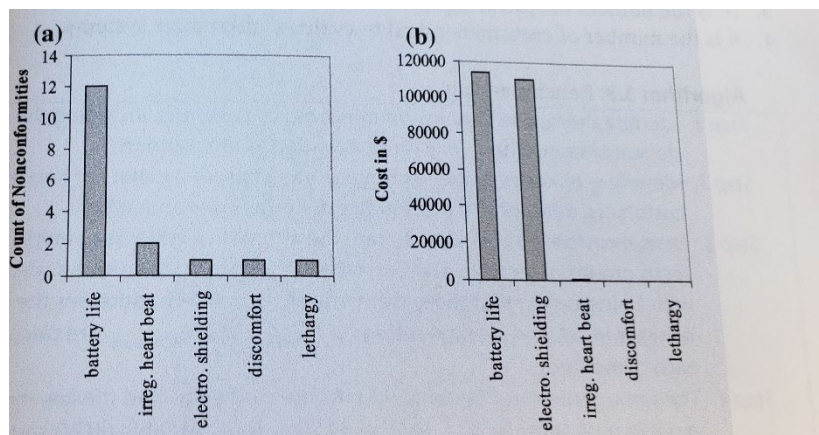


On this example there are a few opportunities to reduce process cycle time – gathering materials could be improved by having pre-assembled order packages ready to go. Food order time could be reduced by having clearer menus and training staff to answer questions. Cook time could be reduced potentially by different processing methods. These are not the only correct answers to this problem.

- 13) Use the following table of nonconformity counts and costs of non-fatal pace maker failures, construct a) a regular Pareto chart of the count of non-conformities, and b) a cost Pareto chart of non-conformities.

Answer:

By hand should look like this

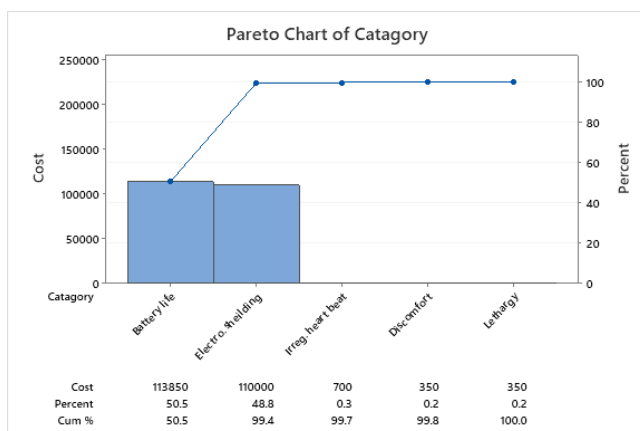
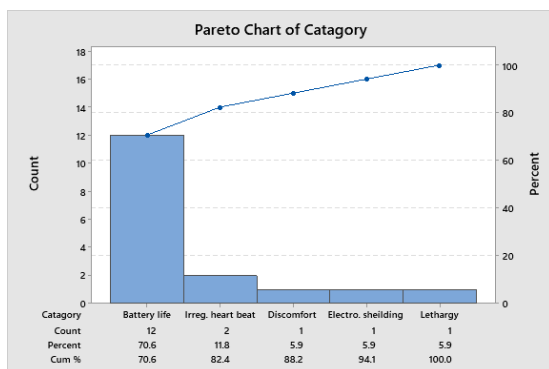


14) Comment on which two non-conformities should be the subject of a process improvement effort in problem 13.

Answer: To reduce the total cost to the company battery life and electromagnetic shielding should be addressed, even though irregular heart beat has a greater number of counts.

15) Use Mini-tab to generate the two graphs you sketched in problem 13:

- Open Mini-tab
- Label columns as "category" "Count" and "Cost"
- Input the correct values from the chart under each heading
- Go to Stat, Quality Tools, Pareto Chart
- Construct both graphs by defining the attribute data is the "category" column (to select, you have to double click and it will appear in the box, then define the frequencies as either "Count" or "Cost" depending on which graph you are making.



16) Describe some ways process time can be reduced and what role a pareto chart can play lean manufacturing

Answer:

A pareto chart can help identify which lean projects will save the most time and money.

17) Describe the objectives of Measure, Analyze, Improve and Control

Answer:

Measure: The objective of the measure step is to evaluate and understand the current state of the process.

Analyze: Use data from the measure step to begin to determine cause and effect relationships and sources of variability

Improve: use some creative thinking and the information gathered in the previous steps to make specific suggestions that will have the desired improvement in the process

Control: complete all remaining work and hand off the improved process so gains are institutionalized

18) Use the following FMEA table constructed for a cookie baking process, which defect requires the most attention?

Answer:

| Defect | Severity | Occurrence | Detection | RPN |
|------------------------|----------|------------|-----------|-----|
| Burnt | 6 | 2 | 1 | 12 |
| Too dry | 4 | 2 | 2 | 16 |
| Too small | 5 | 2 | 1 | 10 |
| Taste is off | 9 | 2 | 4 | 72 |
| Freshness | 8 | 3 | 4 | 96 |
| Number of chips is low | 2 | 2 | 4 | 16 |

Freshness requires the most attention followed by taste being off – improvements could be made in their detection to make them less of a risk