Faculty of engineering

Department of Industrial engineering

Project report

By:

Feras Mohammed (19INDE1086)

Emadeden AL Baghdadi (21INDE1049)

Alina Gurul (21INDE1059)

Introduction:

our comprehensive analysis aims to evaluate the quality control measures for burger meat sourced from Burger King and water bottles from a company named silsal. This project is designed to meticulously assess defects and establish control limits, ensuring the consistency and excellence of these essential items.

In this endeavor, we have collected 25 subgroups of samples, each consisting of 4 units for the burger and 35 samples consisting of 40 bottles for the attribute data

As Variable data: Burger Meat Weight:

Our first focus area is the weight of burger meat sourced from Burger King. The perfect weight for burger meat in this quality control project is 90 grams. By examining subgroups of samples, we aim to discern any variations in weight that may indicate potential quality issues. Establishing control limits for burger meat weight is crucial for maintaining consistency and meeting consumer expectations.

As attribute data : Defective Water Bottles in Boxes of 40 Pieces:

The second aspect of our analysis involves inspecting water bottles from silsal company for defects within boxes containing 40 pieces each. Defects such as damage, misprints, or incorrect bottle weights can impact product integrity and customer satisfaction. Through meticulous subgroup sampling, we endeavor to identify and quantify defects to establish effective control measures.

Examples for Defects which will lead the bottle to be defected is:

- Cracks or Breakage
- Misprints or Labeling Errors
- Seal Integrity Issues
- Incorrect Fill Level
- Cap or Closure Defects
- Foreign Particles
- Bottle Transparency Issues
- Minor scratches on the bottle surface
- Slight discoloration on the label
- Small air bubbles trapped inside the bottle
- Slightly uneven bottle shape
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By applying statistical methodologies and quality control principles, we seek to derive actionable insights that will guide quality enhancement strategies. Our objective is not only to detect existing defects but also to proactively prevent future deviations from quality standards

This report serves as a valuable resource for decision-makers and quality assurance teams, providing a comprehensive overview of defect analysis and control limit establishment for burger meat and water bottles, contributing to the overall excellence and reliability of food products in the industry.

➢ Data Collection (Variable):

Our data collection process for burger weights employed two distinct approaches, each tailored to ensure accuracy and efficiency in gathering essential information.

The first method involved the direct ordering a burger and then taking out the minced meat followed by meticulous weighing. While this method is straightforward and commonly used, . Ordering 125 individual burgers would not only be impractical but also Expensive. Recognizing this limitation, we sought a more streamlined approach.

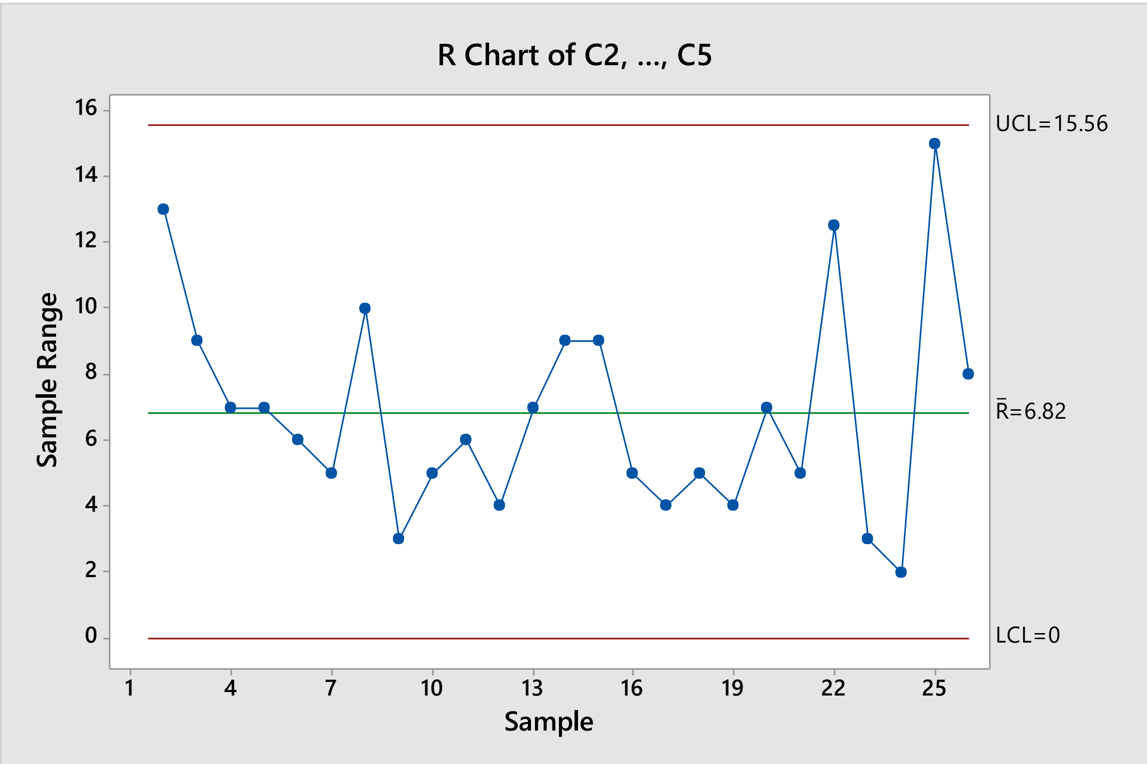
To address this challenge, we collaborated with a trusted colleague who works in a burger kitchen. This individual, with firsthand experience in burger assembly, played a pivotal role in our data collection efforts. Positioned at the final step of burger preparation, just before it is covered and served to customers, our colleague meticulously weighed the meat for each burger. This process, conducted under controlled conditions within the kitchen environment, ensured precise and consistent measurements.

Furthermore, to maintain data integrity and traceability, each weight measurement was diligently recorded on paper. This meticulous documentation allowed us to track and analyze the burger weights accurately, despite the large sample size

	Samples					
subgroups	1	2	3	4	$\bar{x}$	R
1	88	92	79	85	86	13
2	79	84	87	88	84.5	9
3	92	91	90	85	89.5	7
4	89	88	90	95	90.5	7
5	90	88	91	94	90.75	6
6	94	89	92	91	91.5	5
7	88	98	93	94	93.25	10
8	94	94	91	93	93	3
9	91	87	90	92	90	5
10	90	89	94	88	90.25	6
11	89	91	91	93	91	4
12	87	92	88	94	90.25	7
13	86	86	89	95	89	9
14	93	85	94	91	90.75	9
15	95	91	90	90	91.5	5
16	91	90	87	88	89	4
17	90	92	89	87	89.5	5

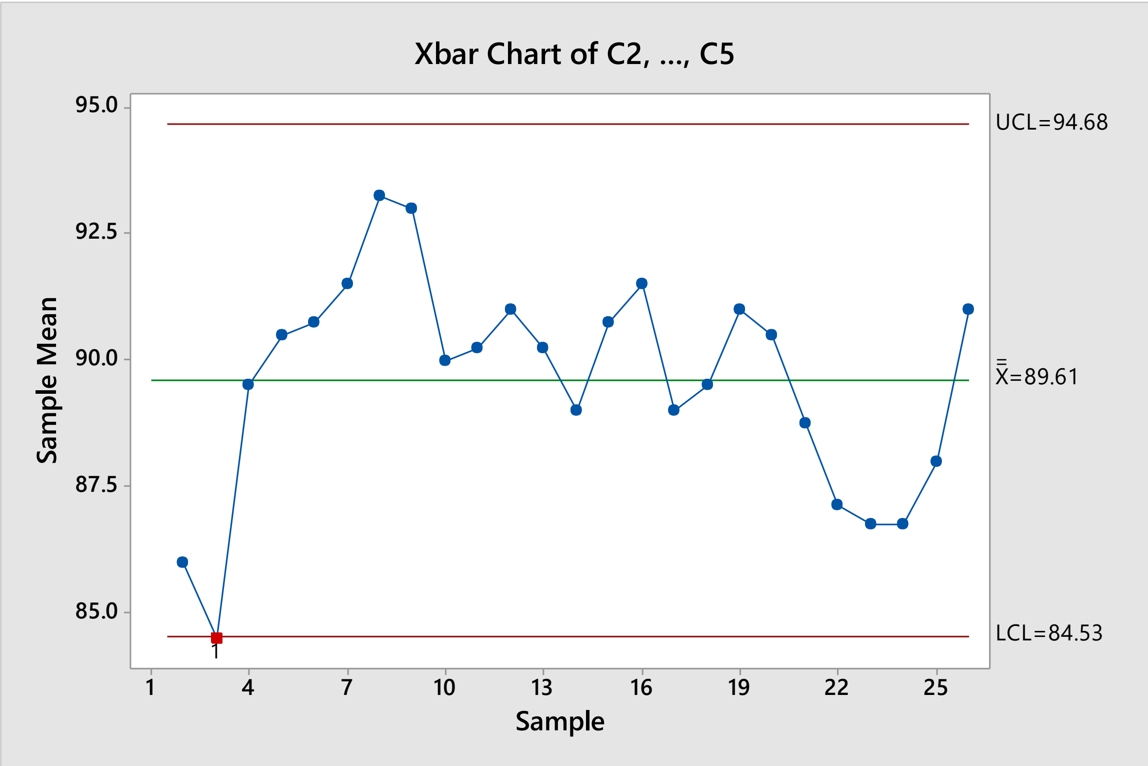
18	89	93	90	92	91	4
19	90	86	93	93	90.5	7
20	87	87	92	89	88.75	5
21	82	81.5	91	94	87.125	12.5
22	87	85	88	87	86.75	3
23	88	86	87	86	86.75	2
24	89	90	79	94	88	15
25	93	94	86	91	91	8
					2240.125	170.5
UCL=15.5496						
LCL=0					89.605	6.82

COTROL CHARTS



since the R chart does not show any out-of-control points, it suggests that the variability within each subgroup, including subgroup 2, remains consistent and within expected limits

This situation can occur due to various reasons, such as a temporary shift in the process mean (due to a special cause) while the overall process variability remains stable



Comment:

In analyzing the control charts, I noticed an interesting observation in the X chart and R chart. While the majority of the data points fall within the expected control limits, there was one instance of an out-of-control point in subgroup number 2 of the X chart. This deviation from the norm, however, is classified as a chance cause, indicating that it is not a significant concern and likely due to random variation.

The perfect control limit for our process is set at 90 grams. Upon closer examination, the out-of-control point in subgroup number 2 was measured at 84.5 grams, which falls below the lower control limit. While this may initially seem concerning, the context of this deviation being a chance cause provides reassurance that it is not indicative of a systemic issue within the process.

This situation serves as a reminder of the importance of understanding and interpreting control charts within their statistical context. While deviations from control limits warrant attention and investigation, the identification of chance causes allows us to differentiate between random variation and meaningful process changes. This nuanced approach to control chart analysis ensures that we focus our efforts on addressing significant issues while avoiding unnecessary alarm for minor fluctuations that are inherent in any process.

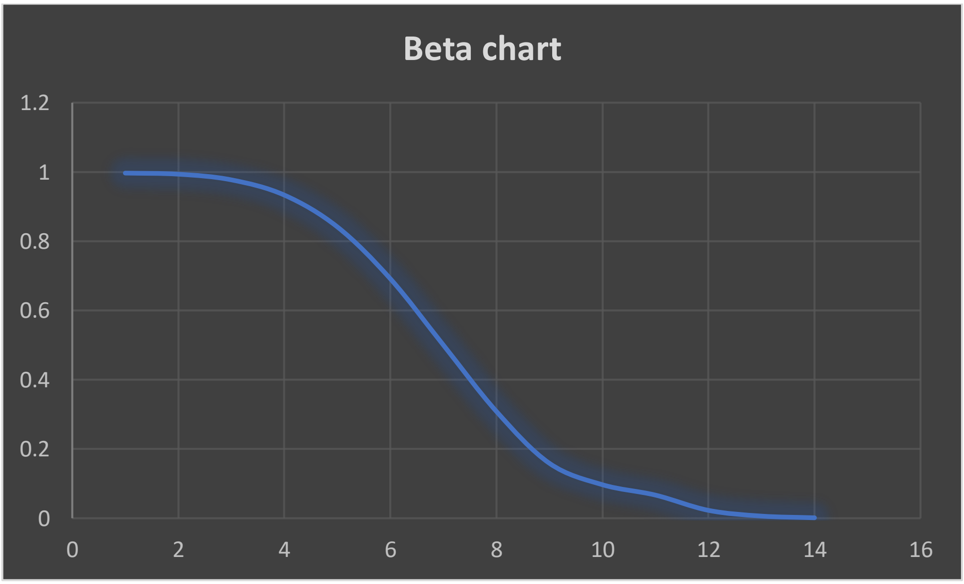
Type-I and Type-II errors:

Type-I error is when the null hypothesis is true but still rejected. The type-I error can be calculated using the following probability P(x>UCL) +P(x<LCL).

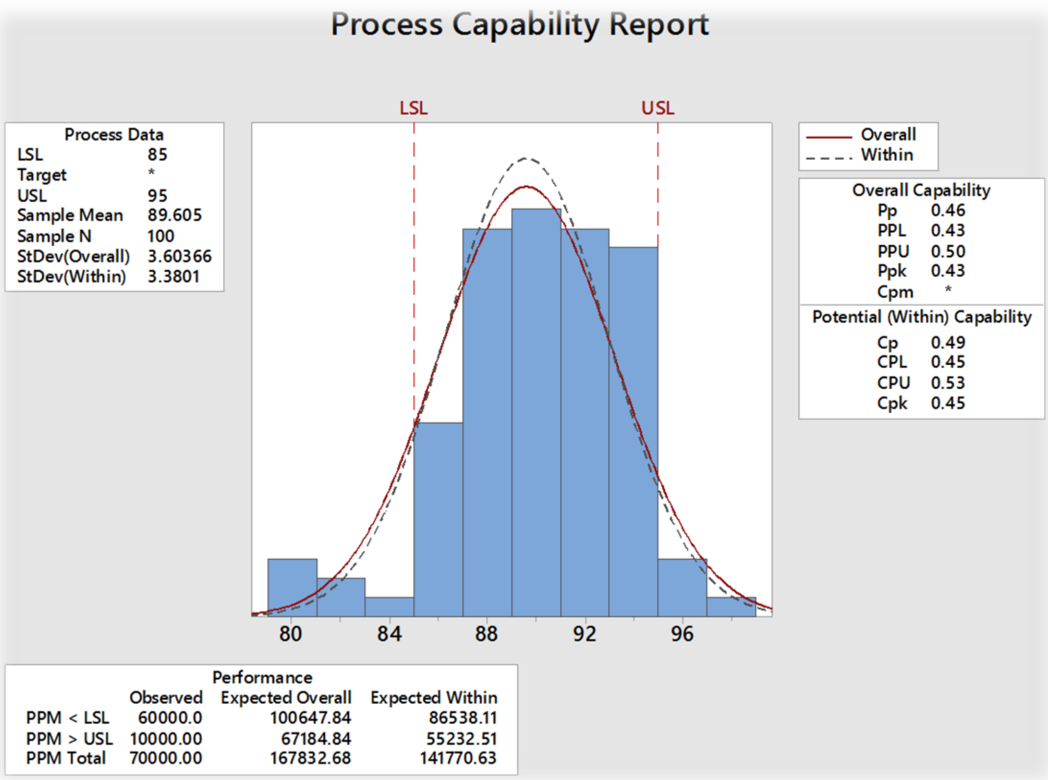
With L=3, n=4 and K= 2, Using the values above, the probability of not detecting a shift will be 0.1587 which is the beta error. So, the probability that such a shift will be detected on the first subsequent sample will be 1-(0.1587) = 0.8413 while ARL1= 1/0.8413 = 1.1886

VARIABLE DATA

k	beta	1st	2nd
0.1	0.99676	0.99744	0.00069
0.25	0.99356	0.99379	0.00023
0.5	0.97722	0.97725	3.2E-05
0.75	0.93319	0.93319	3.4E-06
1	0.84134	0.84134	2.9E-07
1.25	0.69146	0.69146	1.9E-08
1.5	0.5	0.5	9.9E-10
1.75	0.30854	0.30854	4E-11
2	0.15866	0.15866	1.3E-12
2.15	0.0968	0.0968	1.4E-13
2.25	0.06681	0.06681	3.2E-14
2.5	0.02275	0.02275	6.2E-16
2.75	0.00621	0.00621	9.5E-18
3	0.00135	0.00135	1.1E-19



CAPABILITY RATIO



- A Cp value of 0.4606 indicates that the process for burger weights at Burger King is currently not capable of consistently producing burgers within the specified weight limits of 85 to 95 grams. Process improvement efforts are needed to reduce variability and improve consistency to meet quality standards

- High Variability: The process has high variability compared to the tolerance allowed by the specification limits. This means that a significant portion of the burger weights will fall outside the acceptable range (85 to 95).

Attributes data:

Over the course of 35 consecutive days, our research team will conduct a meticulous examination of water bottles sourced from Silsal Company. These bottles will be inspected for defects within boxes, each containing 40 pieces. It's important to note that our sampling process occurs post-shipment, directly from the store, rather than during the initial manufacturing phase at the factory.

The defects under scrutiny encompass a range of issues, including damage, misprints, and incorrect bottle weights. These defects are of paramount concern as they can significantly impact not only the product's integrity but also customer satisfaction levels. By identifying and quantifying these defects through thorough subgroup sampling, we aim to gain a comprehensive understanding of the quality control challenges faced in this context.

- **In our research, we classify non-conformities as the count of defects in the box of bottles of water, indicating that a defect is counted when there is one of the specified errors. These errors encompass damage, misprints, incorrect bottle weights, and other deviations that affect product quality.**

- Cracks or Breakage
- Misprints or Labeling Errors
- Seal Integrity Issues
- Incorrect Fill Level
- Cap or Closure Defects
- Foreign Particles
- Bottle Transparency Issues
- Minor scratches on the bottle surface
- Slight discoloration on the label
- Small air bubbles trapped inside the bottle
- Slightly uneven bottle shape
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- Slight discoloration on the label
- Small air bubbles trapped inside the bottle
- Slightly uneven bottle shap

Class A Defects—Very Serious. The unit is either completely unfit for service, or will fail in service in such a manner that cannot be easily corrected in the field, or will cause personal injury or property damage.

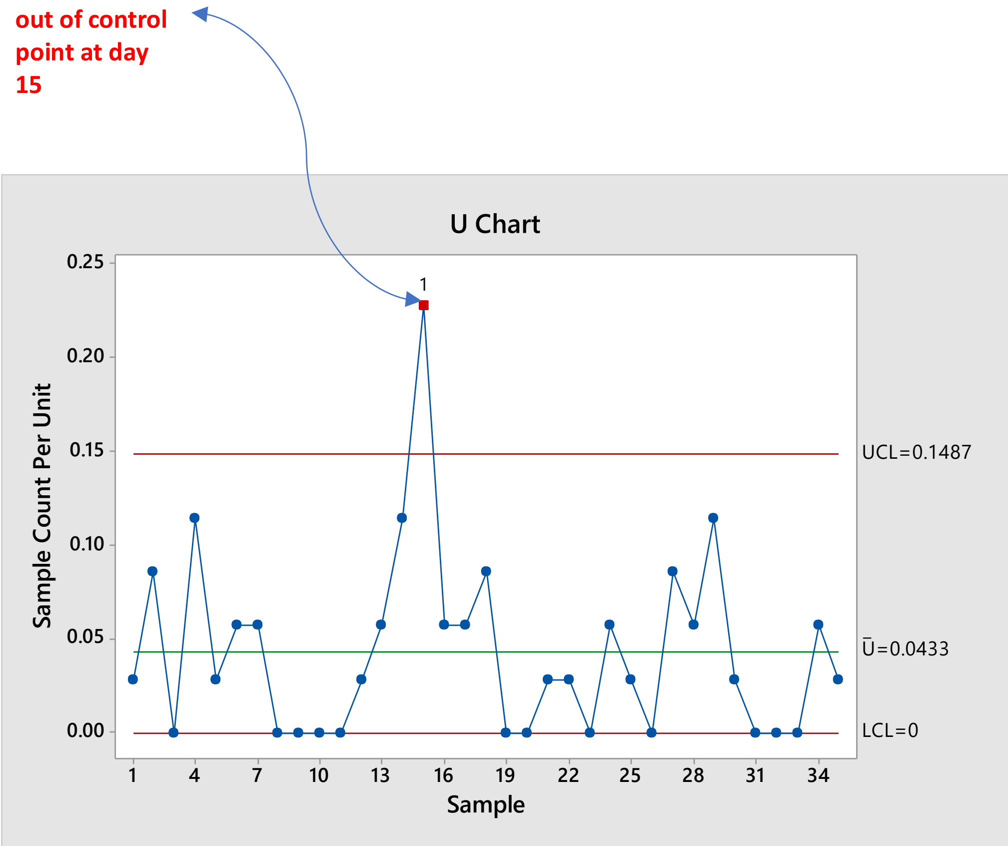
Class B Defects—Serious. The unit will possibly suffer a Class A operating failure, or will certainly cause somewhat less serious operating problems, or will certainly have reduced life or increased maintenance cost.

Class C Defects—Moderately Serious. The unit will possibly fail in service, or cause trouble that is less serious than operating failure, or possibly have reduced life or increased maintenance costs, or have a major defect in finish, appearance, or quality of work.

Class D Defects—Minor. The unit will not fail in service but has minor defects in finish, appearance, or quality of work.

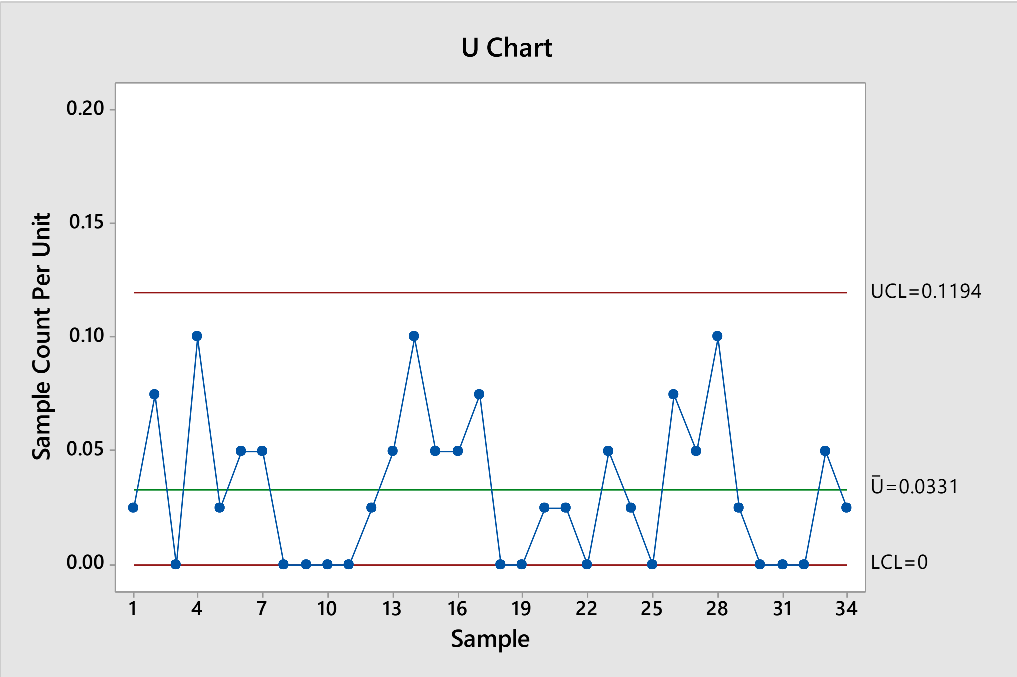
- **Class A Defects (Very Serious):**
  - Cracks or Breakage
  - Seal Integrity Issues
  - Incorrect Fill Level
  - Cap or Closure Defects
- **Class B Defects (Serious):**
  - Misprints or Labelling Errors
  - Foreign Particles
  - Bottle Transparency Issues
- **Class C Defects (Moderately Serious):**
  - Minor scratches on the bottle surface
  - Slight discoloration on the label
  - Small air bubbles trapped inside the bottle
  - Slightly uneven bottle shape
- **Class D Defects (Minor):**
  - Faint ink smudges on the label
  - Tiny specks of dust on the bottle surface
  - Minor variations in bottle cap color
  - Slight distortion in label alignment

sample number	sample size	num of nonconf	avgnonconf
1	40	1	0.025
2	40	3	0.075
3	40	0	0
4	40	4	0.1
5	40	1	0.025
6	40	2	0.05
7	40	2	0.05
8	40	0	0
9	40	0	0
10	40	0	0
11	40	0	0
12	40	1	0.025
13	40	2	0.05
14	40	4	0.1
15	40	**8**	0.35
16	40	2	0.05
17	40	2	0.05
18	40	3	0.075
19	40	0	0
20	40	0	0
21	40	1	0.025
22	40	1	0.025
23	40	0	0
24	40	2	0.05
25	40	1	0.025
26	40	0	0
27	40	3	0.075
28	40	2	0.05
29	40	4	0.1
30	40	1	0.025
31	40	0	0
32	40	0	0
33	40	0	0
34	40	2	0.05
35	40	1	0.025

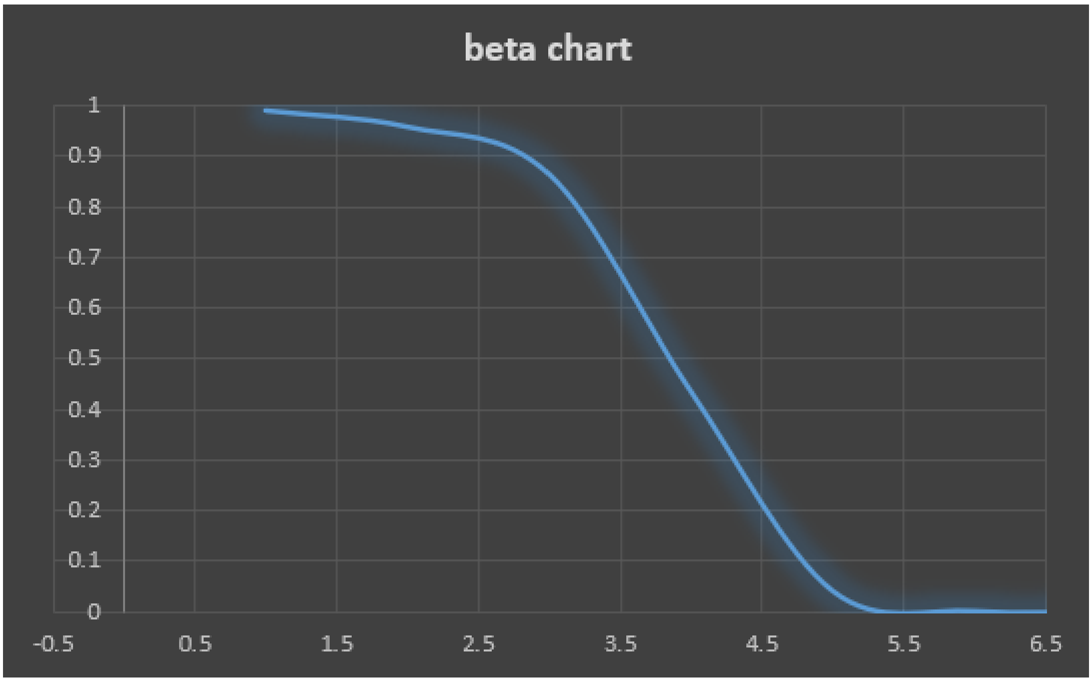


On day 15, our quality control inspection revealed an out-of-control point, which we have identified as being caused by shipping and handling issues. The post-shipment nature of our sampling process means that the bottles are subject to various external factors during transit. It appears that the batch inspected on this particular day may have encountered rough handling or adverse conditions while in transit. Such handling can lead to an array of defects, including cracks, breakages, and cap defects, which significantly compromise the integrity and quality of the bottles. This assignable cause highlights the critical impact that the logistics phase can have on product quality, underscoring the necessity for stringent shipping protocols and careful handling to ensure the maintenance of high standards from factory to store. Our findings on day 15 serve as a crucial reminder of the interconnectedness of each stage in the supply chain and the need for comprehensive quality control measures at every step.

After excluding the out-of-control point and recalculating the control limits, we have determined the new control limits. All points are now within control."LCL = 0 CL=U=0.0331 UCL =0.1194

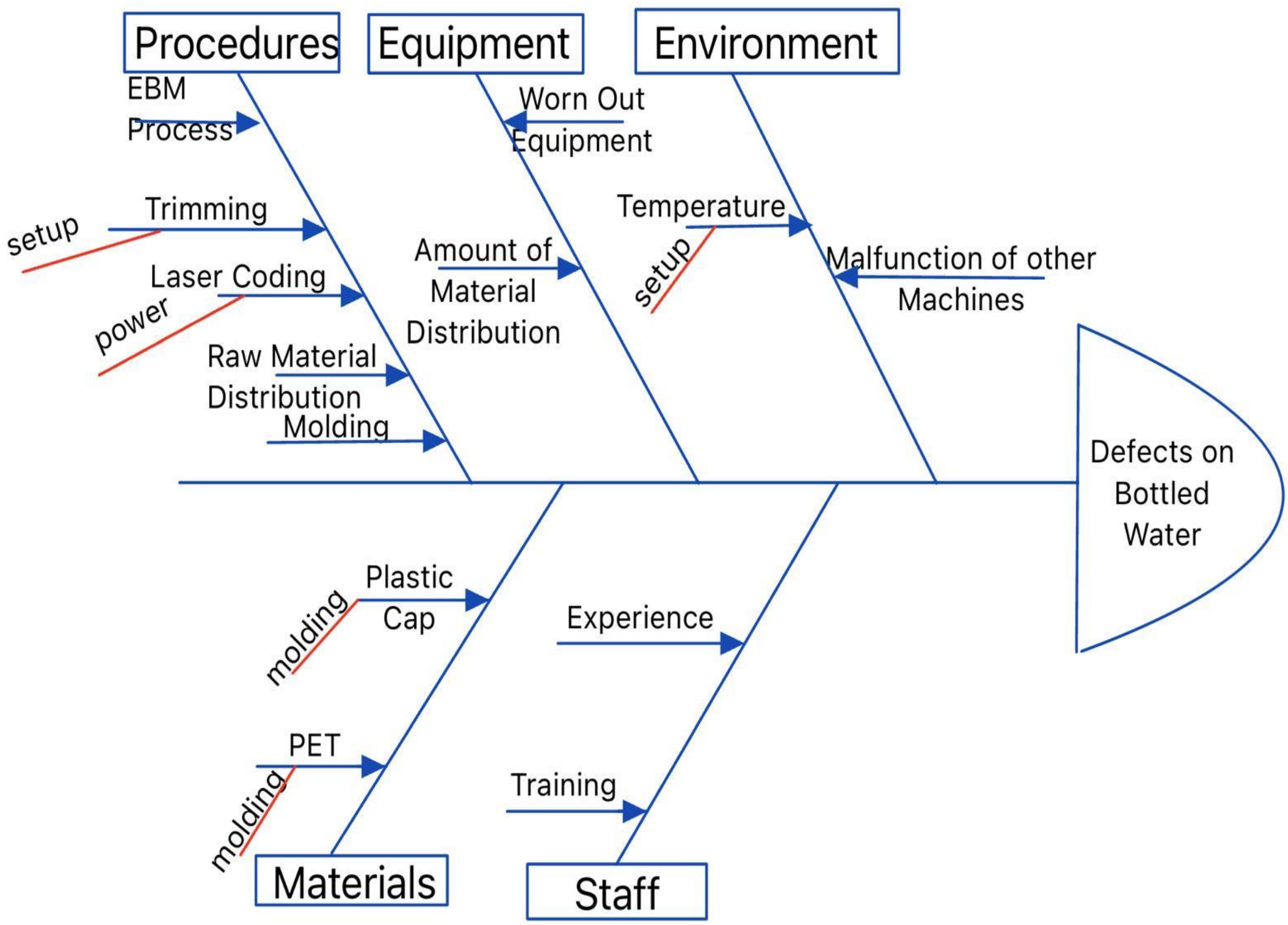


- **Beta Chart Attributes 40 sample size**



The provided OC (Operating Characteristic) curve shows the relationship between the probability of accepting a lot (beta, the consumer's risk) and the quality level of the lot, represented by the defect rate. At low defect rates (less than 2.5%), the probability of accepting the lot (beta) is very high, close to 1. This indicates that the sampling plan is likely to accept lots with low defect rates, ensuring that good quality batches are not unnecessarily rejected. Between defect rates of approximately 2.5% to 4.5%, there is a sharp decline in the probability of acceptance. This transition zone is crucial as it represents the range where the sampling plan becomes more sensitive to defects, decreasing the likelihood of accepting lots as defect rates increase. This sharp decline indicates a good discriminatory power of the sampling plan in distinguishing between acceptable and unacceptable lots.

Cause-and-Effect Diagram of water bottles.



Conclusion:

In this project, we conducted quality control analyses on two types of data sets: variable data for burgers and attribute data for water bottles. For the variable data on burger weights, we utilized R charts and X-bar charts to monitor consistency and identify any shifts in the process mean or variability. Meanwhile, for the attribute data concerning water bottle defects, the U chart was employed to track defect rates over time. During our analysis, we identified an out-of-control point in the U chart, indicating a sudden increase in defects. Immediate action was taken to investigate and rectify the issue, which involved removing the outlier point to stabilize the process. These methods not only highlighted the effectiveness of statistical process control techniques but also underscored the importance of continuous monitoring and intervention in maintaining product quality and process efficiency.

Thank you.