Lab Report

Mouse Factory I

ISEN 350

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Date: 04/19/2024

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Executive Summary

The Mouse Factory has been operating without a dedicated quality manager for the past four months, resulting in a need to reassess our quality control processes. As the newly appointed quality manager, my primary objective is to analyze existing quality and production to improve the overall product quality. This will involve a detailed review of electronic databases that track production records and document quality related expectations.

Our current inspection process involves assessing each part for critical quality characteristics against specified limits. Parts that fail to meet these limits are categorized as "Variable outside of specification," while those that are non-conforming based on the other criteria are labeled as "Part Nonconforming." Additionally parts that show nonconformities, which do not necessarily deem as bad, are recorded as "Nonconformity Found" and are considered "off-spec parts" in production records.

The immediate goals of this quality improvement project are centered around three key objectives. First, we establish clear quality and production benchmarks by analyzing historical data from our production and quality records. This will help us identify trends and areas of improvement in our manufacturing processes. Second, we plan to formulate a quality improvement plan specifically designed to reduce the incidence of non-conforming parts and improve the overall integrity of the production process. We do this by reevaluating our current inspection and quality control protocols to ensure they are effective, and finally we have to ensure that this is consistent in the future. By focusing on these critical areas, our goal is to strengthen our production quality, reduce waste, and increase customer satisfaction.

Introduction

Welcome to our Quality Improvement project. After operating without a quality manager for four months, the factory has experienced increased variability and non-conformance in our production line. As the new Quality Manager, I am tasked with analyzing our production and quality exception records to identify and address root causes of quality issues. This project will focus on setting new quality and production benchmarks, developing an improvement plan, and enhancing our quality management system.

Benchmark Analysis

Total Parts

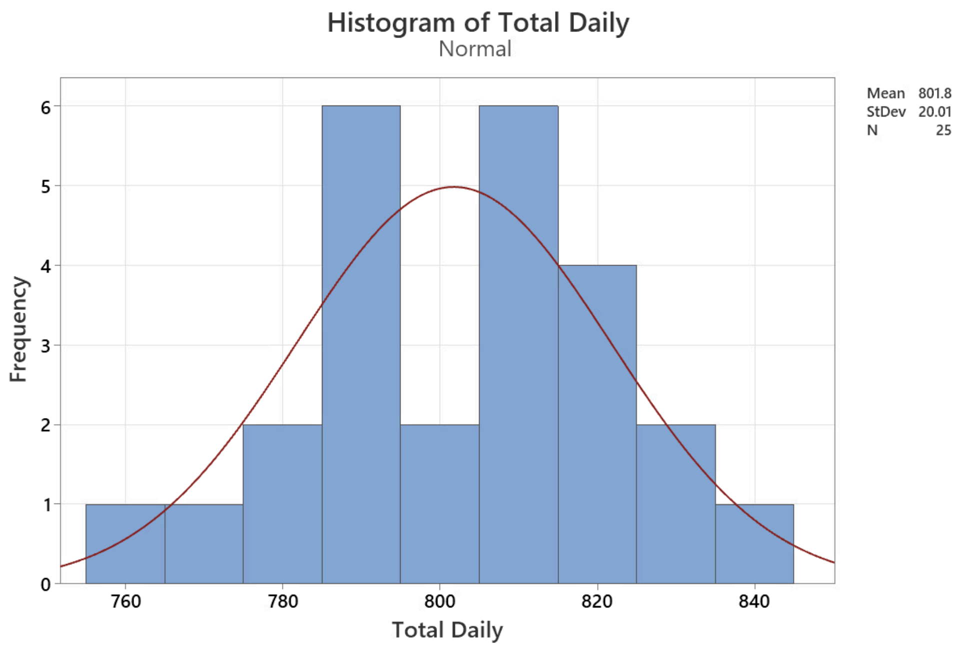


Figure 1: Histogram of Total Parts

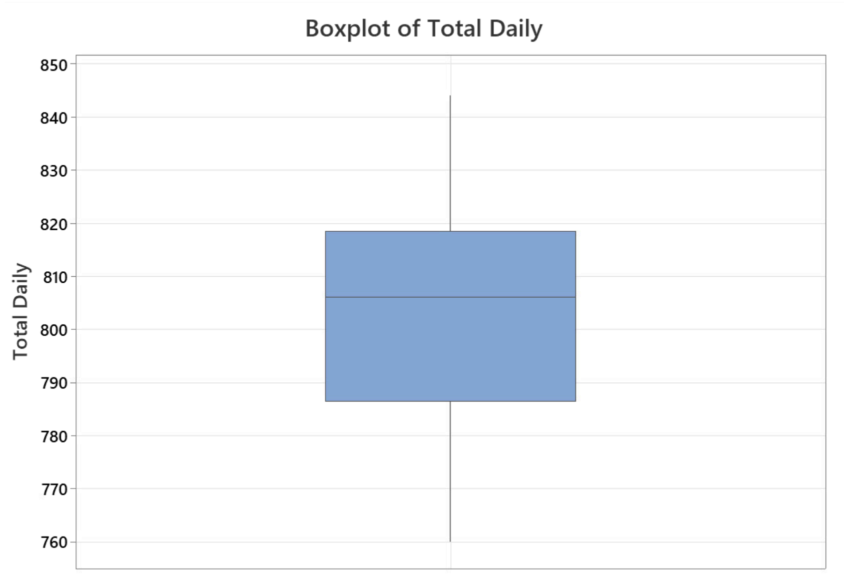


Figure 2: Boxplot of Total Parts

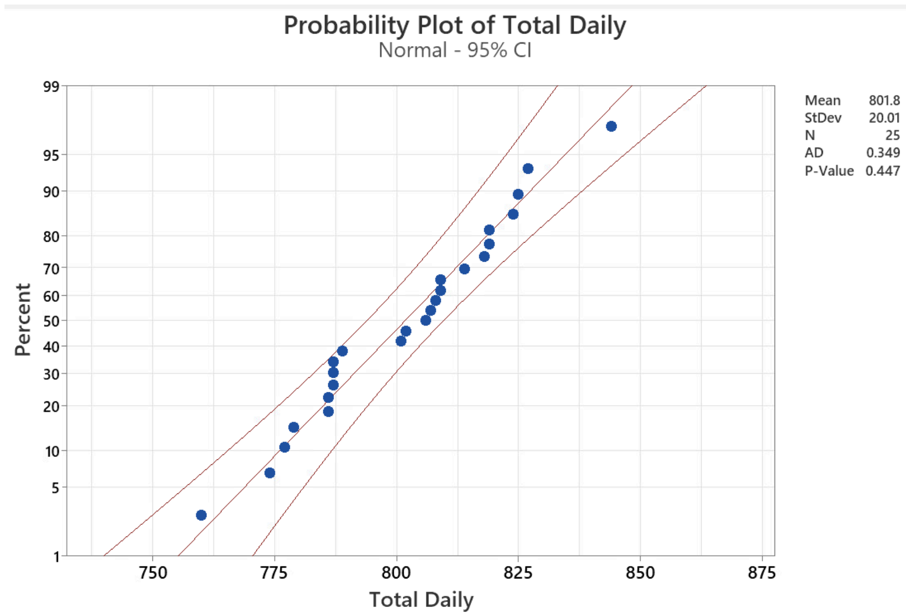


Figure 3: Probability Plot of Total Parts

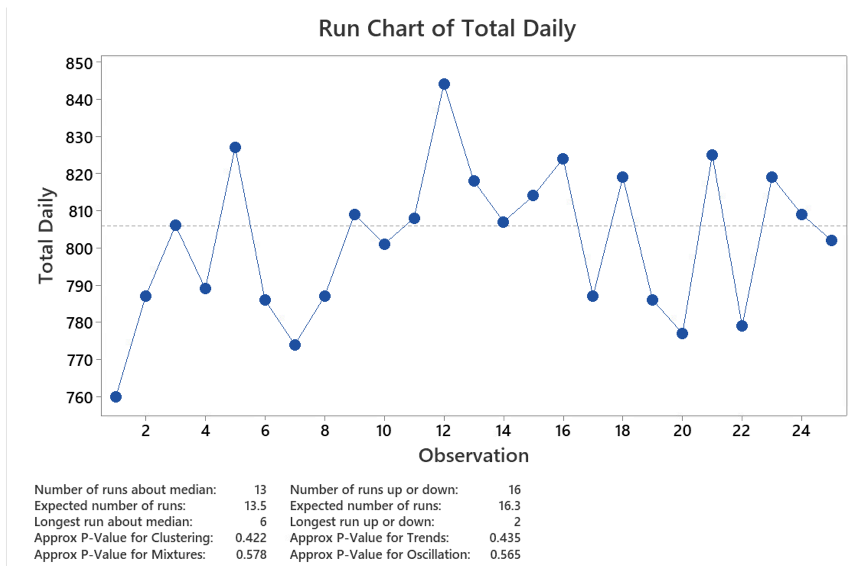


Figure 4: Run Chart of Total Parts

Statistics

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Total Daily	25	0	801.76	4.00	20.01	760.00	786.50	806.00	818.50	844.00

Figure 5: Basic Statistics of Total Parts

Descriptive Statistics

N	Mean	StDev	SE Mean	95% CI for μ
25	801.76	20.01	4.00	(793.50, 810.02)

μ: population mean of Total Daily

Figure 6: 95% Confidence Interval for Total Parts

For the total daily parts, the mean production count stands at 801.76, with a standard deviation of 20.01. This indicates a relatively stable production process with controlled variation. The interquartile range is tight, from 786.50 to 818.50, and the median at 806 suggests a slight skew towards higher production counts. A 95% confidence interval of 793.50 to 810.02 for the mean production count reflects a precise estimate, which shows a production process that is stable but has potential for further improvement in consistency. The prediction interval for a future single observation of total parts, with 95% confidence, is approximately between 759.64 and 843.88. This interval suggests that there is a 95% chance that the next part count will fall within this range, given the current production parameters. **(The code used for the prediction is provided in the appendix at the end of the report)**

Good Parts

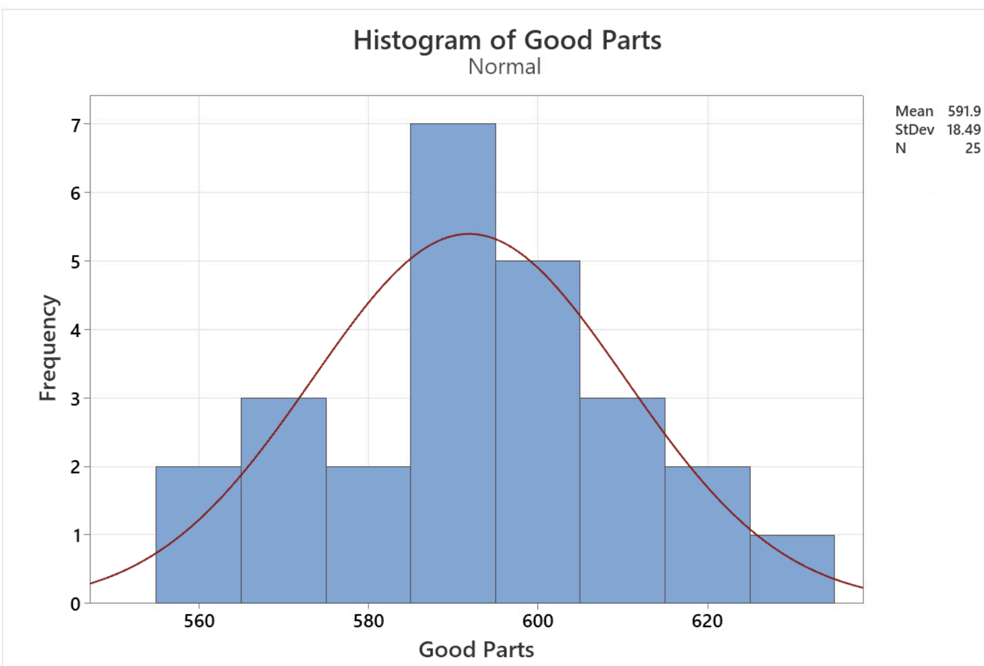


Figure 7: Histogram of Good Parts

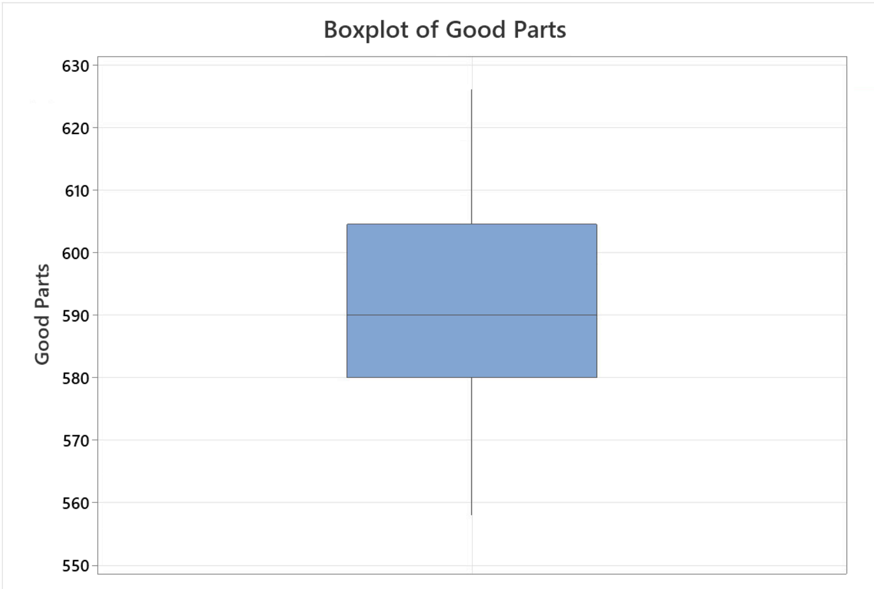


Figure 8: Boxplot of Good Parts

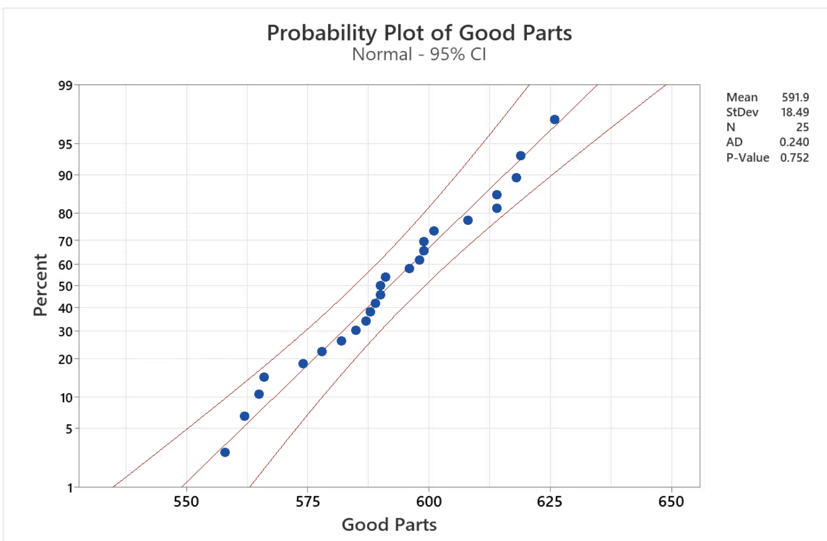


Figure 9: Probability Plot of Good Parts

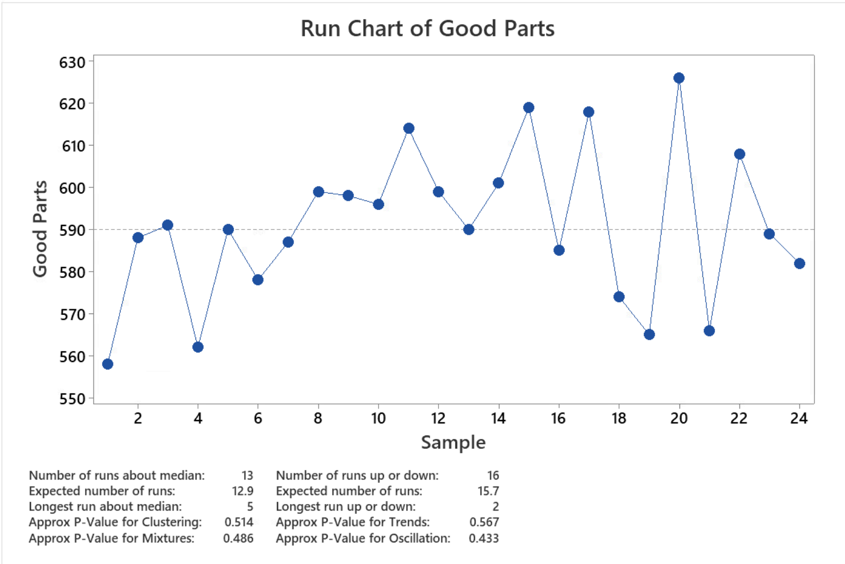


Figure 10: Run Chart of Good Parts

Statistics

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Good Parts	25	0	591.88	3.70	18.49	558.00	580.00	590.00	604.50	626.00

Figure 11: Basic Statistics of Good Parts

Descriptive Statistics

N	Mean	StDev	SE Mean	95% CI for μ
25	591.88	18.49	3.70	(584.25, 599.51)

μ: population mean of Good Parts

Figure 12: 95% Confidence Interval for Good Parts

The production data for good parts at the factory indicates a central tendency around the mean value of 591.9 with minimal variability, as shown by the standard deviation of 18.49. Most parts fall within a middle 50% range of 580 to 604.5, suggesting a consistency in production. The median at 590, suggests a slight skewness in data because it is slightly below the mean. The 95% confidence interval (584.25, 599.51) assures that the true mean is likely within this range. This indicated a controlled and reliable production process. The prediction interval for a future single observation of good parts, with 95% confidence, is approximately between 552.96 and 630.797. This interval suggests that there is a 95% chance that the next good part count will fall within this range, given the current production parameters. **(The code used for the prediction is provided in the appendix at the end of the report)**

Bad Parts

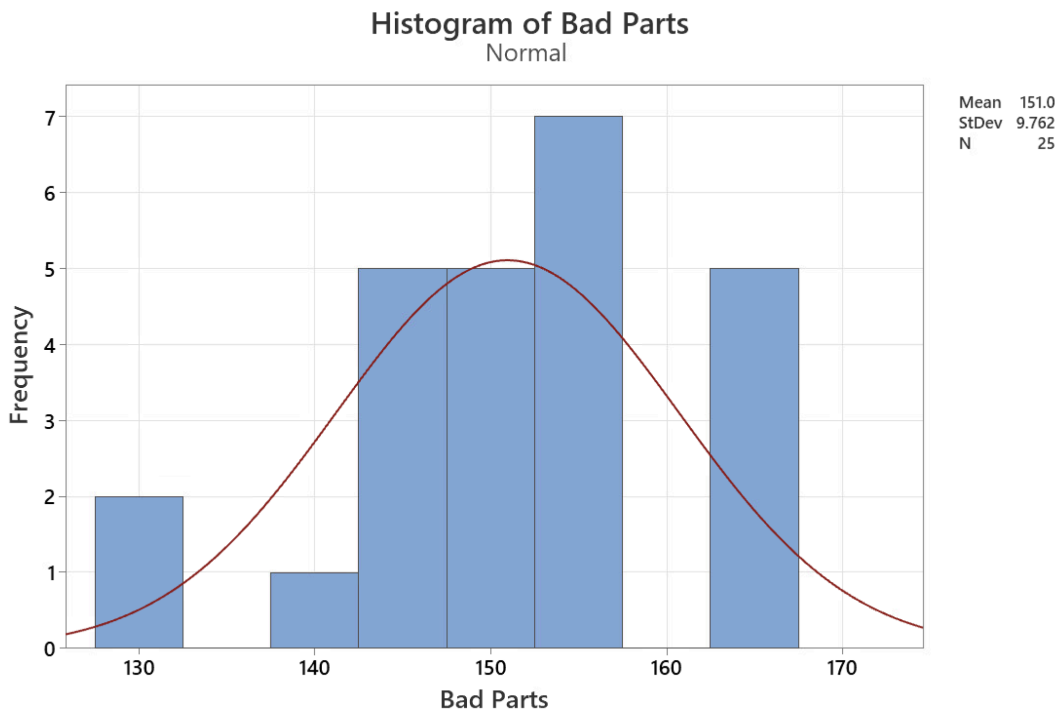


Figure 13: Histogram of Bad Parts

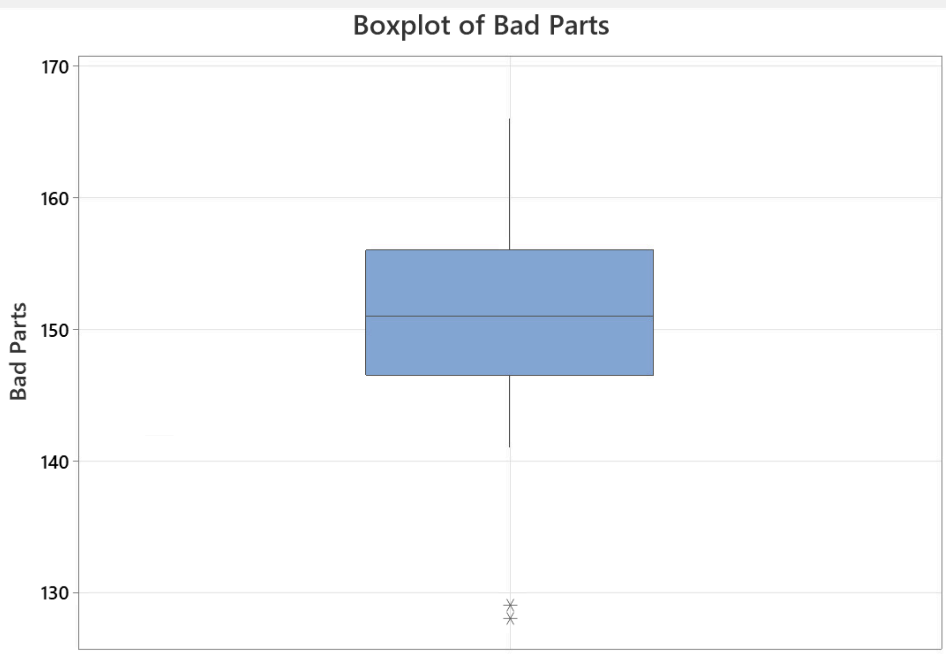


Figure 14: Boxplot of Bad Parts

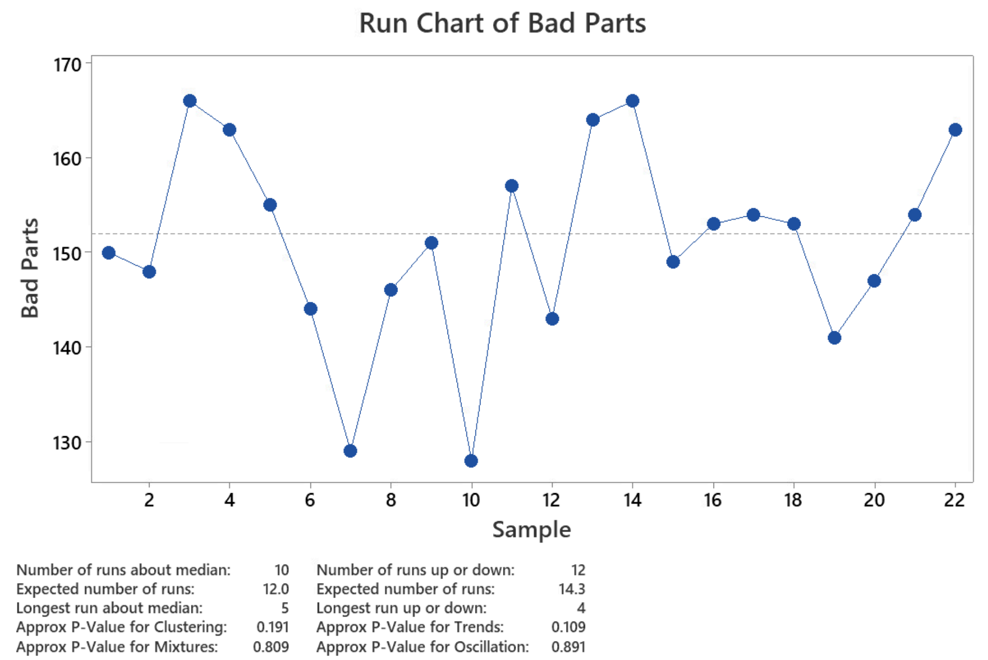


Figure 15: Run Chart of Bad Parts

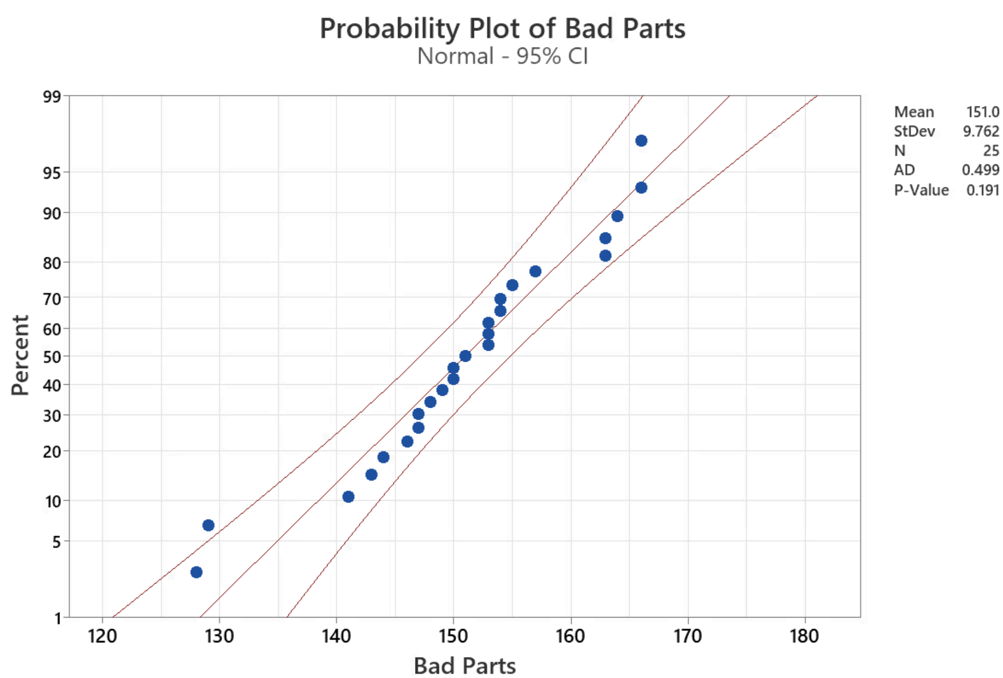


Figure 16: Probability Plot of Bad Parts

Statistics

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Bad Parts	25	0	150.96	1.95	9.76	128.00	146.50	151.00	156.00	166.00

Figure 17: Basic Statistics of Bad Parts

Descriptive Statistics

N	Mean	StDev	SE Mean	95% CI for μ
25	150.96	9.76	1.95	(146.93, 154.99)

μ: population mean of Bad Parts

Figure 18: 95% Confidence Interval for Bad Parts

The production of bad parts shows a pattern, with an average of 150.96 and a tight standard deviation of 9.76, which still indicates consistent production levels. The data is symmetric around the mean, as reflected by the median, and most occurrences fall within a narrow middle range. With a 95% confidence interval between 146.94 and 154.99, the process shows a stable but consistent production of bad parts, highlighting the need for targeted improvements to lower these occurrences. The prediction interval for a future single observation of bad parts, with 95% confidence, is approximately between 130.42 and 171.50. This interval suggests that there is a 95% chance that the next bad part count will fall within this range, given the current production parameters. **(The code used for the prediction is provided in the appendix at the end of the report)**

<u>Off-spec Parts</u>

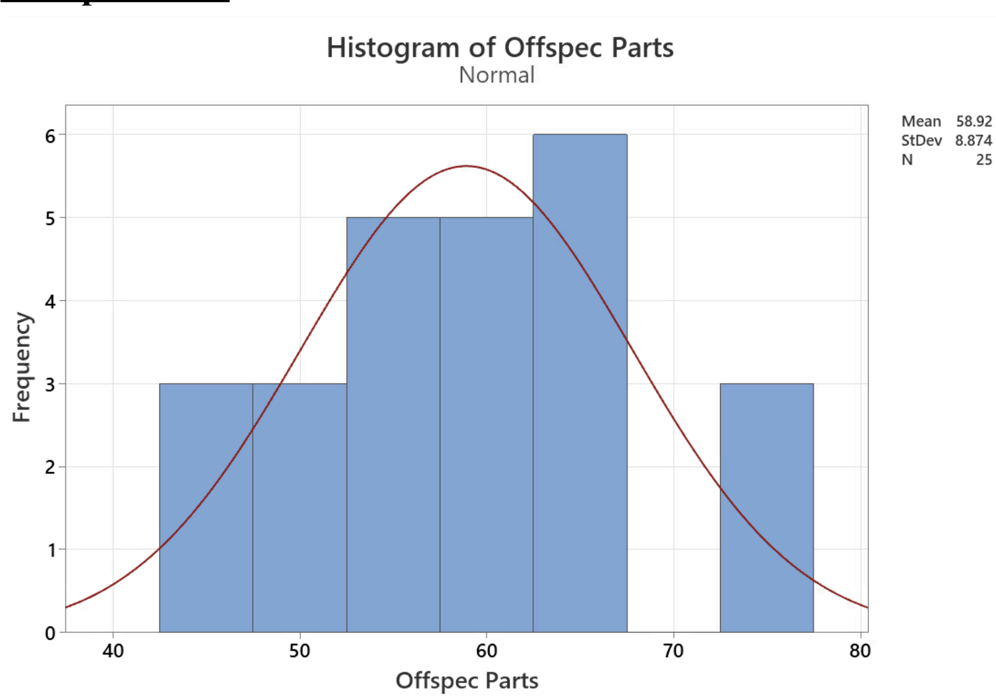


Figure 19: Histogram of Off-spec Parts

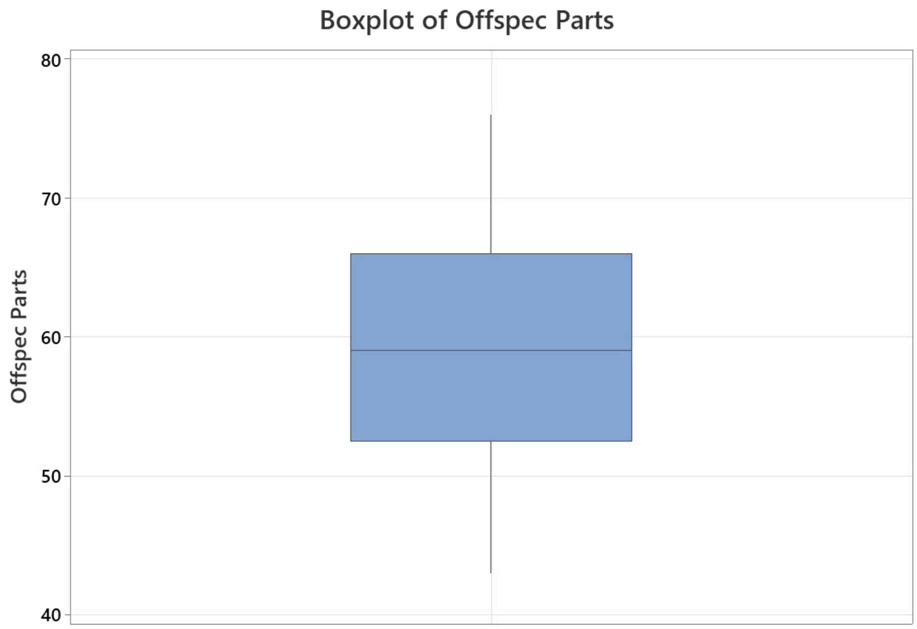


Figure 20: Boxplot of Off-spec Parts

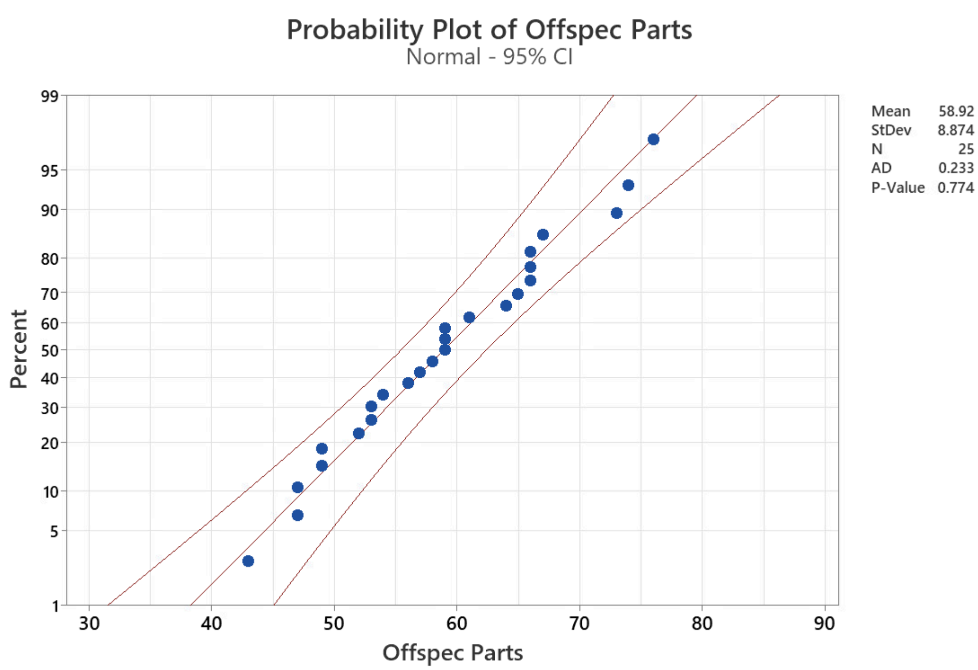
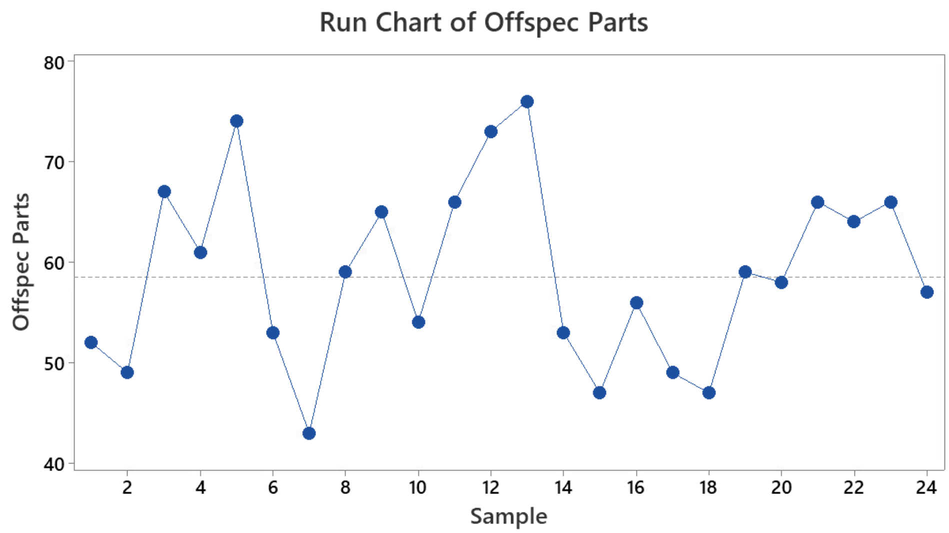


Figure 21: Probability of Off-spec Parts



Number of runs about median:	11	Number of runs up or down:	17
Expected number of runs:	13.0	Expected number of runs:	15.7
Longest run about median:	5	Longest run up or down:	3
Approx P-Value for Clustering:	0.202	Approx P-Value for Trends:	0.749
Approx P-Value for Mixtures:	0.798	Approx P-Value for Oscillation:	0.251

Figure 22: Run Chart of Off-spec Parts

Statistics

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Offspec Parts	25	0	58.92	1.77	8.87	43.00	52.50	59.00	66.00	76.00

Figure 23: Basic Statistics of Off-spec Parts

Descriptive Statistics

N	Mean	StDev	SE Mean	95% CI for μ
25	58.92	8.87	1.77	(55.26, 62.58)

μ: population mean of Offspec Parts

Figure 24: 95% Confidence Interval for Off-spec Parts

The production of Off-spec parts averages at 58.92 with a standard deviation of 8.87, indicating a moderate consistent in these occurrences. The data is tightly distributed, as seen in the interquartile range of 52.50 to 66.0. With a median equal to the mean, the distribution is symmetric. The 95% confidence interval (55.26, 62.58) suggests that production deviations are predictable, which offers a basis for targeted process improvements to minimize these off spec parts. The prediction interval for a future single observation of Off-spec parts, with 95% confidence, is approximately between 40.25 and 77.59. This interval suggests that there is a 95% chance that the next bad part count will fall within this range, given the current production parameters. **(The code used for the prediction is provided in the appendix at the end of the report)**

Defect Check Sheet

Defect Description	Week1	Week2	Week3	Week4	Week5	Grand Total
Base-Black Streaking	3	7	3	4	2	19
Base-Bubble	10	7	2	1	3	23
Base-Burn Spot	3	1	4	6	5	19
Base-Mold Flashing	6	4	5	3	6	24
Base-Part Stuck in Mold	2	3	4	5	2	16
Base-Poor Weld Line		4	2	6		12
Base-Short Shot	1	3	5	3	2	14
Base-Sink Spot	2	1	4	3	2	12
Base-Snap Point Diameter	91	87	88	83	90	439
Base-Snap Point Opening	14	8	7	7	19	55
Base-Surface Imperfection	3	4	2	3	9	21
Base-Warpage	2	1	2		4	9
Button-Black Streaking	7	5	1	3	2	18
Button-Bubble	8	3	2	4	2	19
Button-Burn Spot	7	6	4	1	6	24
Button-Hole Diameter	12	10	9	8	13	52
Button-Mold Flashing	2	3	5	2	3	15
Button-Part Stuck in Mold	3		7	7	3	20
Button-Poor Weld Line	2	4	4	1	7	18
Button-Short Shot	3	2	4	6	3	18
Button-Sink Spot	2	5	6	6	3	22
Button-Surface Imperfection	2	3	2	3	5	15
Button-Warpage	6	4	3	7	4	24
Cover-Black Streaking	3	2	1	5	2	13
Cover-Bubble	4	2	3	9	7	25
Cover-Burn Spot	2	2	3	1		8
Cover-Mold Flashing	4	4	4	3	3	18
Cover-Part Stuck in Mold	2	5	6	1	5	19
Cover-Poor Weld Line	96	81	75	89	60	401
Cover-Shaft Diameter	6	8	7	16	12	49

Cover-Short Shot	6	3	3	5	3	20
Cover-Sink Spot	2	3	1	4	3	13
Cover-Surface Imperfection	5	3	6	2	1	17
Cover-Warpage	2	6	4	1	2	15
Diffuser-Black Specks	200	192	195	176	214	977
Diffuser-Brittleness	5	4	2	2	4	17
Diffuser-Burn Marks	4	1	5	5	4	19
Diffuser-Discoloration	5	6	4	7	7	29
Diffuser-Intensity	18	18	11	12	12	71
Diffuser-Jetting	4	2	4	2	5	17
Diffuser-Part Stuck in Mold		1	2	1	1	5
Diffuser-Splay Marks	2	3	3	5	2	15
Diffuser-Voids	2	2	2	6	3	15
Diffuser-Warpage	3	2	3	2	6	16
Diffuser-Weld lines	5	1	4	5	6	21
Scroll Base-Black Streaking	2	9	2	3	10	26
Scroll Base-Bubble	4	3	9	1	1	18
Scroll Base-Burn Spot	2	4	8	5	8	27
Scroll Base-Hole Diameter	8	13	13	8	6	48
Scroll Base-Mold Flashing	2	4	5	1	6	18
Scroll Base-Opening	268	271	288	262	281	1370
Scroll Base-Part Stuck in Mold	87	77	91	69	77	401
Scroll Base-Pin Diameter	15	11	11	14	9	60
Scroll Base-Poor Weld Line	2	4	6	4	5	21
Scroll Base-Short Shot	6	7	1	4	2	20
Scroll Base-Sink Spot	5	2	1	4	3	15
Scroll Base-Surface Imperfection	5	2	5	2	1	15
Scroll Base-Warpage	4	2	1	6	4	17
Scroll Wheel Assembly-Black Streaking	5	3	3	6	2	19
Scroll Wheel Assembly-Bubbles	4	2		3	8	17
Scroll Wheel Assembly-Burn Spot	3	4	4	3	2	16
Scroll Wheel Assembly-Missing Teeth	4	5	1	3	2	15

Scroll Wheel Assembly-Mold Flashing	217	180	207	213	198	1015
Scroll Wheel Assembly-Part Stuck in Mold	1	1	2	2	1	7
Scroll Wheel Assembly-Shaft Pin Diameter	12	10	10	14	11	57
Scroll Wheel Assembly-Short Shot	1	6	3	4	4	18
Scroll Wheel Assembly-Sink Spot	2	3	3	6	1	15
Scroll Wheel Assembly-Surface Imperfection	4	2	3	5	5	19
Scroll Wheel Assembly-Warpage	4	6	5	4	2	21
Grand Total	1238	1157	1205	1177	1206	5983

Table 1: Defect Check Sheet

The Defect Check Sheet serves as a tool for identifying, quantifying, and tracking different types of defects that occur during our production cycles. This approach categorizes each defect by type and records the occurrence of each defect weekly, leadking to a cumulative assessment over the span of five weeks. This aids in pinpointing recurring production issues and facilitates the implementation of effective quality improvement measures.

Pareto Diagram

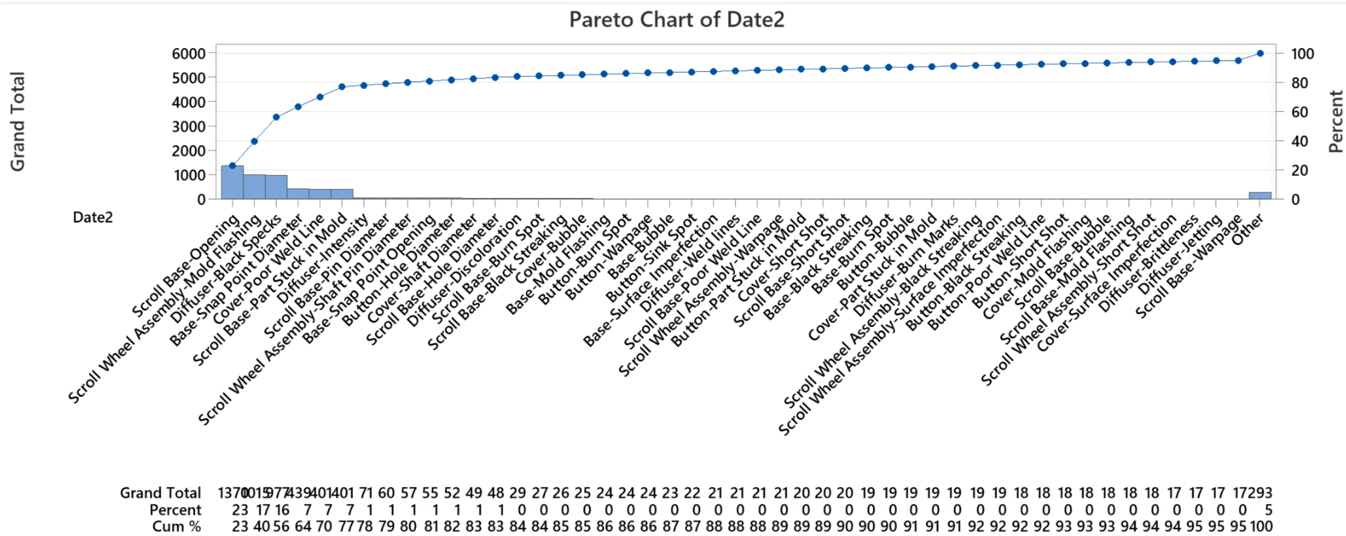


Figure 25: Pareto Chart of the Defects

The Pareto chart analysis pinpoints critical areas within our production line for targeted improvement, notably within the Injection Molding Department. As “Scroll Opening” defects dominate the chart, refining the processes where plastic and rubber components are shaped will be vital, especially since these early-stage defects can affect later phases, including Electronic Assembly and Inspection. The Receiving Area must also strengthen its quality checks to ensure all incoming materials meet our high standards before they enter the production flow.

Additionally, the high frequency of defects noted in Quality Rooms A&B calls for an evaluation of current testing protocols and possibly reset our inspection methods. The Product Assembly and Conveyor System departments are integral for a smooth production process and will indirectly benefit from the enhancements made in the earlier stages. Improving these highlighted regions will ultimately elevate the product’s standards.

Quality Improvement Plan

Objective:
The objective of this Quality Improvement plan is to address quality issues identified in The Mouse Factory, with the aim of improving the production process, reducing defect rates, and improving the end product.

Plan Overview:
The plan involves targeted improvement in critical areas identified through the Pareto Chart analysis, focused on the Injection Molding department, quality control measures in the Receiving Area and Quality Rooms A&B.

Strategic Actions:
1. Injection Molding
    - Detailed analysis of the “Scroll Opening” defect generation. (Identifying the root cause for this defect)
    - Refinement of the molding process with upgraded tools that are more precise than the ones currently present in the factory
    - Training the staff on operating the newly introduced equipment and reviewing their knowledge of standard procedures for defect prevention
2. Receiving Area Enhancement
    - Strengthening incoming inspection protocols for the incoming materials to align with our high standards
    - Strengthen supplier relationships with strict implementation to vendor compliance, promoting clear communication for high quality materials from the outset
3. Quality Inspection Process
    - Adoption of advanced inspection technologies which are more precise in Quality Rooms A&B
    - Enhanced training and review for quality inspectors to improve defect detection

Process Improvements:
1. Product Assembly Workflow
    - Introduction Lean principles to optimize assembly workflow
    - Organizing cross-functional team review for quality control. Conduct a review with the supervisors of each department to know where the defects are coming from
2. Conveyor System Efficiency
    - Implementing scheduled maintenance to reduce machine downtime
    - Establishing real-time monitoring systems to track production flow

Continuous Improvement:
Regular audits need to be conducted to assess the effectiveness of implemented strategies. We also have to incorporate feedback systems from the workers for continuous process improvement. After this, we need to keep on adjusting the plan based on key performance indicators and audit outcomes. Immediate action needs to be taken on critical interventions throughout the factory and quarterly reviews need to be conducted to monitor progress and implement any new adjustments.

Final Thoughts:
By committing to this plan, The Mouse Factory will take steps toward a significant quality improvement. This approach not only addresses immediate concerns but also lays down a framework for consistent quality enhancement and continuous improvement.

Conclusion

In summary, our analysis of the Mouse Factory's operations through defect check sheets and Pareto charts has pinpointed critical areas for quality improvement, particularly within the Injection Molding Department. Targeted actions taken in this department, and our Quality Rooms A&B, are expected to cut "Scroll Opening" defects substantially. Upgrades in equipment and training, along with detailed checks in the Receiving Area and the Inspection processes, will lead to a reduction in quality issues.

This project also lays a blueprint for continuous improvement and sets a path for achieving high product quality. With continuous monitoring and adaptive strategies, we predict to have reduction in waste, and improved customer satisfaction.

Appendix

Code for Future Performance Prediction (Total Parts)

```
from scipy.stats import t
import numpy as np

#Total Parts
mean = 801.76
std_dev = 20.01
sample_size = 25
alpha = 0.05

# Calculate the t critical value
t_critical = t.ppf(1 - alpha/2, df=sample_size-1)

# Calculate the prediction interval
prediction_interval = [
    mean - t_critical * std_dev * np.sqrt(1 + 1/sample_size),
    mean + t_critical * std_dev * np.sqrt(1 + 1/sample_size)
]

prediction_interval
```

Code for Future Performance Prediction (Good Parts)

```
from scipy.stats import t
import numpy as np

#Good Parts
mean = 591.88
std_dev = 18.49
sample_size = 25
alpha = 0.05

# Calculate the t critical value
t_critical = t.ppf(1 - alpha/2, df=sample_size-1)

# Calculate the prediction interval
prediction_interval = [
```

```
    mean - t_critical * std_dev * np.sqrt(1 + 1/sample_size),
    mean + t_critical * std_dev * np.sqrt(1 + 1/sample_size)
]

prediction_interval
```

Code for Future Performance Prediction (Bad Parts)

```
from scipy.stats import t
import numpy as np

#Bad Parts
mean = 150.96
std_dev = 9.76
sample_size = 25
alpha = 0.05

# Calculate the t critical value
t_critical = t.ppf(1 - alpha/2, df=sample_size-1)

# Calculate the prediction interval
prediction_interval = [
    mean - t_critical * std_dev * np.sqrt(1 + 1/sample_size),
    mean + t_critical * std_dev * np.sqrt(1 + 1/sample_size)
]

prediction_interval
```

Code for Future Performance Prediction (Off-spec Parts)

```
from scipy.stats import t
import numpy as np

#offspec parts
mean = 58.92
std_dev = 8.87
sample_size = 25
alpha = 0.05

# Calculate the t critical value
```

```
t_critical = t.ppf(1 - alpha/2, df=sample_size-1)

# Calculate the prediction interval
prediction_interval = [
    mean - t_critical * std_dev * np.sqrt(1 + 1/sample_size),
    mean + t_critical * std_dev * np.sqrt(1 + 1/sample_size)
]

prediction_interval
```