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ECSA Graduate Attributes Project

Industrial Engineering
Quality Assurance 344

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Table of contents

	Page
List of figures	iii
List of tables.....	v
1 Introduction.....	1
2 Descriptive Statistics	2
3 Statistical Process Control.....	7
3.1 Control Charts	7
3.1.1 Keyboard.....	7
3.1.2 Software	7
3.1.3 Cloud	8
3.1.4 Monitor.....	8
3.1.5 Laptop.....	8
3.1.6 Mouse.....	8
3.2 Delivery Process Times	9
3.2.1 Keyboard.....	9
3.2.2 Mouse.....	9
3.2.3 Laptop.....	9
3.2.4 Monitor.....	9
3.2.5 Software	10
3.2.6 Cloud	10
3.2.7 Sample out of Specification.....	10
3.3 Process Capability Indices.....	13
3.4 Sample Observations.....	14
3.4.1 Samples Outside of the Upper Control Limit.....	14
4 Probability Calculations	15
4.1 Type I Errors	15
4.2 Type II Errors	15
4.3 Differences Product Data and Head-Office Data	15
5 Optimisation of Profit	16
5.1 Time To Serve	16
5.2 Time To Serve 2	17
6 ANOVA.....	19

7	Reliability of service.....	20
7.1	Reliable Service Days Left	20
7.1.1	Time To Serve	20
7.1.2	Time To Serve 2.....	20
7.2	Optimisation of Company to Improve Profit	21
8	References	22

List of figures

	Page
Figure 1: Order Quantity Amount	2
Figure 2: Product Selling Price	2
Figure 3: Head office Product Selling Price.....	2
Figure 4: Amount in an Hour of Day.....	3
Figure 5: Month of Order	3
Figure 6: Quantity vs. Picking Hours.....	3
Figure 7: ProductID Occurrence Amount	4
Figure 8: Customer Age Count	4
Figure 9:Income vs City.....	5
Figure 10:City of Customers.....	5
Figure 11: Income of Customers	6
Figure 12: Ages of Customers	6
Figure 13: Keyboard X and S Bar	7
Figure 14: Software X and S Bar	7
Figure 15: Cloud X and S Bar	8
Figure 16: Monitor X and S Bar	8
Figure 17: Laptop X and S Bar	8
Figure 18: Mouse X and S Bar	8
Figure 19: Keyboard Time X and S Bar	9
Figure 20: Mouse Time X and S Bar.....	9
Figure 21: Laptop Time X and S Bar	9
Figure 22: Monitor Time X and S Bar	9
Figure 23: Software Time X and S Bar	10
Figure 24: Cloud Time X and S Bar	10
Figure 25: Keyboard Out of Spec	10
Figure 26: Mouse Out of Spec.....	11
Figure 27: Laptop Out of Spec	11
Figure 28: Software Out of Spec	12

Figure 29: Cloud Out of Spec	12
Figure 30: Monitor Out of Spec	13
Figure 31: Selling Price Products Data.....	15
Figure 32: Baristas that Helped number of customers	16
Figure 33: Baristas Serving Times.....	16
Figure 34: Profit made by Baristas	16
Figure 35: Baristas that Helped number of Customers.....	17
Figure 36: Baristas Serving Times.....	17
Figure 37: Profit Made by Baristas	17
Figure 38: Reliable Service Level 1	20
Figure 39: Reliable Service Level 2	20
Figure 40: Cost of Employees.....	21

List of tables

	Page
Table 1: Keyboard.....	13
Table 2: Mouse.....	13
Table 3: Laptop.....	13
Table 4:Software	13
Table 5: Cloud	13
Table 6: Monitor.....	13
Table 7: Anova.....	19

1 Introduction

The following report is constructed to give recommendations to management and feedback based on different scenarios and problems in a business. Firstly, we will look at the data and wrangle it to determine what data is useable and what is unnecessary. Thereafter we will take the usable data and perform descriptive statistics to visualise the data and perform data analysis on the visualization.

2 Descriptive Statistics

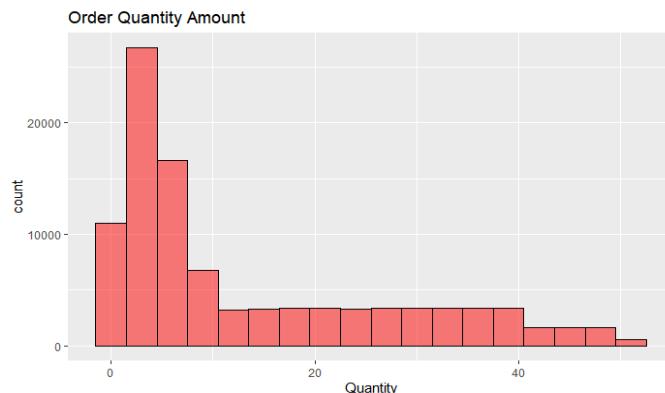


Figure 1: Order Quantity Amount

From the graph above we can see that most people buy smaller amounts of products. Meaning there is little to no commercial buyers.



Figure 2: Product Selling Price

From this graph we can assume that most revenue comes from products that is less than 5000.

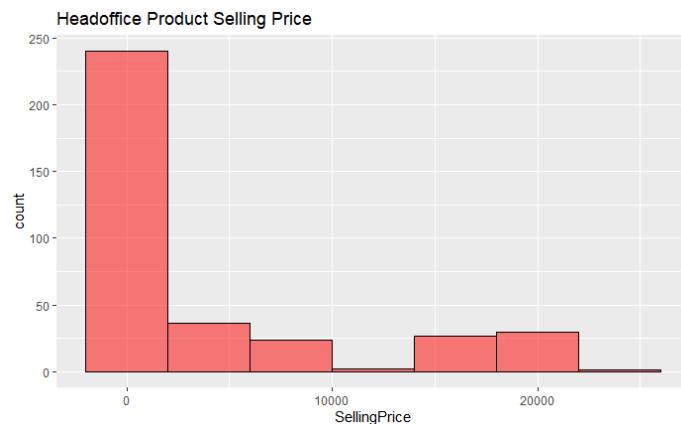


Figure 3: Head office Product Selling Price

The graph previously mentioned reflects the distribution of the products that is being sold from the Head office which indicates that the sales are good.

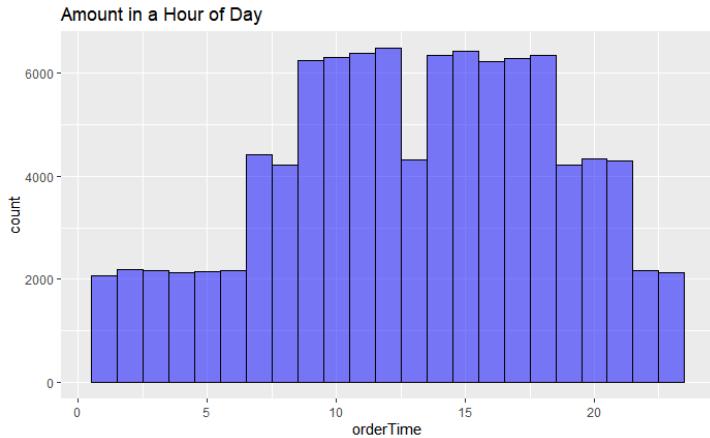


Figure 4: Amount in an Hour of Day

From this visualization we can clearly see that most of the purchases happens within the early morning hours and in the evening around 15h00 until closing time which looks to be around 17h00 to 18h00.



Figure 5: Month of Order

From the graph above we can conclude that the products sell good through the year with drops in numbers sold in January and in December due to holidays.

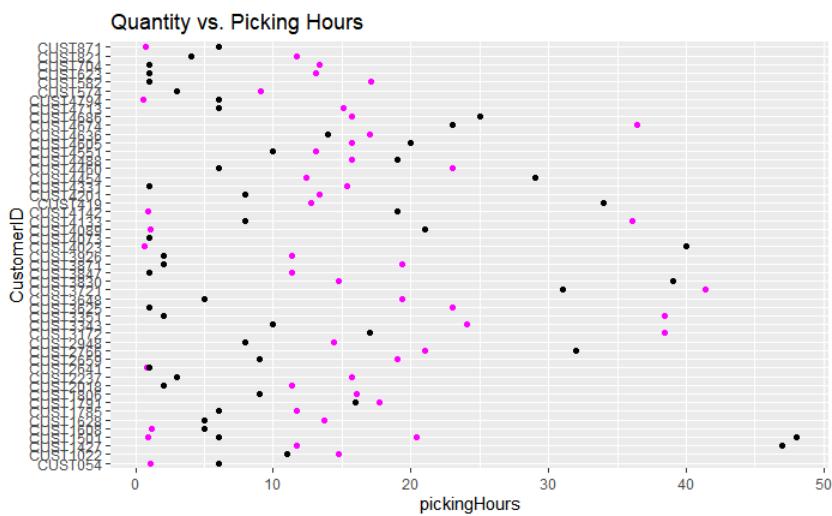


Figure 6: Quantity vs. Picking Hours

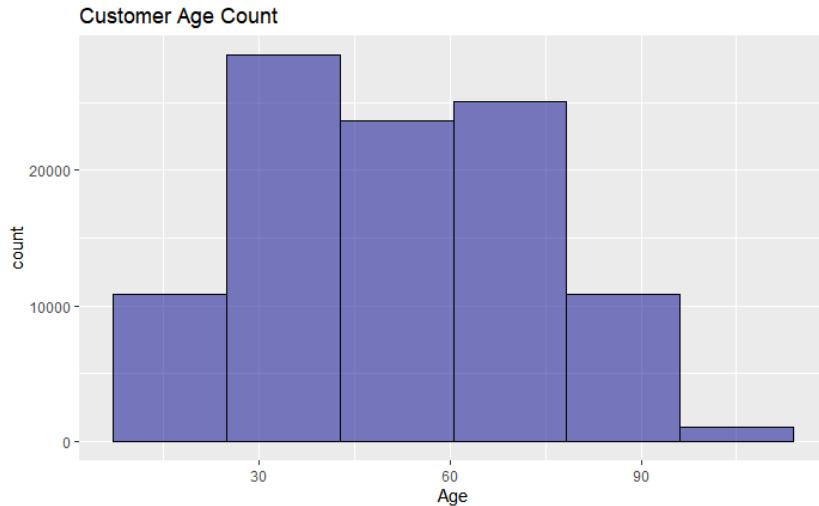


Figure 8: Customer Age Count

From the above graph we can see that most of the electronic devices is being sold to younger people of the age around 30. This is due to the fact that they have their own salary and can buy it themselves. The products that are being bought by older or elderly people are more than likely parents who buy the products for kids to be able to work or as gifts.

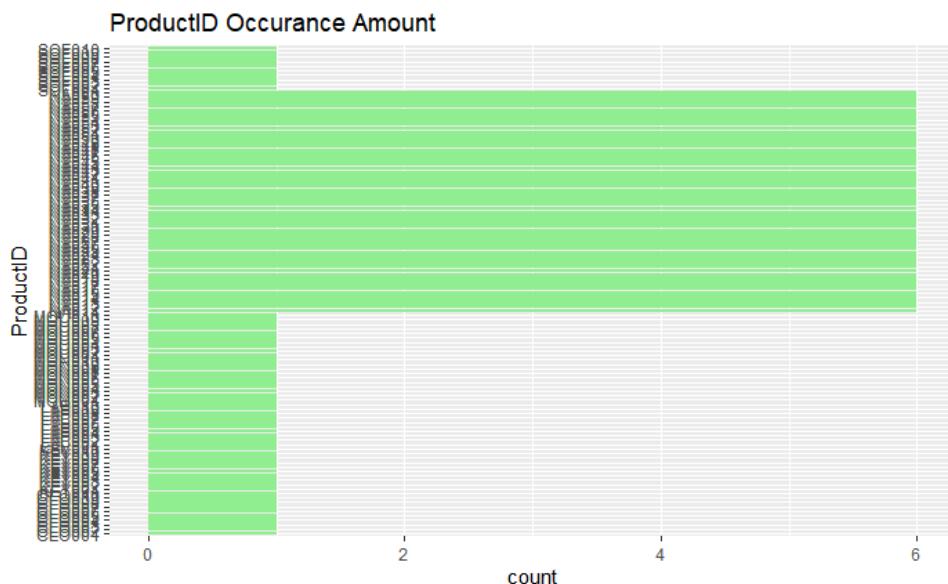


Figure 7: ProductID Occurrence Amount

From this graph we can see that there are a clear productID that occurs the most and that is NA which is wrong.

(Note)The graphs below are generated in Radiant and therefore there is no code for these graphs.

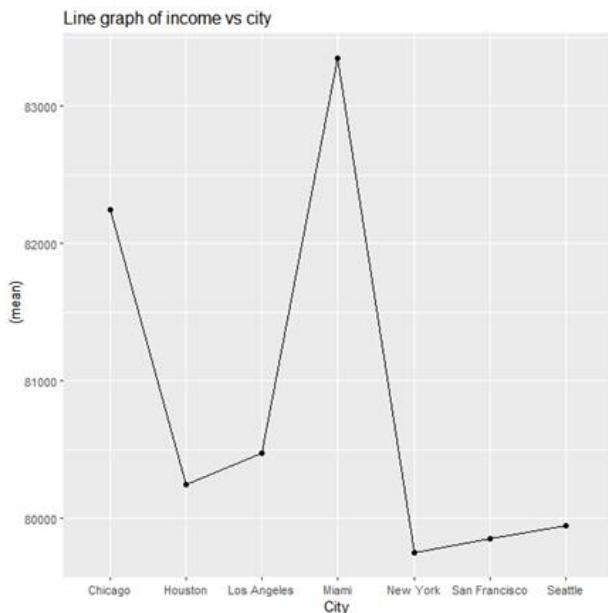


Figure 9:Income vs City

As we can see from the graph above, we can conclude that the most income is earned from the city of Miami and not San Francisco which is one of the cities with the least amount of income and which has the most sales. From this we can conclude that the income does not influence the number of sales in a specific city.



Figure 10:City of Customers

We can also see that the most people buy from our products from the regions of San Francisco. But we can also conclude that the products sell good all over the cities that is targeted with Miami being the least.

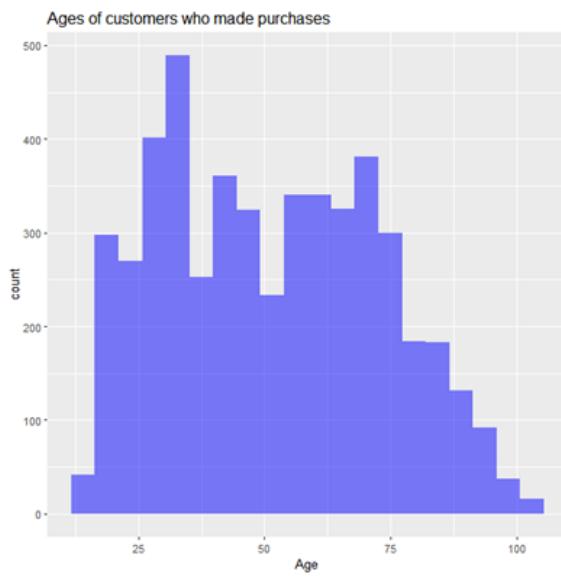


Figure 12: Ages of Customers

From the graph above we can conclude that more younger customers buy our businesses products with the highest number of products sold to people at around 30. And the elderly people buying the electronic products is more likely since they are buying presents for their children or it could be parents that need it for work. Or for their children to be able to work and study.

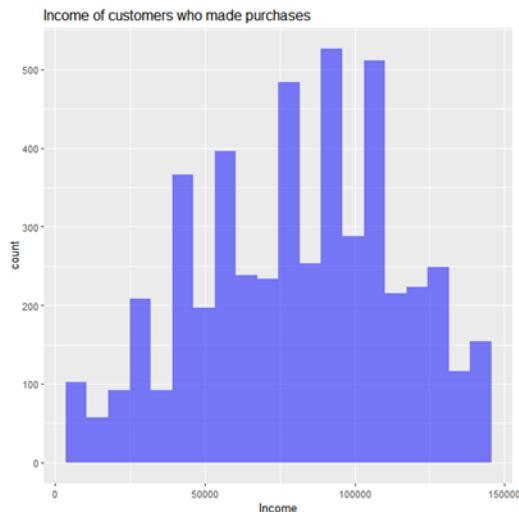


Figure 11: Income of Customers

As we can assume from the graph above, we can see that the most of our products gets bought by people with an income around 100000 with the biggest number of products bought by people earning just under 100000 a month.

3 Statistical Process Control

3.1 Control Charts

Based on the first 30 samples recorded, control chart limits were constructed using the methodology:

For \bar{x} -bar chart $\rightarrow UCL = \bar{x}_{\text{bar_bar}} + A3(\bar{s}_{\text{bar}})$

$$LCL = \bar{x}_{\text{bar_bar}} - A3(\bar{s}_{\text{bar}})$$

For s -bar chart $\rightarrow UCL = B4(\bar{s}_{\text{bar}})$

$$LCL = B3(\bar{s}_{\text{bar}})$$

3.1.1 Keyboard

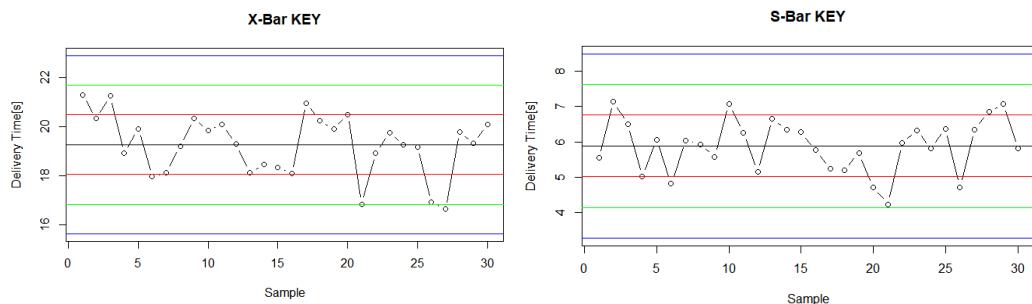


Figure 13: Keyboard X and S Bar

3.1.2 Software

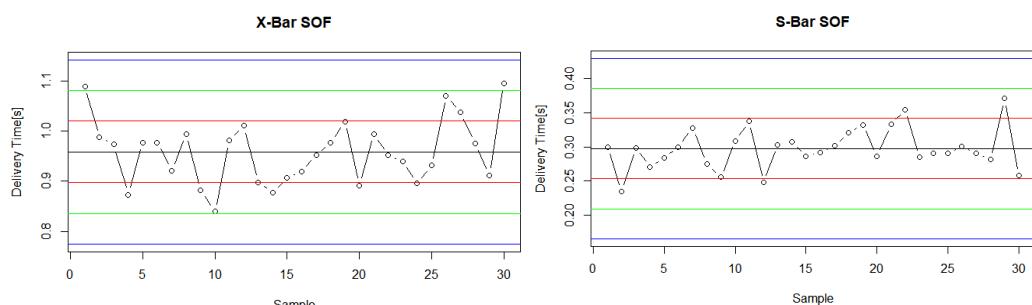


Figure 14: Software X and S Bar

3.1.3 Cloud

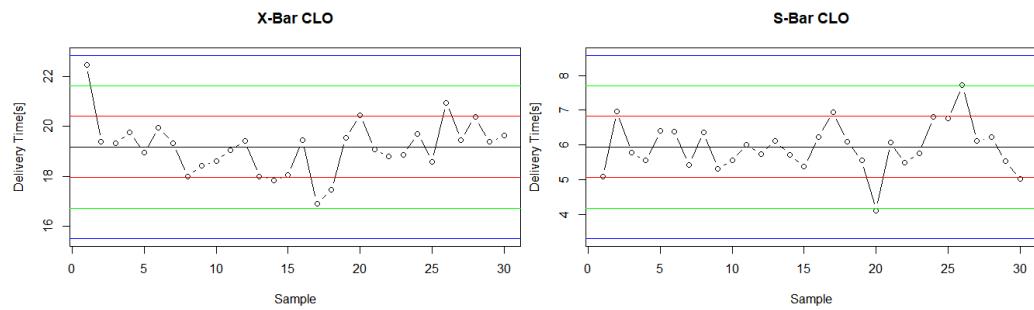


Figure 15: Cloud X and S Bar

3.1.4 Monitor

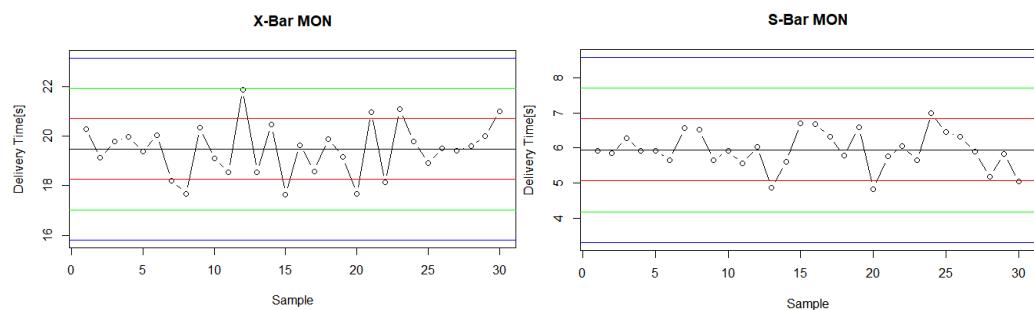


Figure 16: Monitor X and S Bar

3.1.5 Laptop

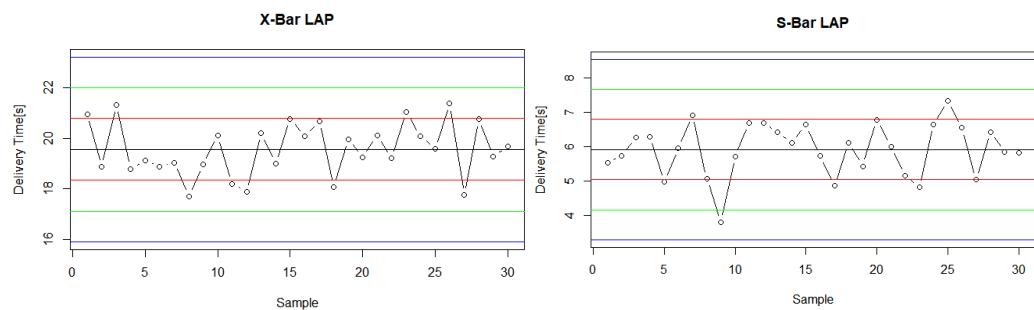


Figure 17: Laptop X and S Bar

3.1.6 Mouse

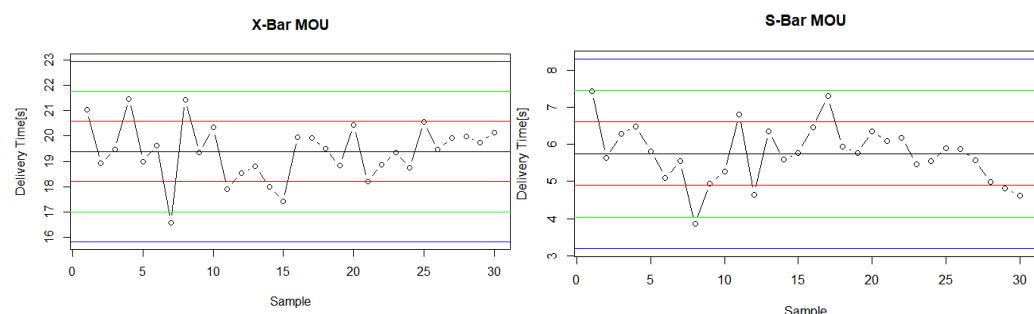


Figure 18: Mouse X and S Bar

3.2 Delivery Process Times

3.2.1 Keyboard

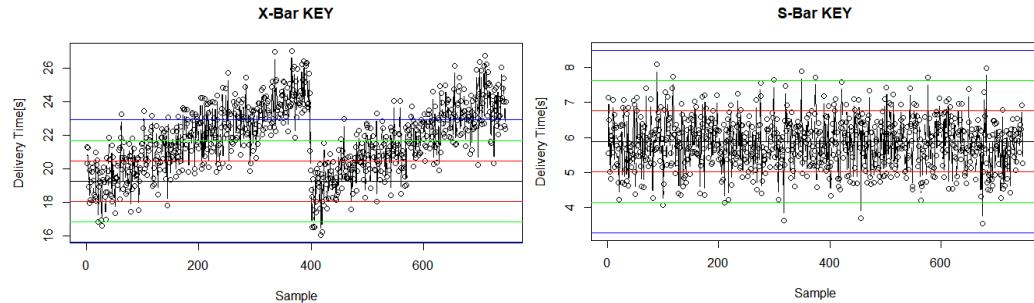


Figure 19: Keyboard Time X and S Bar

3.2.2 Mouse

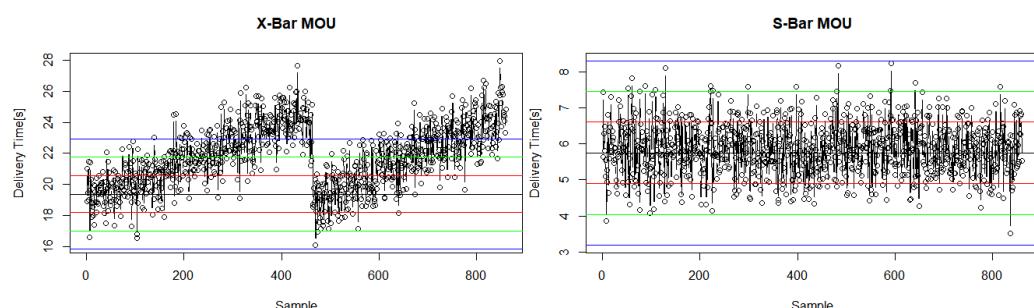


Figure 20: Mouse Time X and S Bar

3.2.3 Laptop

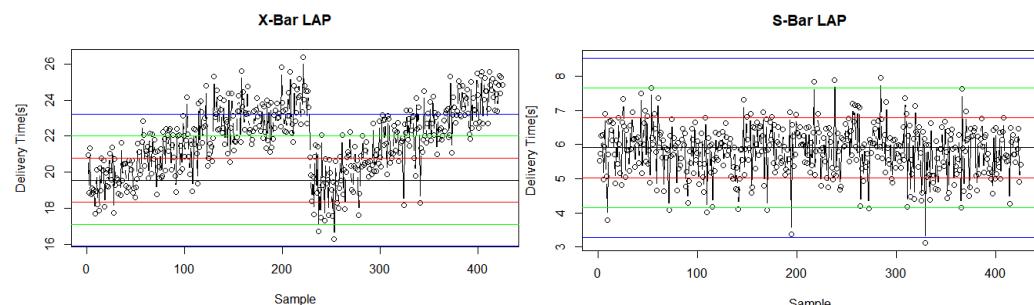


Figure 21: Laptop Time X and S Bar

3.2.4 Monitor

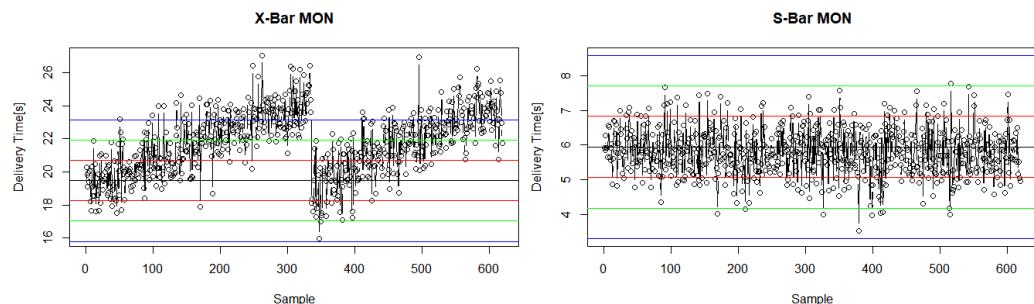


Figure 22: Monitor Time X and S Bar

3.2.5 Software

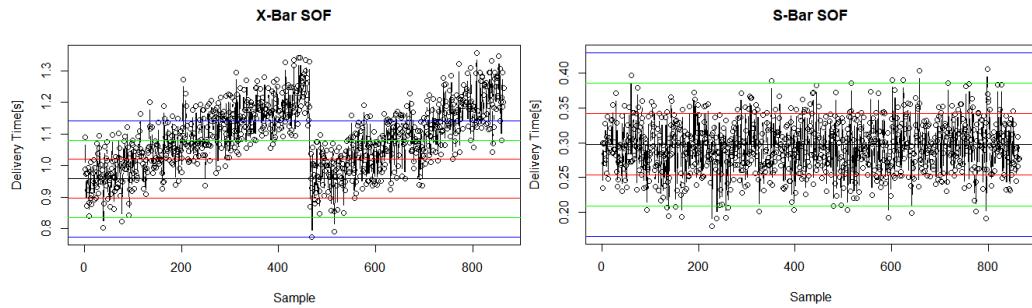


Figure 23: Software Time X and S Bar

3.2.6 Cloud

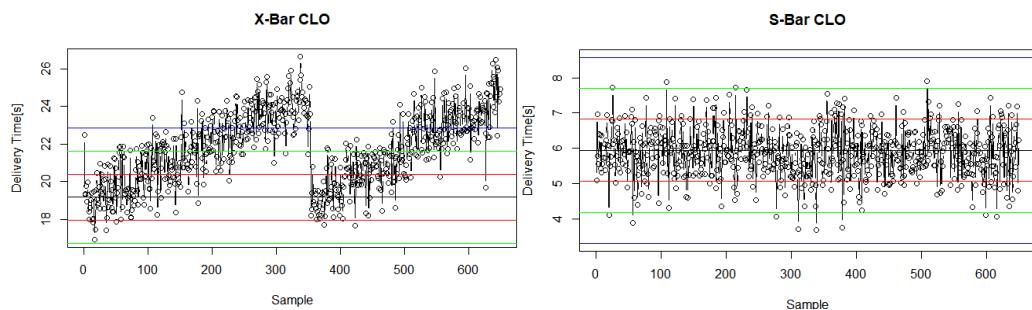


Figure 24: Cloud Time X and S Bar

It would be best if all the product managers adjust or check their process control at every 400 samples that gets sold. Except for the laptops process control which it is recommended to check it every 200 samples that gets sold.

3.2.7 Sample out of Specification

3.2.7.1 Keyboard

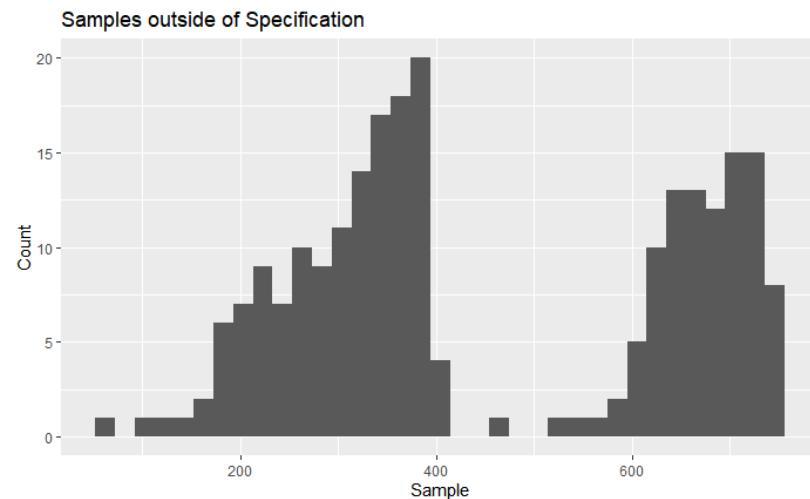


Figure 25: Keyboard Out of Spec

3.2.7.2 Mouse

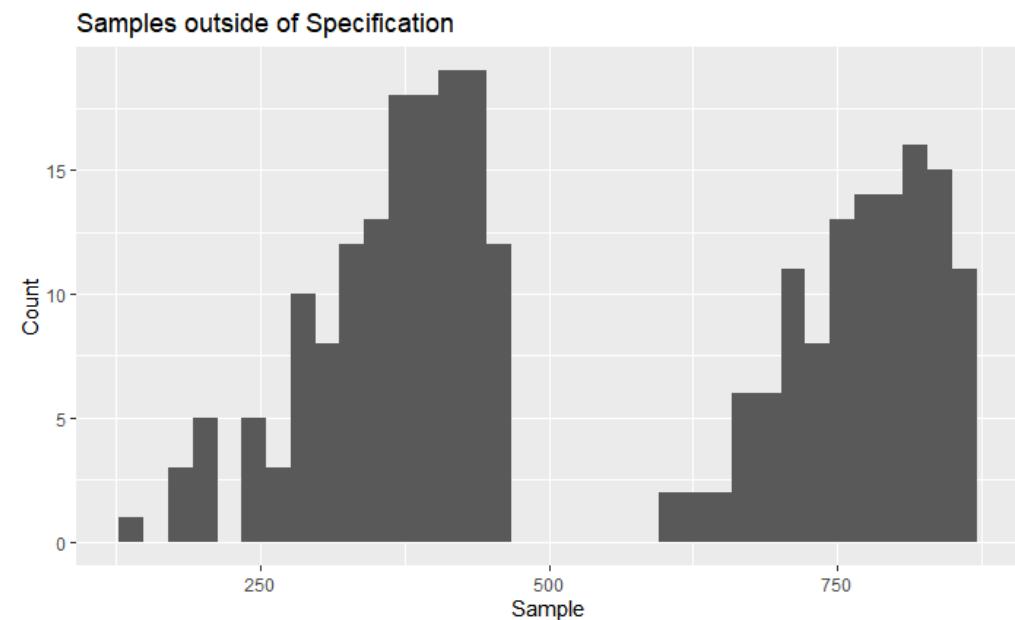


Figure 26: Mouse Out of Spec

3.2.7.3 Laptop

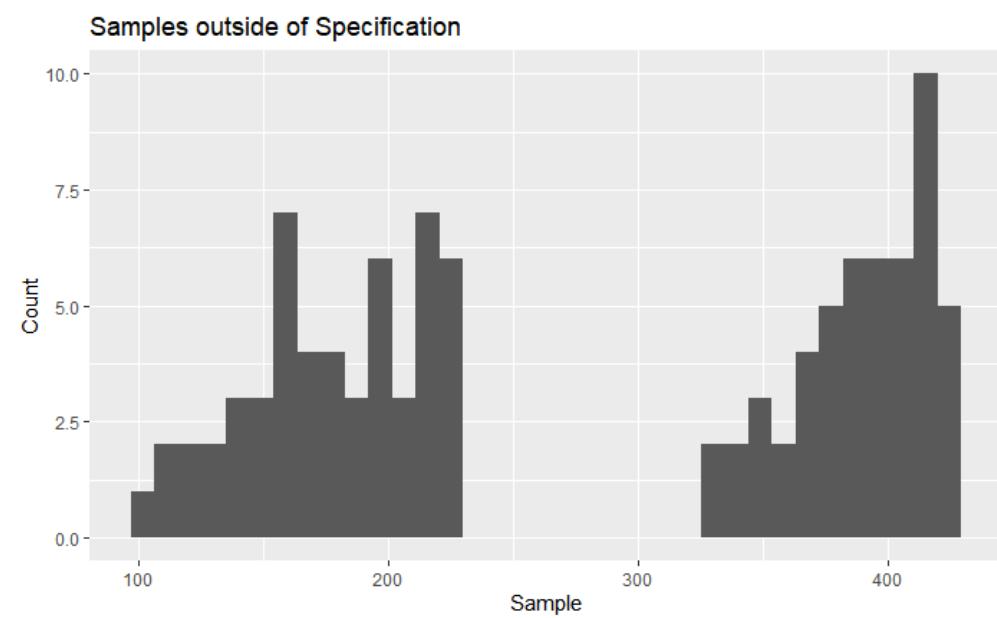


Figure 27: Laptop Out of Spec

3.2.7.4 Software

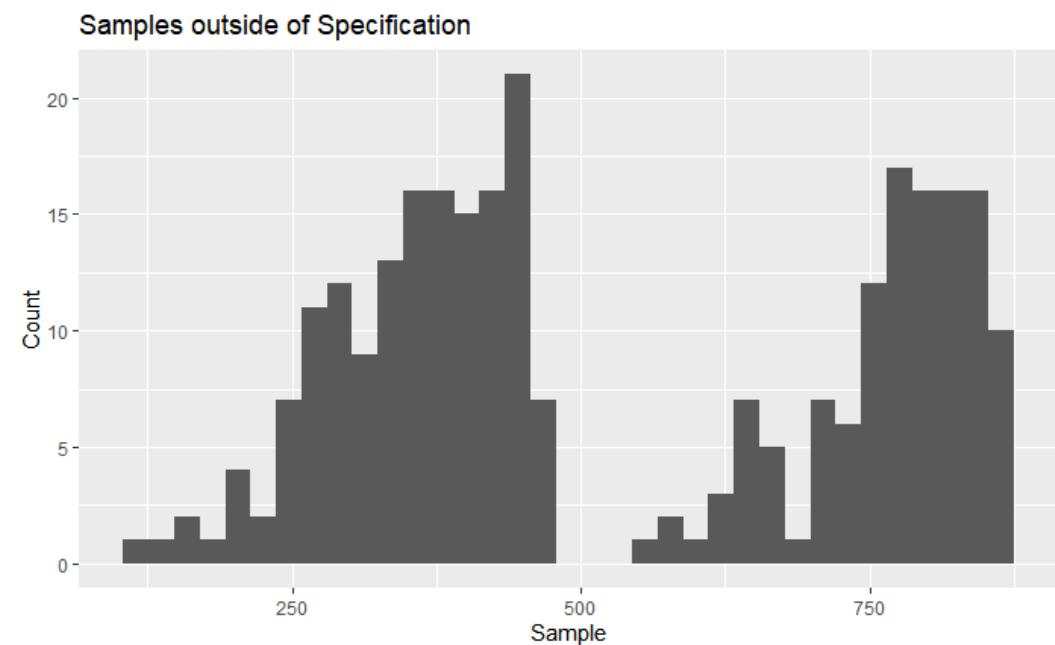


Figure 28: Software Out of Spec

3.2.7.5 Cloud

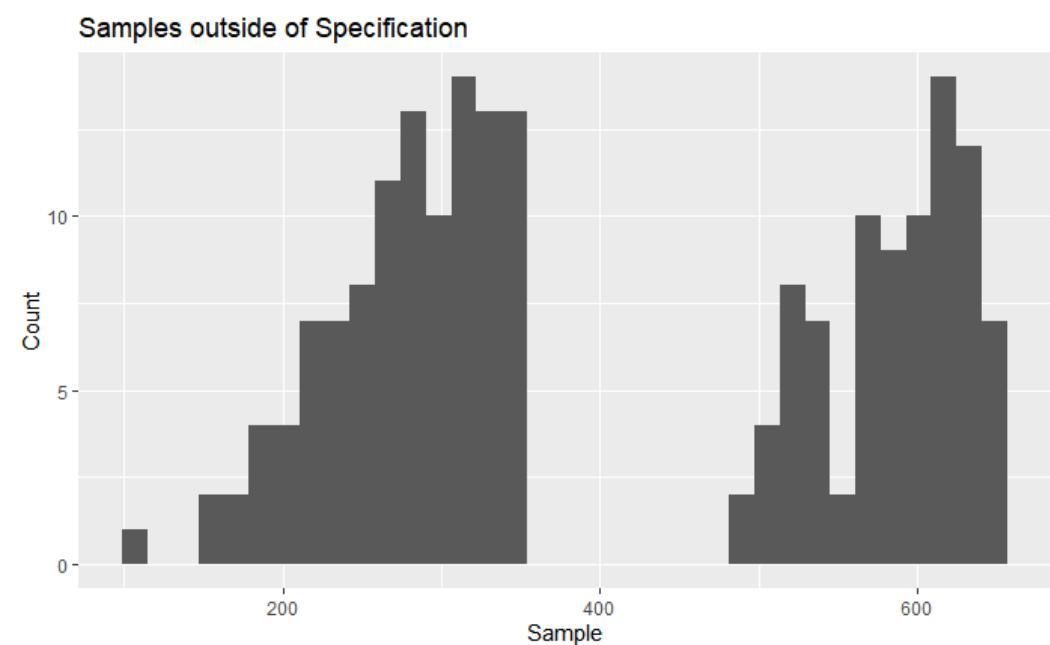


Figure 29: Cloud Out of Spec

3.2.7.6 Monitor

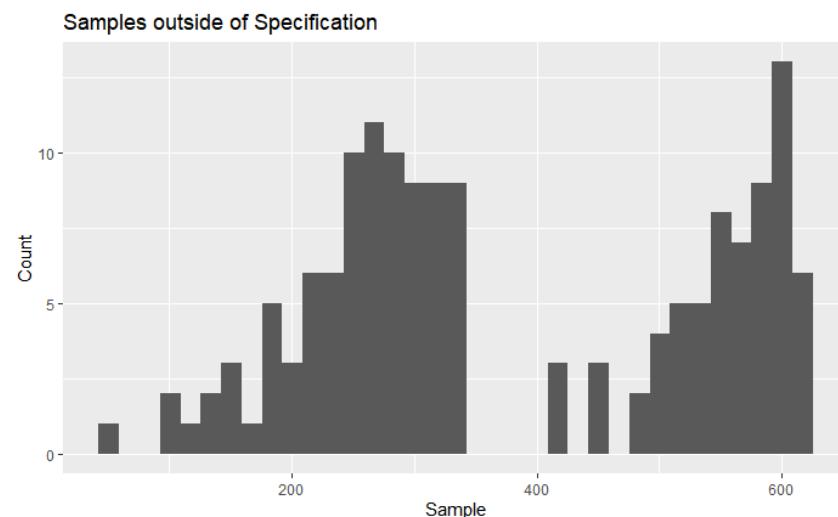


Figure 30: Monitor Out of Spec

3.3 Process Capability Indices

Table 1: Keyboard

Cp	Cpl	Cpu	Cpk
0.9171375	1.104921	0.7293536	0.7293536

Table 2: Mouse

Cp	Cpl	Cpu	Cpk
0.9151848	1.103799	0.726571	0.726571

Table 3: Laptop

Cp	Cpl	Cpu	Cpk
0.8987816	1.101345	0.6962187	0.6962187

Table 4: Software

Cp	Cpl	Cpu	Cpk
18.16573	1.084182	35.24728	1.084182

Table 5: Cloud

Cp	Cpl	Cpu	Cpk
0.8977458	1.078754	0.7167378	0.7167378

Table 6: Monitor

Cp	Cpl	Cpu	Cpk
0.889049	1.078528	0.6995705	0.6995705

From the tables above we can see that the all will meet the voice of the customer except for software which is very high and has a very wide spread.

3.4 Sample Observations

3.4.1 Samples Outside of the Upper Control Limit

From the data we can see that there are no instances where the standard deviation of a sample goes above the specified limit (UCL). The samples recorded is consistent with the first 30 samples. This indicates that the data has little variance meaning that the delivery times are consistent and short. This does not mean that the data does not have trends over time. This measurement does not conclude whether or not the data have trends over time.

4 Probability Calculations

4.1 Type I Errors

Type 1 error: **A** Probability: 0.0013498980316301

B Probability: 0.682689492137086

C Probability: 2.678771559804e-07

4.2 Type II Errors

Type 2 error probability: 0.841178284182247

4.3 Differences Product Data and Head-Office Data

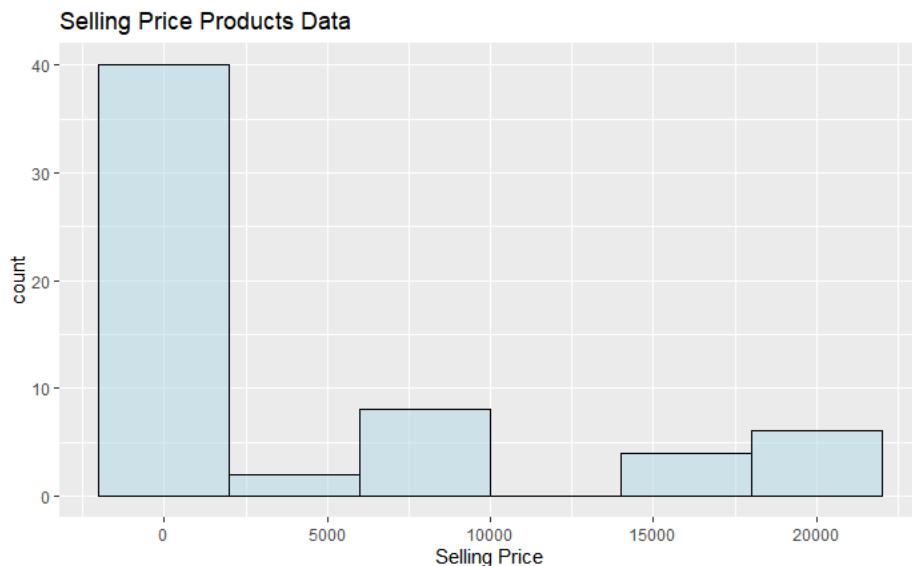


Figure 31: Selling Price Products Data

The sum of 2023 sales: **KEY** = 5378598.87

MOU = 3773413.87

LAP = 86027413.33

MON = 43126707.90

CLO = 7261887.10

SOF = 4867780.65

5 Optimisation of Profit

5.1 Time To Serve

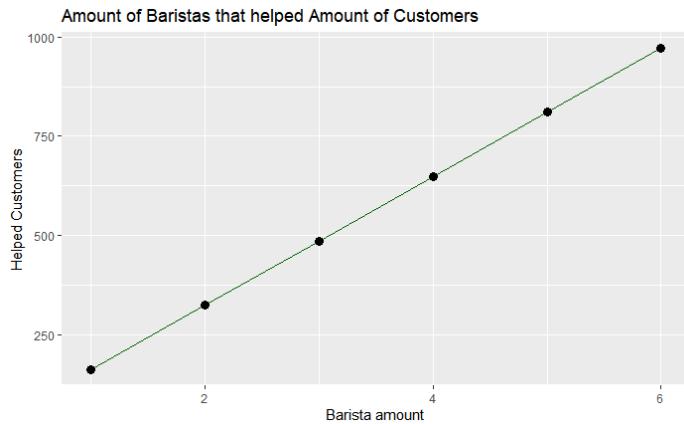


Figure 32: Baristas that Helped number of customers

Sum of profits:

3856.215[1], 7703.409[2], 11592.02[3], 15447.63[4], 19323.21[5], 23140.49[6]

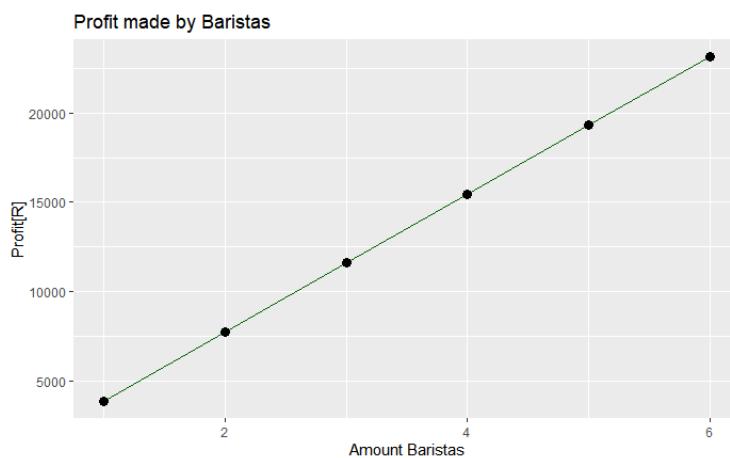


Figure 34: Profit made by Baristas

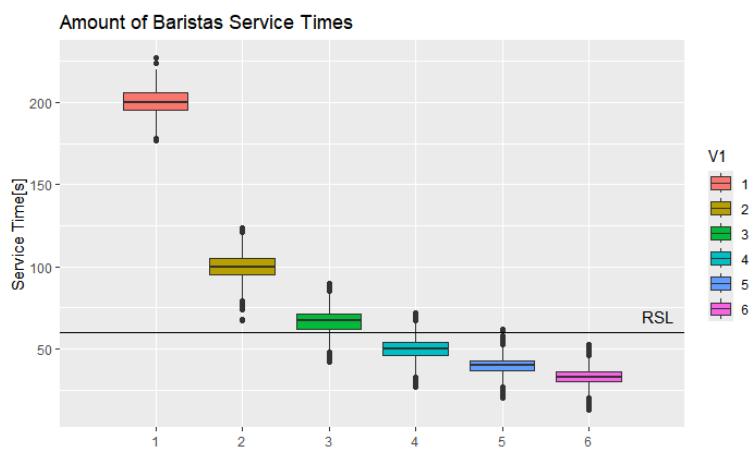


Figure 33: Baristas Serving Times

5.2 Time To Serve 2

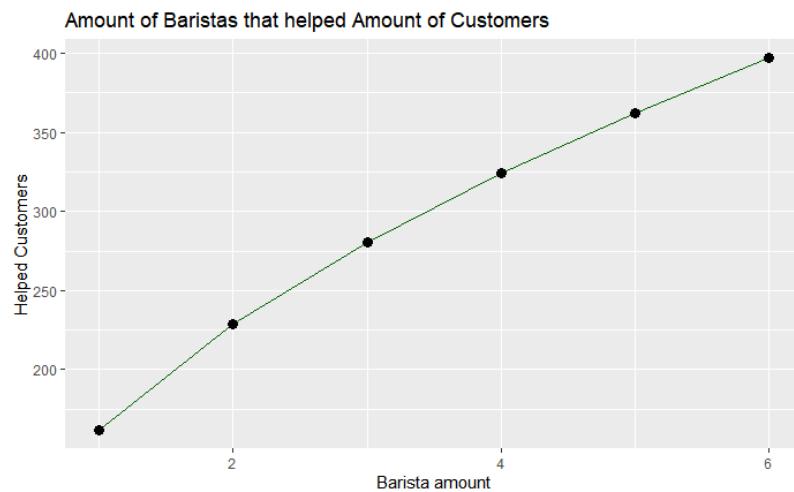


Figure 35: Baristas that Helped number of Customers

Sum of Profits:

3855.898[1], 4868.548[2], 5419.892[3], 5718.516[4], 5868.111[5], 5905.532[6]

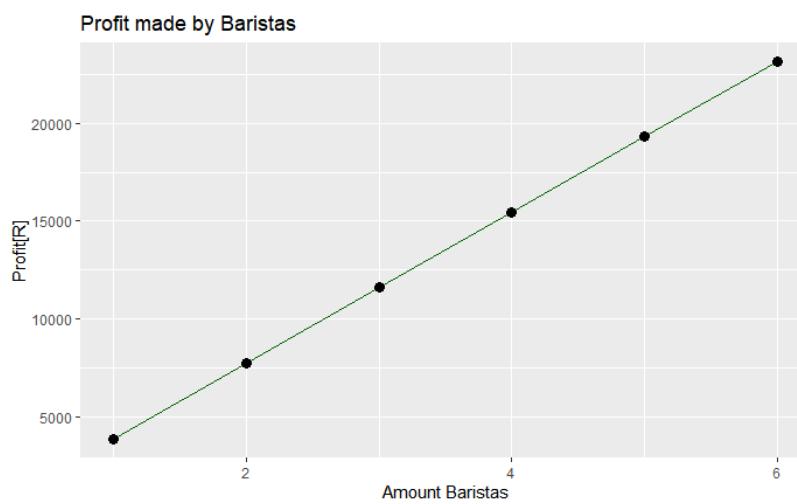


Figure 37: Profit Made by Baristas

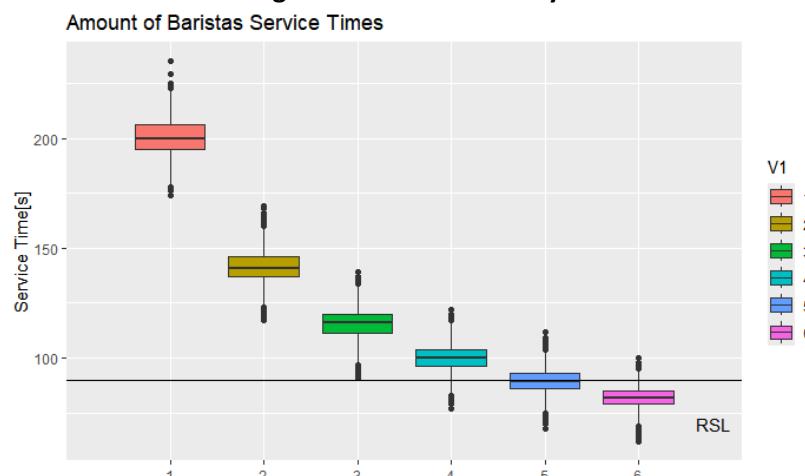


Figure 36: Baristas Serving Times

From the comparison between Time to Serving and Time to Serving2 we can clearly see an improvement with the profit made by the number clients served by the Baristas, this we see in the increase in servings. The profit made by Baristas did not particularly went up, but rather the amount of servings.

6 ANOVA

Table 7: Anova

		Df	Sum Sq	Mean Sq	F - Value	Pr(>F)
Keyboard	Order Year	1	302	302.42	8.088	0.00446
	Residuals	17918	669951	37.39		
Mouse	Order Year	1	20	20.13	0.53	0.467
	Residuals	20660	784450	37.97		
Laptop	Order Year	1	19	18.92	0.513	0.474
	Residuals	10205	376427	36.89		
Monitor	Order Year	1	17	17.38	0.472	0.492
	Residuals	14862	547395	36.83		
Software	Order Year	1	0	0.01695	0.179	0.672
	Residuals	20747	1966	0.09475		
Cloud	Order Year	1	2	1.85	0.049	0.825
	Residuals	15596	588231	37.72		

7 Reliability of service

7.1 Reliable Service Days Left

7.1.1 Time To Serve

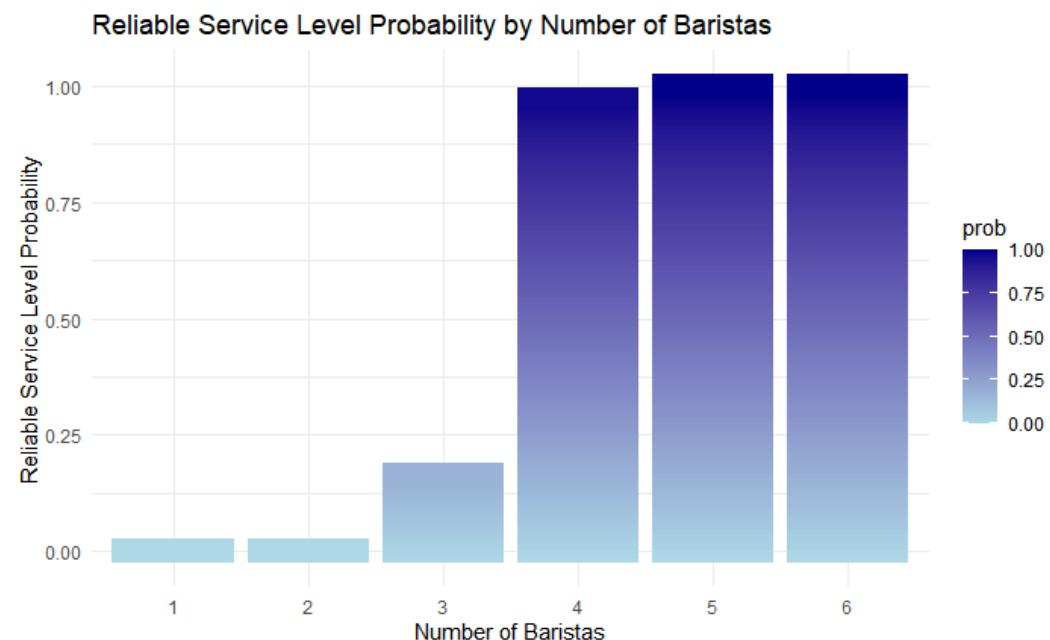


Figure 38: Reliable Service Level 1

7.1.2 Time To Serve 2

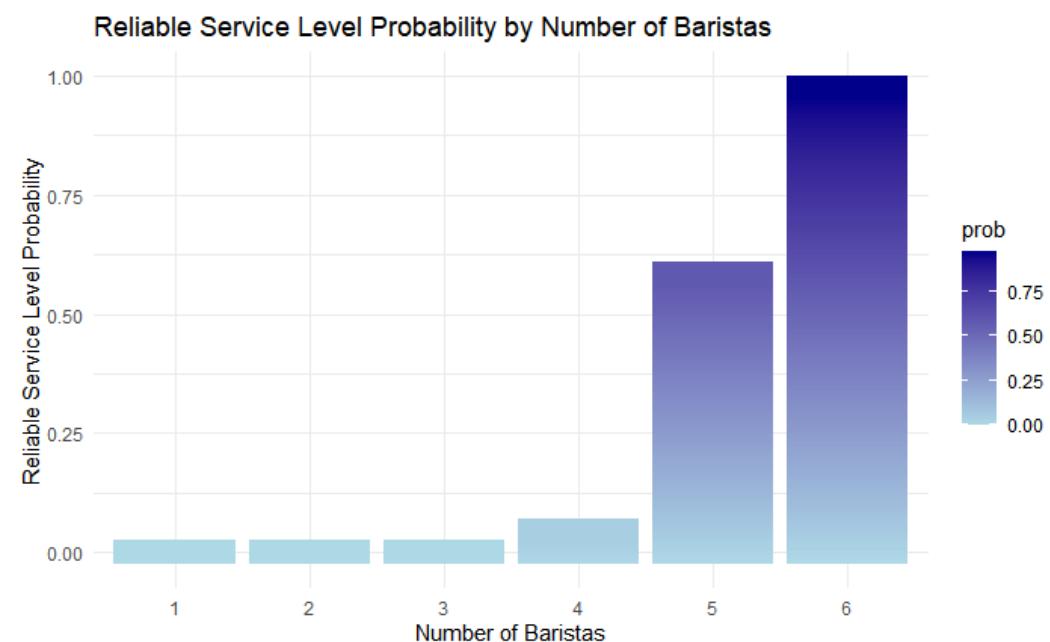


Figure 39: Reliable Service Level 2

In graph 1 (TimeToServe) we see that it shows us that there is more efficient staffing scenario. The graph indicates that reliability is reached to a 100% within 4 baristas. Whereas in graph 2 (TimeToServe2) it indicates that a less efficient or more demanding service strategy is followed. Which requires at least 6 baristas to meet the same reliability level as the first graph. This all is due to the increase in the servings and customer demand.

7.2 Optimisation of Company to Improve Profit

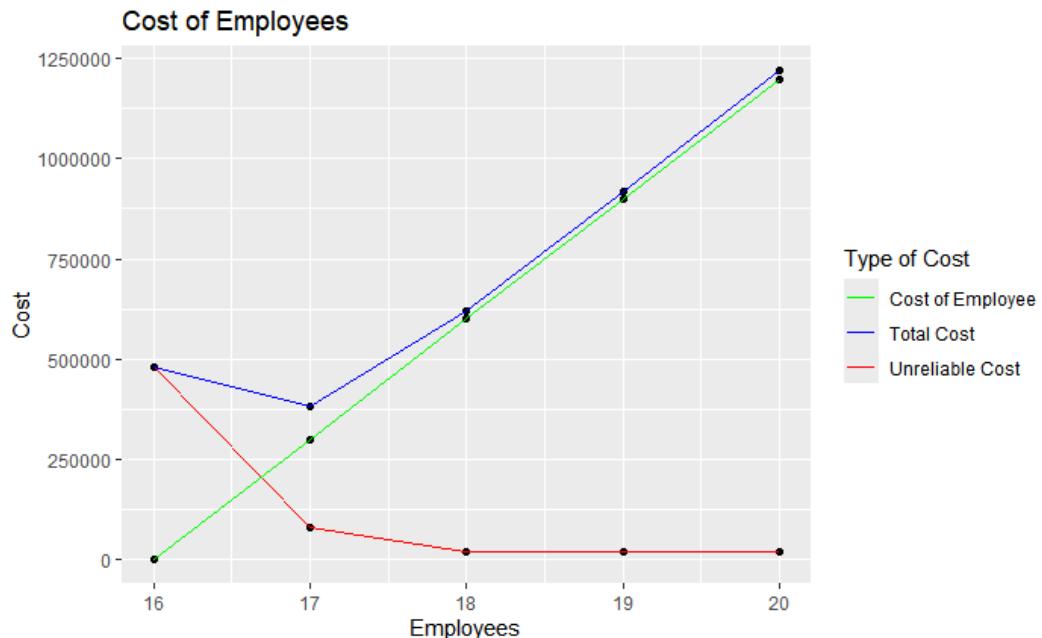


Figure 40: Cost of Employees

In the visualisation above we can conclude that the graph shows us the trade-off between Employee Cost and Reliability. In other words, increasing the employees will reduce the total cost by improving the reliability of the services. But after 18 employees there is no point in increasing the number of employees or hiring additional employees since it will have no effect on improving the reliability. From this we can finally conclude that the most cost-effective employee numbers will lie between 17 to 18 employees, whilst still maintaining a high reliability of serves.

8 References

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