

# **Flow Pattern of Drinks at Einstein Bros bagel ®.**



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**INDE-330: Introduction to Statistics & Probability**

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## **INTRODUCTION :**

Nowadays managing inventory has become quite cumbersome for businesses since demand for an item at a given time of the day has become quite unpredictable given the different needs of the customer.

Be it a business entity just starting out into the market or a very well established one. The quantities and qualities of the inventories have been the major cause of the inconsistency in their businesses.

To find out a mitigation for this issue we had collected a couple of weeks long of data in real time from the counters of one of the popular American food chains - The Einstein bros bagels ® at CSUEB to understand the trend of the orders at a certain time of the day and day of the week. We found that this restaurant at CSUEB was facing an inventory - management issue.

To depict and highlight the trends we analyzed the acquired data and found the probabilities of the type of drinks that are in demand Which had helped gauge the manpower needed at hand and the quantum of inventory required to sustain and serve the demand at a specific point/period of the day and day of the week.

## **SAMPLING METHOD :**

The data we obtained represents the winter season beverages sales pattern where sales of different drinks are analyzed with respect to their temperature. The obtained sample data is also used for estimation of ice consumption in the store everyday based on sales of cold beverages and to determine the highest sold drink for this season.

Sampling is done for on three bases:

- We are categorizing the data based on sales of hot and cold beverages throughout the day.
- Then, the data is subcategorized based on only sales of cold drinks for determining ice consumption.
- Tools used for analysis and data sampling: Minitab, Excel

## **STATISTICAL METHOD:**

With the obtained dataset, we constructed a data distribution graph and observed that all our data points lie closer to the mean . This tells us that the distribution is a normal distribution.

### **Normal distribution:**

Normal distribution is a type of continuous probability distribution . In this distribution most of the data points lie closer to the mean and small number of data points lie at both extreme ends of the curve.

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}(\frac{x-\mu}{\sigma})^2}$$

x = value of the variable or data being examined and f(x) the probability function

$\mu$  = the mean

$\sigma$  = the standard deviation

### Parameters of normal distribution:

1. **Mean:** The Mean is a measure of central tendency. In Normal distribution, mean defines the peak on the normal curve and other data points clustered around the mean.
2. **Standard Deviation:** This measures the dispersion of the points relative to the mean. In a normal distribution graph, standard deviation determines the width of the curve. A small standard deviation will result in a steep curve and a large standard deviation will give a flat curve.

### METHODOLOGY & CONCEPTS USED:

#### Measure of central tendency:

**Central Tendency:** It is defined as the “statistical measure that identifies the single value to represent the entire distribution”. This single value provides an accurate description of the entire data.

Three measures of central tendency: **Mean, Median and Mode.**

- **Mean:** The sum of the observed values divided by the total number of values in the dataset.

$$\text{Mean} = \frac{\text{Sum of the all observations}}{\text{Total number of observations}}$$

- **Median:** The Middle value in the ordered dataset.

$$\begin{aligned} \text{If } n = \text{Even, } \text{Median} &= ((n/2)^{\text{th}} \text{ term} + ((n/2) + 1)^{\text{th}} \text{ term})/2 \\ \text{If } n = \text{odd, } \text{Median} &= ((n + 1)/2)^{\text{th}} \text{ term} \end{aligned}$$

- **Mode:** Frequent value in the dataset. It is possible to have more than one mode in a distribution.

#### Conditional probability distribution:

conditional probability is a measure of the probability of an event occurring, given that another event has already occurred.

$$P(A|B) = \frac{P(B|A) P(A)}{P(B)}$$

To calculate the probability that the customer prefers a specific drink we have utilized conditional probability for each drink. For example: If a person is ordering a hot crew or cold crew.

## Cold Brew - total:-

## **Recorded data:**

Cold Brew	Total		Time				Avg				Total drinks				Total Orders					
	Date	Day	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	Avg	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	Week Day Avg
3-Nov	Th	31	24	6	61						62	50	10	122		115	80	27	222	
4-Nov	Fri	16	16	4	36						29	19	14	62		43	46	29	118	
7-Nov	Mon	21	16	1	38						32	44	5	81		109	128	31	268	
8-Nov	Tue	33	15	12	60						64	27	16	107		124	91	43	258	
9-Nov	Wed	27	19	6	52						46	36	10	92		108	107	32	247	
10-Nov	Thu	17	22	4	43						40	38	12	90		114	104	39	257	
14-Nov	Mon	13	17	9	39	17	17	5	39	37	30	15	82	82	102	131	52	285	277	
15-Nov	Tue	25	20	3	48	41	26	10	78	50	37	7	94	101	102	106	34	242	250	
16-Nov	Wed	33	16	13	62	34	20	12	64	51	34	17	102	97	131	99	31	261	254	
17-Nov	Thu	28	27	4	59	25	24	5	54	54	38	10	102	105	132	112	44	288	256	
18-Nov	Fri	14	5	0	19	15	11	2	28	21	10	0	31	47	49	46	0	95	107	

Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter.

## Cold Brew - classic:-

### Recorded data

Cold Brew Classic		Time				Avg				Total drinks				Total Orders					
Date	Day	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Avg	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Avg
3-Nov	Th	4	0	4	8					62	50	10	122		115	80	27	222	
4-Nov	Fri	3	4	0	7					29	19	14	62		43	46	29	118	
7-Nov	Mon	4	4	0	8					32	44	5	81		109	128	31	268	
8-Nov	Tue	3	2	0	5					64	27	16	107		124	91	43	258	
9-Nov	Wed	3	5	2	10					46	36	10	92		108	107	32	247	
10-Nov	Thu	1	10	1	12					40	38	12	90		114	104	39	257	
14-Nov	Mon	1	4	1	6	3	4	1	7	37	30	15	82	82	102	131	52	285	277
15-Nov	Tue	2	2	1	5	4	4	1	9	50	37	7	94	101	102	106	34	242	250
16-Nov	Wed	5	2	1	8	5	5	2	10	51	34	17	102	97	131	99	31	261	254
17-Nov	Thu	4	2	2	8	3	4	2	9	54	38	10	102	105	132	112	44	288	256
18-Nov	Fri	3	0	0	3	3	2	0	5	21	10	0	31	47	49	46	0	95	107

**Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter.**

Cold Brew Classic		Time				P(Coffee)				P(Coffee   Drinks)					
Date	Day	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Week Day	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Week Day
3-Nov	Th	4	0	4	8	3.48%	0.00%	14.81%	3.60%		6.45%	0.00%	40.00%	6.56%	
4-Nov	Fri	3	4	0	7	6.98%	8.70%	0.00%	5.93%		10.34%	21.05%	0.00%	11.29%	
7-Nov	Mon	4	4	0	8	3.67%	3.13%	0.00%	2.99%		12.50%	9.09%	0.00%	9.88%	
8-Nov	Tue	3	2	0	5	2.42%	2.20%	0.00%	1.94%		4.69%	7.41%	0.00%	4.67%	
9-Nov	Wed	3	5	2	10	2.78%	4.67%	6.25%	4.05%		6.52%	13.89%	20.00%	10.87%	
10-Nov	Thu	1	10	1	12	0.88%	9.62%	2.56%	4.67%		2.50%	26.32%	8.33%	13.33%	
14-Nov	Mon	1	4	1	6	0.98%	3.05%	1.92%	2.11%	2.53%	2.70%	13.33%	6.67%	7.32%	8.59%
15-Nov	Tue	2	2	1	5	1.96%	1.89%	2.94%	2.07%	3.45%	4.00%	5.41%	14.29%	5.32%	8.59%
16-Nov	Wed	5	2	1	8	3.82%	2.02%	3.23%	3.07%	4.03%	9.80%	5.88%	5.88%	7.84%	10.56%
17-Nov	Thu	4	2	2	8	3.03%	1.79%	4.55%	2.78%	3.65%	7.41%	5.26%	20.00%	7.84%	8.92%
18-Nov	Fri	3	0	0	3	6.12%	0.00%	0.00%	3.16%	4.69%	14.29%	0.00%	0.00%	9.68%	10.75%
Mean		3	3	1	7										
Sd		1	3	1	2										
Var		2	8	1	6										
Median		3	2	1	8										
Mode		3	2	0	8										

## Cold Brew - caramel:-

### Recorded data

Cold Brew Caramel		Time				Avg				Total drinks				Total Orders					
Date	Day	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Avg	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Avg
3-Nov	Th	10	13	0	23					62	50	10	122		115	80	27	222	
4-Nov	Fri	5	4	0	9					29	19	14	62		43	46	29	118	
7-Nov	Mon	11	0	1	12					32	44	5	81		109	128	31	268	
8-Nov	Tue	19	2	4	25					64	27	16	107		124	91	43	258	
9-Nov	Wed	5	3	1	9					46	36	10	92		108	107	32	247	
10-Nov	Thu	7	4	1	12					40	38	12	90		114	104	39	257	
14-Nov	Mon	6	6	4	16	9	3	3	14	37	30	15	82	82	102	131	52	285	277
15-Nov	Tue	10	5	1	16	19	6	3	29	50	37	7	94	101	102	106	34	242	250
16-Nov	Wed	13	4	6	23	11	6	5	20	51	34	17	102	97	131	99	31	261	254
17-Nov	Thu	12	16	1	29	10	11	1	21	54	38	10	102	105	132	112	44	288	256
18-Nov	Fri	5	2	0	7	5	3	0	8	21	10	0	31	47	49	46	0	95	107

**Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter.**

## Cold Brew- Vanilla:-

### Recorded data

Cold Brew >		Time				Avg			Total drinks				Total Orders						
Date	Day	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Avg	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Avg
3-Nov	Th	14	9	1	24				62	50	10	122	115	80	27	222			
4-Nov	Fri	6	7	0	13				29	19	14	62	43	46	29	118			
7-Nov	Mon	3	10	0	13				32	44	5	81	109	128	31	268			
8-Nov	Tue	5	8	3	16				64	27	16	107	124	91	43	258			
9-Nov	Wed	9	8	1	18				46	36	10	92	108	107	32	247			
10-Nov	Thu	6	7	2	15				40	38	12	90	114	104	39	257			
14-Nov	Mon	3	6	4	13	3	8	2	13	37	30	15	82	82	102	131	52	285	
15-Nov	Tue	8	10	1	19	10	13	3	26	50	37	7	94	101	102	106	34	242	
16-Nov	Wed	11	10	2	23	12	10	2	23	51	34	17	102	97	131	99	31	261	
17-Nov	Thu	9	6	1	16	10	7	1	18	54	38	10	102	105	132	112	44	288	
18-Nov	Fri	3	3	0	6	5	5	0	10	21	10	0	31	47	49	46	0	95	

**Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter.**

Cold Brew >		Time				P(Coffee)			P(Coffee   Drinks)								
Date	Day	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Week Day	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Week Day		
3-Nov	Th	14	9	1	24	12.17%	11.25%	3.70%	10.81%		22.58%	18.00%	10.00%	19.67%			
4-Nov	Fri	6	7	0	13	13.95%	15.22%	0.00%	11.02%		20.69%	36.84%	0.00%	20.97%			
7-Nov	Mon	3	10	0	13	2.75%	7.81%	0.00%	4.85%		9.38%	22.73%	0.00%	16.05%			
8-Nov	Tue	5	8	3	16	4.03%	8.79%	6.98%	6.20%		7.81%	29.63%	18.75%	14.95%			
9-Nov	Wed	9	8	1	18	8.33%	7.48%	3.13%	7.29%		19.57%	22.22%	10.00%	19.57%			
10-Nov	Thu	6	7	2	15	5.26%	6.73%	5.13%	5.84%		15.00%	18.42%	16.67%	16.67%			
14-Nov	Mon	3	6	4	13	2.94%	4.58%	7.69%	4.56%		4.70%	8.11%	20.00%	26.67%	15.85%	15.95%	
15-Nov	Tue	8	10	1	19	7.84%	9.43%	2.94%	7.85%		10.20%	16.00%	27.03%	14.29%	20.21%	25.37%	
16-Nov	Wed	11	10	2	23	8.40%	10.10%	6.45%	8.81%		9.06%	21.57%	29.41%	11.76%	22.55%	23.73%	
17-Nov	Thu	9	6	1	16	6.82%	5.36%	2.27%	5.56%		7.17%	16.67%	15.79%	10.00%	15.69%	17.52%	
18-Nov	Fri	3	3	0	6	6.12%	6.52%	0.00%	6.32%		8.92%	14.29%	30.00%	0.00%	19.35%	20.43%	
		Mean	7	8	1	16											
		Sd	4	2	1	5											
		Var	13	5	2	25											
		Median	6	8	1	16											
		Mode	3	10	1	13											

## Cold Brew - chocolate:-

### Recorded data

Cold Brew Chocolate		Time				Avg			Total drinks				Total Orders						
Date	Day	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Avg	7 AM - 11 A	11 AM - 2 P	2 PM - 5 PM	Total	Avg
3-Nov	Th	3	2	1	6				62	50	10	122	115	80	27	222			
4-Nov	Fri	2	1	4	7				29	19	14	62	43	46	29	118			
7-Nov	Mon	3	2	0	5				32	44	5	81	109	128	31	268			
8-Nov	Tue	6	3	5	14				64	27	16	107	124	91	43	258			
9-Nov	Wed	10	3	2	15				46	36	10	92	108	107	32	247			
10-Nov	Thu	3	1	0	4				40	38	12	90	114	104	39	257			
14-Nov	Mon	3	1	0	4	3	2	0	5	37	30	15	82	82	102	131	52	285	
15-Nov	Tue	5	3	0	8	8	4	3	15	50	37	7	94	101	102	106	34	242	
16-Nov	Wed	4	0	4	8	8	2	4	13	51	34	17	102	97	131	99	31	261	
17-Nov	Thu	3	3	0	6	3	2	0	5	54	38	10	102	105	132	112	44	288	
18-Nov	Fri	3	0	0	3	3	1	2	5	21	10	0	31	47	49	46	0	95	

**Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter.**

## **Strawberry smoothie:**

## Recorded data

Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter.

### **Cold Brew shake:-**

## Recorded data

Cold Bshake	Total	Time					Avg			Total drinks			Total Orders							
		Date	Day	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	Avg	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total
3-Nov	Th	11	14	2	27						62	50	10	122		115	80	27	222	
4-Nov	Fri	5	1	3	9						29	19	14	62		43	46	29	118	
7-Nov	Mon	6	12	3	21						32	44	5	81		109	128	31	268	
8-Nov	Tue	17	8	4	29						64	27	16	107		124	91	43	258	
9-Nov	Wed	5	10	2	17						46	36	10	92		108	107	32	247	
10-Nov	Thu	6	7	6	19						40	38	12	90		114	104	39	257	
14-Nov	Mon	7	6	4	17		7	9	4	19	37	30	15	82	82	102	131	52	285	27
15-Nov	Tue	10	6	3	19		18	11	5	34	50	37	7	94	101	102	106	34	242	25
16-Nov	Wed	8	13	1	22		8	13	2	23	51	34	17	102	97	131	99	31	261	25
17-Nov	Thu	13	10	5	28		10	10	4	25	54	38	10	102	105	123	112	44	288	25
18-Nov	Fri	6	4	0	10		6	3	2	10	21	10	0	31	47	49	46	0	95	10

**Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter.**

### **Cold brew shake - Caramel:-**

## Recorded data

Cold Bshake	Caramel	Time			Avg			Total drinks			Total Orders								
		Date	Day	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	Avg			
3-Nov	Th	3	5	1	9			62	50	10	122	115	80	27	222				
4-Nov	Fri	2	1	2	5			29	19	14	62	43	46	29	118				
7-Nov	Mon	3	1	2	6			32	44	5	81	109	128	31	268				
8-Nov	Tue	6	4	2	12			64	27	16	107	124	91	43	258				
9-Nov	Wed	2	3	1	6			46	36	10	92	108	107	32	247				
10-Nov	Thu	1	3	3	7			40	38	12	90	114	104	39	257				
14-Nov	Mon	3	4	1	8	3	3	2	7	37	30	15	82	82	102	131	52	285	27
15-Nov	Tue	2	2	1	5	6	4	2	12	50	37	7	94	101	102	106	34	242	25
16-Nov	Wed	4	5	0	9	4	5	1	9	51	34	17	102	97	131	99	31	261	25
17-Nov	Thu	5	1	1	7	3	3	2	8	54	38	10	102	105	132	112	44	288	26
18-Nov	Fri	3	2	0	5	3	2	1	5	21	10	0	31	47	49	46	0	95	10

**Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter**

## Cold brew shake - Vanilla: -

### Recorded data

Cold Bshake	Vanilla	Time				Avg			Total drinks			Total Orders							
		7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	Avg	7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	Avg
3-Nov	Th	5	3	1	9					62	50	10	122		115	80	27	222	
4-Nov	Fri	1	0	0	1					29	19	14	62		43	46	29	118	
7-Nov	Mon	3	5	1	9					32	44	5	81		109	128	31	268	
8-Nov	Tue	6	2	0	8					64	27	16	107		124	91	43	258	
9-Nov	Wed	0	2	0	2					46	36	10	92		108	107	32	247	
10-Nov	Thu	3	1	0	4					40	38	12	90		114	104	39	257	
14-Nov	Mon	1	0	1	2					37	30	15	82		102	131	52	285	
15-Nov	Tue	4	3	1	8					50	37	7	94		101	102	106	34	242
16-Nov	Wed	1	3	0	4					51	34	17	102		97	131	99	31	261
17-Nov	Thu	1	2	2	5					54	38	10	102		105	132	112	44	288
18-Nov	Fri	2	1	0	3					21	10	0	31		47	49	46	0	95

**Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter.**

Cold Bshake	Vanilla	Time				P(Coffee)			P(Coffee Drinks)										
		7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	Week Day	7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	Week Day				
3-Nov	Th	5	3	1	9	4.35%	3.75%	3.70%	4.05%		8.06%	6.00%	10.00%	7.38%					
4-Nov	Fri	1	0	0	1	2.33%	0.00%	0.00%	0.85%		3.45%	0.00%	0.00%	1.61%					
7-Nov	Mon	3	5	1	9	2.75%	3.91%	3.23%	3.36%		9.38%	11.36%	20.00%	11.11%					
8-Nov	Tue	6	2	0	8	4.84%	2.20%	0.00%	3.10%		9.38%	7.41%	0.00%	7.48%					
9-Nov	Wed	0	2	0	2	0.00%	1.87%	0.00%	0.81%		0.00%	5.56%	0.00%	2.17%					
10-Nov	Thu	3	1	0	4	2.63%	0.96%	0.00%	1.56%		7.50%	2.63%	0.00%	4.44%					
14-Nov	Mon	1	0	1	2	0.98%	0.00%	1.92%	0.70%	1.99%	2.70%	0.00%	6.67%	2.44%	6.75%				
15-Nov	Tue	4	3	1	8	3.92%	2.83%	2.94%	3.31%	4.20%	8.00%	8.11%	14.29%	8.51%	10.45%				
16-Nov	Wed	1	3	0	4	0.76%	3.03%	0.00%	1.53%	1.77%	1.96%	8.82%	0.00%	3.92%	4.64%				
17-Nov	Thu	1	2	2	5	0.76%	1.79%	4.55%	1.74%	2.35%	1.85%	5.26%	20.00%	4.90%	5.73%				
18-Nov	Fri	2	1	0	3	4.08%	2.17%	0.00%	3.16%	1.88%	9.52%	10.00%	0.00%	9.68%	4.30%				
Mean		2	2	1	5														
Sd		2	1	1	3														
Var		4	2	0	9														
Median		2	2	0	4														
Mode		1	3	0	9														

## Cold brew shake - Chocolate:-

### Recorded data

Cold Bshake	Chocolate	Time				Avg			Total drinks			Total Orders							
		7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	Avg	7 AM-11 AM	11 AM-2 PM	2 PM-5 PM	Total	Avg
3-Nov	Th	3	6	0	9					62	50	10	122		115	80	27	222	
4-Nov	Fri	2	0	1	3					29	19	14	62		43	46	29	118	
7-Nov	Mon	0	6	0	6					32	44	5	81		109	128	31	268	
8-Nov	Tue	5	2	2	9					64	27	16	107		124	91	43	258	
9-Nov	Wed	3	5	1	9					46	36	10	92		108	107	32	247	
10-Nov	Thu	2	3	3	8					40	38	12	90		114	104	39	257	
14-Nov	Mon	3	2	2	7					37	30	15	82		102	131	52	285	
15-Nov	Tue	4	1	1	6					50	37	7	94		101	102	106	34	242
16-Nov	Wed	3	5	1	9					51	34	17	102		97	131	99	31	261
17-Nov	Thu	7	7	2	16					54	38	10	102		105	132	112	44	288
18-Nov	Fri	1	1	0	2					21	10	0	31		47	49	46	0	95

**Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter.**

## **Classic Coffee:-**

## Recorded data

Classic Coffee		Time				Avg			Total drinks			Total Orders							
Date	Day	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	Avg	7 AM - 11 AM	11 AM - 2 PM	2 PM - 5 PM	Total	Avg
3-Nov	Th	15	6	0	21				62	50	10	122			115	80	27	222	
4-Nov	Fri	8	1	6	15				29	19	14	62			43	46	29	118	
7-Nov	Mon	8	2	1	11				32	44	5	81			109	128	31	268	
8-Nov	Tue	11	2	0	13				64	27	16	107			124	91	43	258	
9-Nov	Wed	11	4	2	17				46	36	10	92			108	107	52	247	
10-Nov	Thu	14	4	2	20				40	38	12	90			114	104	39	257	
14-Nov	Mon	12	2	2	16	10	2	2	14	37	30	15	82	82	102	131	52	285	27
15-Nov	Tue	9	2	0	11	15	3	1	19	50	37	7	94	101	102	106	34	242	25
16-Nov	Wed	5	2	3	10	10	4	3	16	51	34	17	102	97	131	99	31	261	25
17-Nov	Thu	9	1	0	10	13	4	1	17	54	38	10	102	105	132	112	44	288	25
18-Nov	Fri	1	0	0	1	5	1	3	8	21	10	0	31	47	49	46	0	95	10

Calculated conditional probability of cold brew shake being ordered given that the customer had decided to buy a drink at the drinks counter.

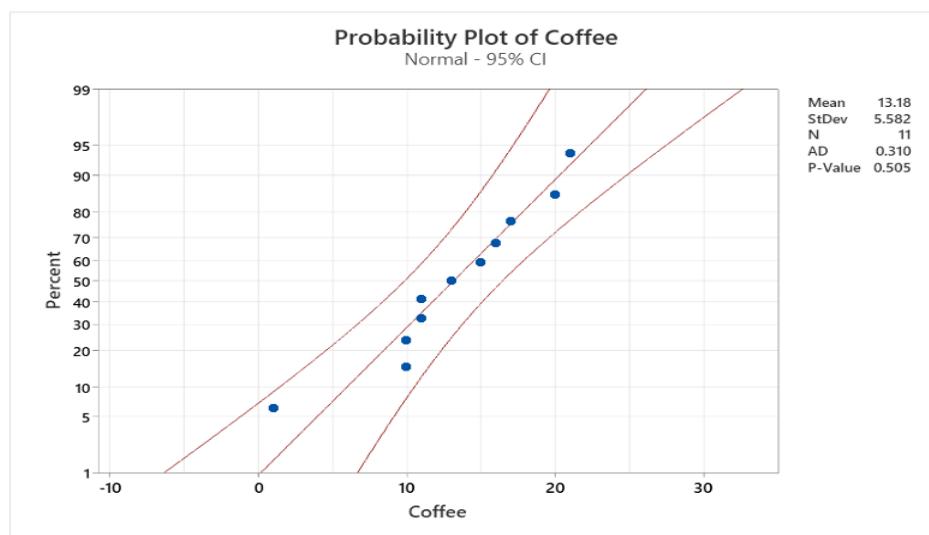
### **Normal distribution calculation:**

**Carried out tests to validate the alignment of the data of drink individually, to check if the data follow normality.**

#### **Check for Normality**

##### **1.) Hot Coffee:**

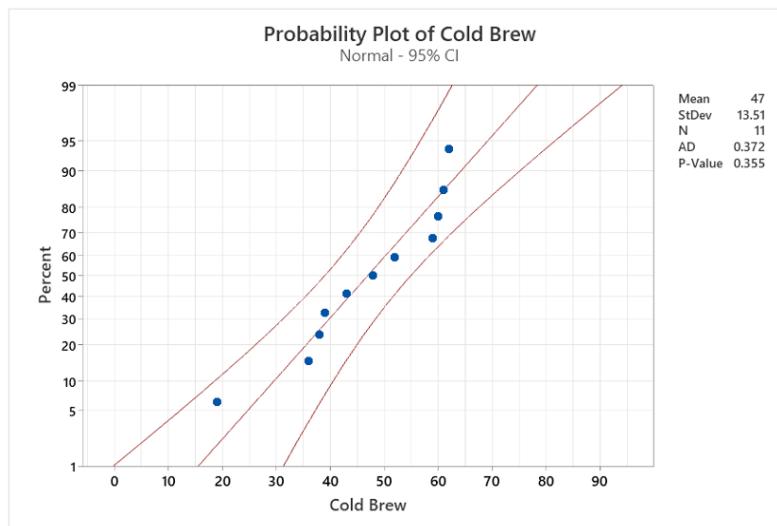
Date	Total Sales
3-Nov	21
4-Nov	15
7-Nov	11
8-Nov	13
9-Nov	17
10-Nov	20
14-Nov	16
15-Nov	11
16-Nov	10
17-Nov	10
18-Nov	1



The data of hot coffee is normally distributed within the 95% confidence interval. As per the above probability chart.

## 2) Cold Brew:

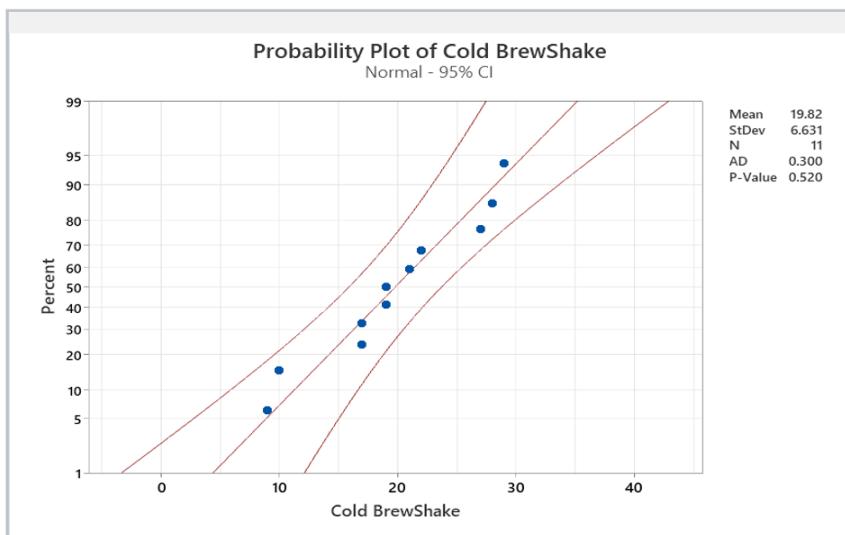
Date	Total Sales
3-Nov	61
4-Nov	36
7-Nov	38
8-Nov	60
9-Nov	52
10-Nov	43
14-Nov	39
15-Nov	48
16-Nov	62
17-Nov	59
18-Nov	19



The data of cold brew is normally distributed within 95% confidence interval. As per the above probability chart.

## 3) Cold Brew Shake:

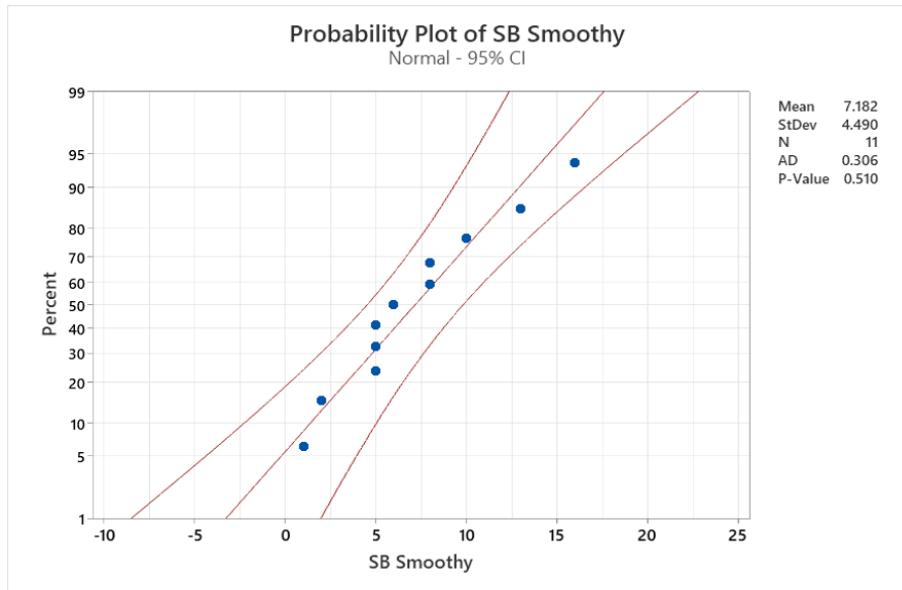
Date	Total Sales
3-Nov	27
4-Nov	9
7-Nov	21
8-Nov	29
9-Nov	17
10-Nov	19
14-Nov	17
15-Nov	19
16-Nov	22
17-Nov	28
18-Nov	10



The data of cold brew shake is normally distributed within 95% confidence interval. As per the above probability chart.

#### 4) Strawberry banana Smoothie:

Date	Total Sales
3-Nov	13
4-Nov	2
7-Nov	5
8-Nov	5
9-Nov	6
10-Nov	8
14-Nov	10
15-Nov	16
16-Nov	8
17-Nov	5
18-Nov	1



The data on Strawberry smoothie is normally distributed within 95% confidence interval. As per the above probability chart.

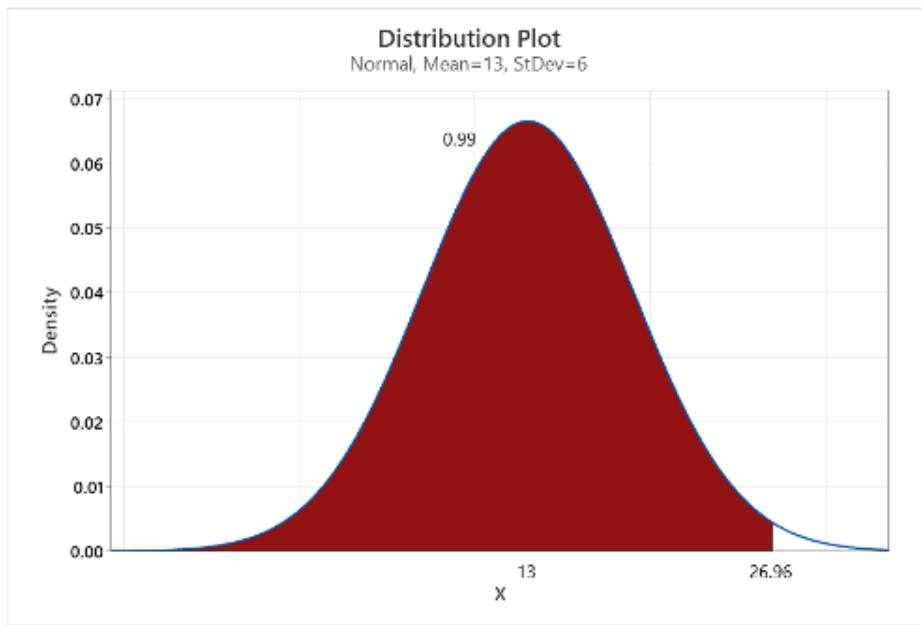
### **Hot coffee optimal production Qty:**

#### **Assumptions:**

- 1.) Required level of customer satisfaction – 99 percentiles.
- 2.) Iterations of coffee production per day – 1 / day.
- 3.) Leftover coffee is trashed hence accounted as loss to the business.
- 4.) Stockout of Coffee results into loss of sales.

The distribution plot was set-up based on the data and the assumptions using Minitab to gauge the optimal number/quantity of production required per day in order to satisfy Customers on percentile basis.

**Number of cup of coffees to be prepared to satisfy 99 percentiles of customers at least**



### **Findings:**

It was observed that making 27 cups of coffee each day would result into 99 percentile of customer satisfaction.

### **Suggestions:**

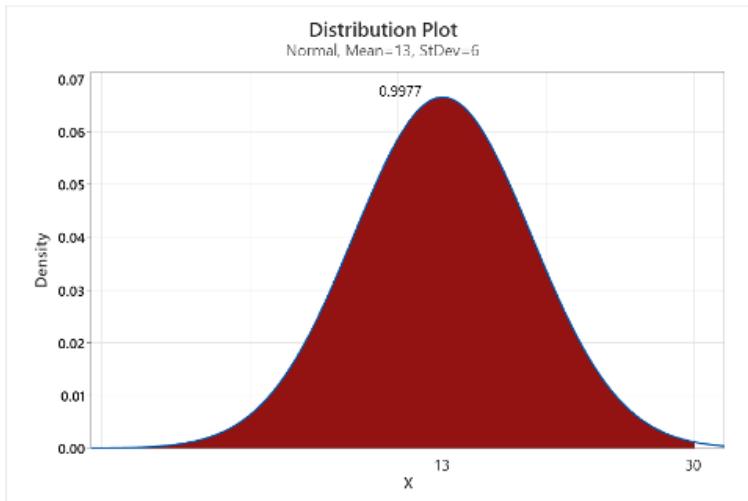
Make 3 or 4 more cups of coffee as fail safe just to support the unforeseen extra demand with minimal loss incurred.

## **INCREMENTAL and ITERATIVE ANALYSIS**

In order to understand the behavior of customer satisfaction level with respect to the quantum of Coffee being produced and suggest a better contingency quantum of production needed, the following iterations were performed.

### **case 1:**

#### **1.) N = 30 cups.**

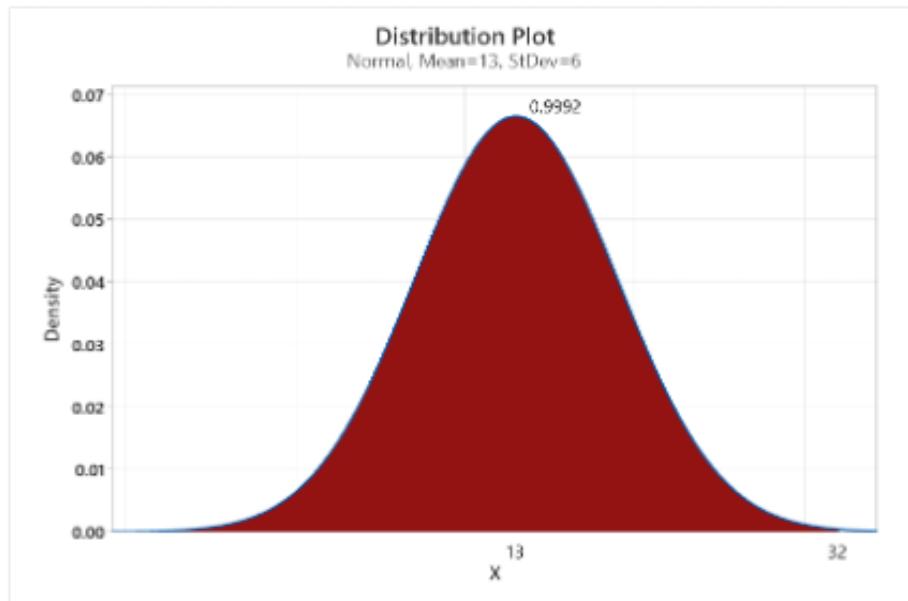


**Findings:**

- The customer satisfaction level raised to **99.77 percentile**
- In comparison to the suggested optimal quantity the increased quantity of production seemed to have improved the Customer satisfaction level by **0.77 percentile**.

**case 2:**

2) **N = 32 cups**

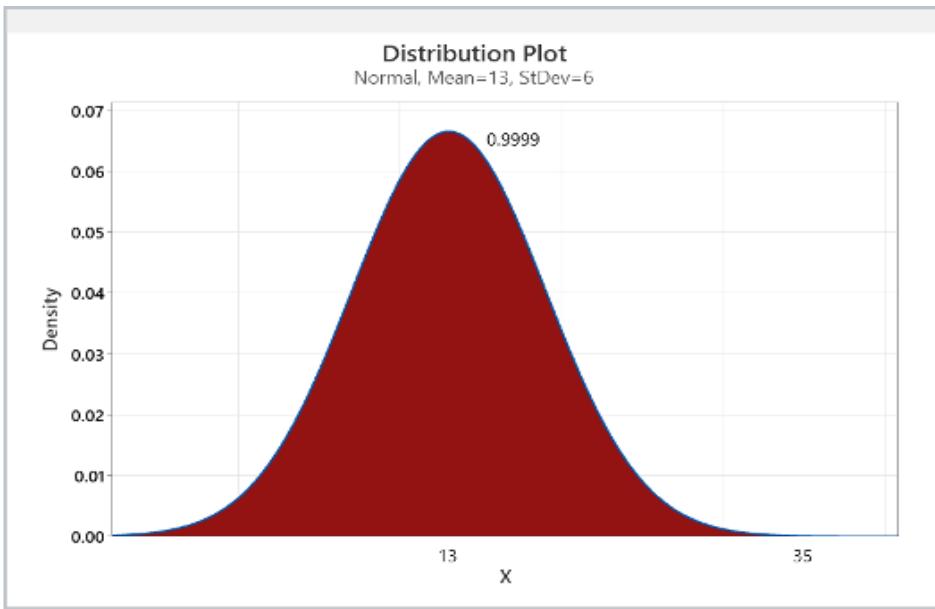


**Findings:**

- The customer satisfaction level raised to **99.92 percentile**
- In comparison to the suggested optimal quantity the increased quantity of production seemed to have improved the Customer satisfaction level by **0.92 percentile**.

**case 3**

3) **N = 35 cups**



### Findings:

- The customer satisfaction level raised to 99.99 percentile
- In comparison to the suggested optimal quantity the increased quantity of production seemed to have improved the Customer satisfaction level by 0.99 percentile .

### Suggestions:

Considering a surplus of 8 more quantities of coffees would serve as a better contingency plan instead of just 3 which was an obvious minimal quantum.

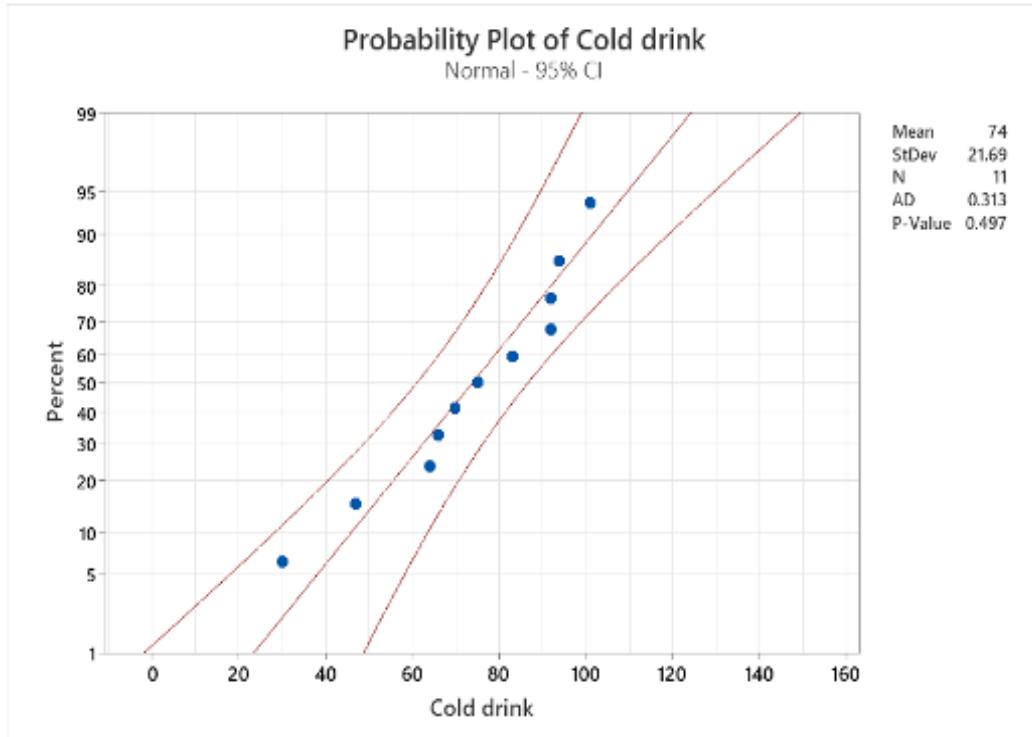
### Normality Check for Cold beverages (with Ice):

#### data:

Date	Cold Brew	Cold Brew Shake	Strawberry shake	Sum
3-Nov	61	27	13	101
4-Nov	36	9	2	47
7-Nov	38	21	5	64
8-Nov	60	29	5	94
9-Nov	52	17	6	75
10-Nov	43	19	8	70
14-Nov	39	17	10	66
15-Nov	48	19	16	83
16-Nov	62	22	8	92
17-Nov	59	28	5	92
18-Nov	19	10	1	30

<b>Mean</b>	<b>74</b>
<b>Standard Deviation</b>	<b>22</b>

The probability plot for the cold drinks was set up to verify its alignment with respect to normality.



### Findings:

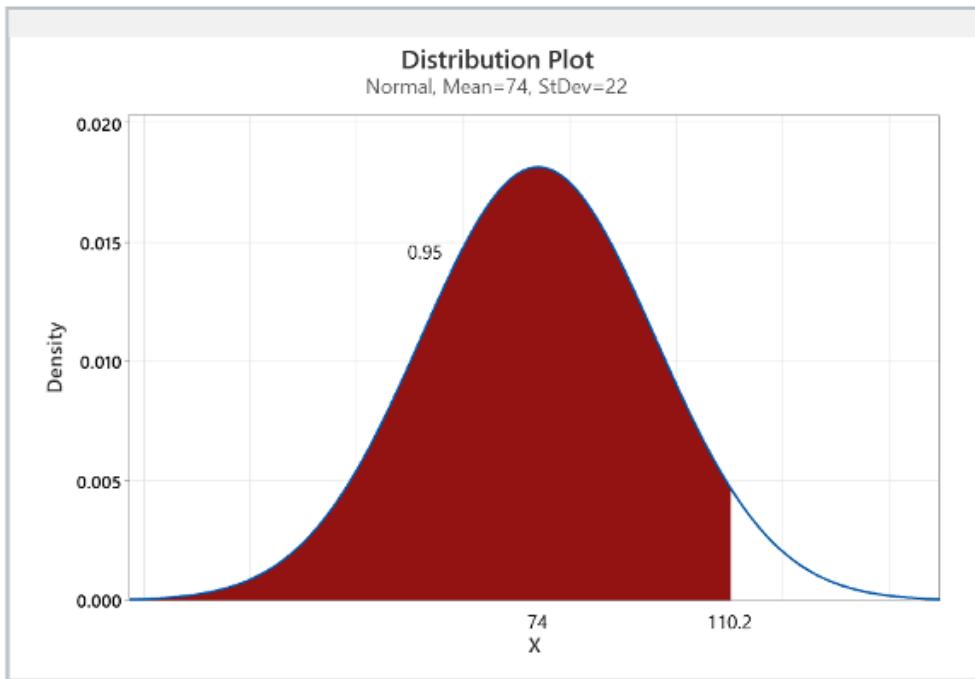
- It was observed that the data complied with normality and had distributed within a 95% confidence interval as per the above probability chart.

### Optimal Qty of Ice to be stocked/ day:

#### Assumptions:

- 1.) Required min level of customer satisfaction – 95percentiles
- 2.) Ice can be stocked per day depending on the flow
- 3.) Holding cost of ice is negligible.
- 4.) Each drink required the same amount of ice regardless of the size of the saleable cup. (Standard cup used for ice)
- 5.) Stockout of ice results in loss of sales

In order to understand number of cups of ice required to be stocked per day to satisfy 95 percentiles of customers at least the data was placed on the following distribution plot.



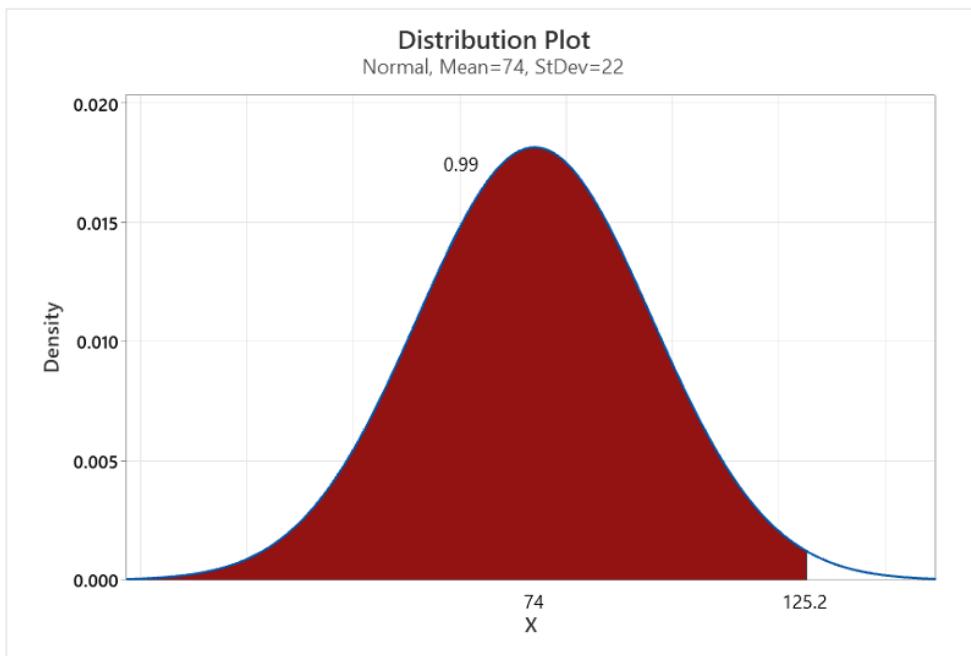
#### **Findings:**

- **It was observed that at least 110 cups of ice are required per day to have 95 percentiles of the customers served.**

#### **INCREMENTAL and ITERATIVE ANALYSIS**

To understand the behavior of customer satisfaction level with respect to the quantum of ice being stocked and suggest a better contingency quantum of Stock up needed , the following iteration were performed.

#### **To reach a customer serving of 99 percentiles:**



**Findings:**

- **It was observed that at least 125 cups of ice are required per day to have 99 percentiles of the customers served.**

## **Conclusion:**

### **1.) Probability and Conditional probability:**

- The conditional probity of drinks for each weekday, clearly show us that the probability of getting orders of Cold brew is the highest, simply indicating it as the hot selling drink.
- The average of probabilities of each week day for a customer ordering a drink is ranging between 40-45%, which mean 55-60% of orders do not consist of drinks. These 55-60% of orders only pertain to bagels, whilst some part of the 40-45% of orders of drink include bagels.
- In addition to the above point, since the store has two major segments viz. Drinks and Bagels. This result establishes the fact that the major selling commodity at Einstein bros is bagels.

### **2.) Optimal production of hot coffee:**

- To cater to 99.99 percentile of customer orders for hot coffee, Einstein bros store need to produce not more than 35 cups of hot coffee.

### **3.) Optimal Storage of Ice:**

- To cater to 99 percentile of customer orders for iced drinks, Einstein bros store need to stock not more than 125 cups of ice per day.

## **Shortcomings and Suggested improvements:**

- 1.) The data collected is only for 2 weeks, giving the average of only 2 samples for each week day.
- 2.) The Optimal quantity of hot coffee and ice are calculated on weekly average, these can be further improved by calculating the same for each week day. As there is a seasonal pattern with respect to weekdays. Which can clearly be identified from the conditional probabilities for drinks.
- 3.) To perform the same calculation for Ice and hot coffee with respect to respective week day we need data for at least few more weeks.
- 4.) The data collect was for drinks and in the season of winter, drink consumption ratio is bound to change subjected to change in seasons and weather. This is as per the experience of the store manager. Hence, these results will not hold good when there is a change in season or weather.

**References used:**

<https://corporatefinanceinstitute.com/resources/data-science/normal-distribution/>

<https://www.investopedia.com/terms/n/normaldistribution.asp>

**DOUGLAS C. MONTGOMERY- Applied Statistics and Probability for Engineers**

**REFERENCES TO RELATE**



**TUMBLER USED FOR ICE -16(oz).**



## **SIZE OF THE ICE FOR REFERENCE**



**The two sizes of cups being used by the business entity**

- **Small size cup - 532 ml**
- **Large size cup - 710 ml**

## RAW DATA

Item	DATE	3/11/22				4/11/22			
		DAY	TIME	7AM - 11AM	11AM - 2PM	2PM - 5PM	7AM - 11 AM	11AM - 2PM	2PM - 5PM
1 Classic coffee									
2 C.B									
3 CLS									
4 CR									
5 V									
6 Ch									
7 CBS									
8 CR									
9 V									
10 Ch									
11 SB Shake									
12 SB									
Total orders				115	80	26+1	103 43	46	29

Date	7 NOV 2022		
Day	MONDAY		
Time	7 am - 11 am	11 am - 2 pm	2pm - 5pm
Slot	Morning	Afternoon	Evening
Sr. no.			
<b>Hot Bevrg</b>			
1 Classic Coffee			
<b>Cold Brews</b>			
2 Classic CB			
3 Caramel CB			
4 VanillaCB			
5 Chocolate CB			
<b>Shakes - Cold Brew</b>			
6 Caramel CBS			
7 VanillaCBS			
8 Chocolate CBS			
<b>Strawberry Banana</b>			
9 SB Smoothy			
Total	109	128	31
Total Orders (Inclusive of all items i.e bagles, water, retail items etc)			

8 Nov 2022					
Date	11/08/2022				
Day	Tuesday				
Time	7 am - 11 am				
Slot	Morning				
Sr. no.	Hot Bevrg				
1	Classic Coffee				
Cold Brews					
2	Classic CB				
3	Caramel CB				
4	VanillaCB				
5	Chocolate CB				
Shakes - Cold Brew					
6	Caramel CBS				
7	VanillaCBS				
8	Chocolate CBS				
Strawberry Banana					
9	SB Smoothy				
Total Orders (Inclusive of all items i.e bagles, water, retail items etc)					
10	Total	124	91	43	

9 Nov 2022					
Date	9/11/2022				
Day	wed				
Time	7 am - 11 am				
Slot	Morning				
Sr. no.	Hot Bevrg				
1	Classic Coffee				
Cold Brews					
2	Classic CB				
3	Caramel CB				
4	VanillaCB				
5	Chocolate CB				
Shakes - Cold Brew					
6	Caramel CBS				
7	VanillaCBS				
8	Chocolate CBS				
Strawberry Banana					
9	SB Smoothy				
Total Orders (Inclusive of all items i.e bagles, water, retail items etc)					
10	Total	108	108	107	32
8 Nov					
7 Nov					

Date	10 nov		
Day	Thu		
Time	7 am - 11 am	11 am - 2 pm	2pm - 5pm
Slot	Morning	Afternoon	Evening
Sr. no		Hot Bevrg	
1 Classic Coffee	/		/
		Cold Brews	
2 Classic CB	/		/
3 Caramel CB	/		/
4 VanillaCB			/
5 Chocolate CB			
		Shakes - Cold Brew	
6 Caramel CBS	/		/
7 VanillaCBS	/		
8 Chocolate CBS	/		/
		Strawberry Banana	
9 SB Smoothy			
		Total Orders (Inclusive of all items i.e bagles, water, retail items etc)	
10 Total	117	104	$\frac{35}{3.318m} + 4 = 39$

9th nov → 32

Date	10.11 NOV		
Day			
Time	7 am - 11 am	11 am - 2 pm	2pm - 5pm
Slot	Morning	Afternoon	Evening
Sr. no		Hot Bevrg	
1 Classic Coffee	/		/
		Cold Brews	
2 Classic CB	/		/
3 Caramel CB	/		/
4 VanillaCB			/
5 Chocolate CB			
		Shakes - Cold Brew	
6 Caramel CBS			/
7 VanillaCBS			/
8 Chocolate CBS	( )		/
		Strawberry Banana	
9 SB Smoothy			
		Total Orders (Inclusive of all items i.e bagles, water, retail items etc)	
10 Total	37	30	15

102      131      52

	Date	16 Nov		
	Day			
	Time	7 am - 11 am	11 am - 2 pm	2pm - 5pm
Sr. no.	Slot	Morning	Afternoon	Evening
Hot Bevrg				
1	Classic Coffee			
Cold Brews				
2	Classic CB			
3	Caramel CB			
4	VanillaCB			
5	Chocolate CB			
Shakes - Cold Brew				
6	Caramel CBS			
7	VanillaCBS			
8	Chocolate CBS			
Strawberry Banana				
9	SB Smoothy			
Total Orders (Inclusive of all items i.e bagles, water, retail items etc)				
10 Total		131	99	31

	Date	17 <sup>th</sup> NOV 22		
	Day			
	Time	7 am - 11 am	11 am - 2 pm	2pm - 5pm
Sr. no.	Slot	Morning	Afternoon	Evening
Hot Bevrg				
1	Classic Coffee			
Cold Brews				
2	Classic CB			
3	Caramel CB			
4	VanillaCB			
5	Chocolate CB			
Shakes - Cold Brew				
6	Caramel CBS			
7	VanillaCBS			
8	Chocolate CBS			
Strawberry Banana				
9	SB Smoothy	(		
Total Orders (Inclusive of all items i.e bagles, water, retail items etc)				
10 Total		132	112	$32 + 11 = 43 + 1$ 2-23pm +1 44 =